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NUCLEAR ENERGY AGENCY
COMMITTEE ON NUCLEAR REGULATORY ACTIVITIES

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WORKING GROUP ON INSPECTION PRACTICES (WGIP)

INSPECTION OF MAINTENANCE ON SAFETY SYSTEMS DURING NPP OPERATION

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OECD / NEA
Committee on Regulatory Activities (CNRA)
Working Group on Inspection Practices (WGIP)

Inspection of Maintenance on Safety systems during NPP operation

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The mission of the NEA is:

- to assist its Member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for a safe, environmentally friendly and economical use of nuclear energy for peaceful purposes, as well as
- to provide authoritative assessments and to forge common understandings on key issues, as input to government decisions on nuclear energy policy and to broader OECD policy analyses in areas such as energy and sustainable development.

Specific areas of competence of the NEA include safety and regulation of nuclear activities, radioactive waste management, radiological protection, nuclear science, economic and technical analyses of the nuclear fuel cycle, nuclear law and liability, and public information. The NEA Data Bank provides nuclear data and computer program services for participating countries.

In these and related tasks, the NEA works in close collaboration with the International Atomic Energy Agency in Vienna, with which it has a Co-operation Agreement, as well as with other international organisations in the nuclear field.

COMMITTEE ON NUCLEAR REGULATORY ACTIVITIES

The Committee on Nuclear Regulatory Activities (CNRA) of the OECD Nuclear Energy Agency (NEA) is an international committee made up primarily of senior nuclear regulators. It was set up in 1989 as a forum for the exchange of information and experience among regulatory organisations and for the review of developments which could affect regulatory requirements.

The Committee is responsible for the programme of the NEA, concerning the regulation, licensing and inspection of nuclear installations. The Committee reviews developments which could affect regulatory requirements with the objective of providing members with an understanding of the motivation for new regulatory requirements under consideration and an opportunity to offer suggestions that might improve them or avoid disparities among Member Countries. In particular, the Committee reviews current practices and operating experience.

The Committee focuses primarily on power reactors and other nuclear installations currently being built and operated. It also may consider the regulatory implications of new designs of power reactors and other types of nuclear installations.

In implementing its programme, CNRA establishes co-operative mechanisms with NEA's Committee on the Safety of Nuclear Installations (CSNI), responsible for co-ordinating the activities of the Agency concerning the technical aspects of design, construction and operation of nuclear installations insofar as they affect the safety of such installations. It also co-operates with NEA's Committee on Radiation Protection and Public Health (CRPPH) and NEA's Radioactive Waste Management Committee (RWMC) on matters of common interest.

ABSTRACT

From the view of the NPP operator (licensee) the effectiveness of electricity generation and the availability of the plant can be improved by shortening outage duration. The regulatory inspection authorities throughout the world are facing such ideas and have to consider their possible effects on safety.

With the increasing economic pressures being faced and the potential for shortening outage times, this report looks at how inspection authorities in the NEA Member countries evaluate the way licensees perform maintenance on plant safety systems during plant operation. Commendable practices (not international standards or guidelines) are identified.

FOREWORD

The NEA Committee on Nuclear Regulatory Activities (CNRA) believes that an essential factor in ensuring the safety of nuclear installations is the continuing exchange and analysis of technical information and data. To facilitate this exchange the Committee has established Working Groups and Groups of Experts in specialised topics. The Working Group on Inspection Practices (WGIP) was formed in 1990 with the mandate "... to concentrate on the conduct of inspections and how the effectiveness of inspections could be evaluated...".

Based on a proposal made by the Japanese delegation, WGIP with the approval of CNRA began a task on the Inspection of Maintenance on Safety Systems during Operation of NPPs is 1999. Response to a survey provided information on the way NEA Member countries inspect licensees during this process. The report compiles the responses and provides analysis of the results. The report also provides conclusions and commendable practices.

The commendable practices are not international standards nor guidelines. Inspection practices should be determined by each country, considering its regulatory environment and practices as well as its social and cultural backgrounds. Commendable practices can be useful reference when each country improves its inspection practices.

In offering thanks to the members of WGIP who provided valuable time and considerable efforts towards the production of this report, the NEA Secretariat also wishes to acknowledge the special work of several key persons. Mr. Hiroyoshi Koizumi of JAPEIC in Japan and Dr. Hartmut Klonk of BfS in Germany provided much of the analysis provided in the report and many hours in editing and compiling the final report.

The members of WGIP who participated in providing input for the report were Dr. Jean-Jacques Van Binnebeek and Mr. André Vandewalle AVN, Belgium, Mr. François Rinfret and Dr. John D. Detorakis, CNSC, Canada, Mr. Pavel Pittermann and Mr. Radomir Rehacek, SONS, Czech Republic, Ms. Seija Suksi, STUK, Finland, Mr. Yves Balloffet, DRIRE, France, Mr. Gyula Fichtinger, HAEA, Hungary, Mr. Yoshihiro Nishiwaki, METI, Japan, Mr. Luis Miguel Gutierrez Ruiz, CNSNS, Mexico, Mr. Evert C. Des Bouvrie, MINVROM, Netherlands, Mr. Jesus Gil CSN, Spain, Mr. Staffan Forsberg, SKI, Sweden, Dr. Friedrich Kaufmann, HSK, Switzerland, Mr. John Lyndon Summers, NII, United Kingdom, Mr. Douglas Coe, Mr. William Dean and Mr. Michael Johnson, NRC, United States.

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1. INTRODUCTION

From the view of the NPP operator (licensee) the effectiveness of electricity generation and the availability of the plant can be improved by shortening outage duration. The regulatory inspection authorities throughout the world are facing such ideas and have to consider their possible effects on safety.

The duration of outages for fuel exchange in light water reactors is determined not only by the fuel exchange operations themselves but also by the conduct of preventive maintenance tasks, tests and inspections on safety systems. In the past, many of these preventive maintenance tasks and tests have been restricted for deterministic safety reasons to be performed only during shut-down of the NPP. Tests and their results are reviewed by the inspection authority, in some countries these tests are witnessed by the regulatory inspectors or even performed by themselves.

On technical reasons alone a substantial part of these preventive maintenance and test activities indeed do not require the shut-down state of the reactor. This offers a potential to shorten the outage time by shifting such work to the operating phase of the plant. In some countries these approaches are summarised under the term of “on-line-maintenance”. Within this report, this approach is called “preventive maintenance during operation – PMO”.

When the outage duration of a NPP is shortened by such approaches, the safety level of the plant should not be jeopardised. This is to be verified by the inspection authority.

For example, preventive maintenance on components of safety systems, which are designed based on redundancy and installed as three (3 x 100%) or four (4 x 50%) lines, could be shifted to during operation provided that there is still sufficient redundancy available to cope with accidents.

2. QUESTIONNAIRE AND EXAMPLES OF KEY POINTS

To grasp the contents of the subject appropriately, a questionnaire was set up and examples of key points were listed.

1. What is your national policy for allowing performance of preventive maintenance and testing of safety systems during operation of the reactor?

   - Existing rules and regulations for preventive maintenance and testing of safety systems during operation of reactor
   - Plans for future rules and regulations

2. Is it expected that the licensees will further apply to perform preventive maintenance and testing during operation when such activities were previously performed during outages? If yes, give examples.

   - relevant safety systems
   - relevant safety related systems

3. By what means is the safety level of the plant evaluated if individual trains of redundant safety systems are taken out of service?

   - Who evaluates this safety?
   - How is it evaluated?
   - Review by the inspection authority?

4. Are there deterministic and/or probabilistic requirements to be fulfilled and to be presented to the inspection authority for approval?

   - Kind of calculation

5. Are maximum time spans specified for taking individual trains of safety systems out of service?

If yes, give examples: name of train, maximum time span

6. Is there a regulatory procedure for inspection of licensee's performance of preventive maintenance and testing during operation?

   - describe procedure, give example

7. How does the regulatory inspection authority verify that all tests on safety systems and components are performed as required?

   - Kind of inspection
   - reporting by licensee

8. Is there any difference on preventive maintenance methods and testing between performing during outage and during operation? If yes, give examples:

   - systems, components, difference of tests, test condition and test methods

9. Are there other safety requirements, regulatory practices and inspection activities related to this subject?

10. Is this problem a major issue in your country and how is it dealt with by the regulatory body?

    - plans of licensees
    - approaches of the regulatory body
    - future developments
    - status of discussion.

Fifteen countries answered these questions. Their contributions are presented in full length in Annex 1. The given answers are reviewed and discussed in the following chapter. An abstract of the answers is summarised in tabular form.

Chapter 5 presents “Commendable practices” resulting from the described national inspection practices.

3. COMPILATION AND REVIEW OF ANSWERS

For presentation of similarities and differences in the individual national approaches the most important facts of the given answers are summarised in Table 1.

A review of the presented contributions and the answers is given below.

3.1 National policy for preventive maintenance during operation

In most countries preventive maintenance of safety systems during reactor operation (PMO) is based on a concept of maximum accepted unavailability time spans for systems and components important to safety. In most countries the regulatory bodies allow licensees to have an internal rule of maximum unavailability time spans. Generally, this is part of the Technical Specifications and hence part of the license. However, most regulatory bodies do not have their own specific rule except Finland, Germany, Spain and US.

The degree of redundancy and the number of redundant trains of the safety system are one of the key items which determine the possibility of performing preventive maintenance during power operation.

In Germany, the regulatory bodies licensed PMO on the basis of a recommendation by the Reactor Safety Commission (RSK). The US have a maintenance rule (10CFR 50.65). Spain has established the rule based on the US-Rule 10CFR 50.65.

In Germany, RSK established the recommendation concerning preventive maintenance activities during operation (PMO), which describes the allowable maintenance and test conditions related to the degree of redundancy. For example, PMO is allowed only for one train out of n+2 trains of stand-by safety systems such as residual-heat removal chain, and PMO is only allowed during undisturbed normal operation. All NPPs are designed with three (3x100%) or four (4x50%) trains enabling to conduct preventive maintenance on these systems during operation.

In France, the licensee will propose a strategy based on the NPP-design of four trains of safety systems (4x50%). The principle has been accepted by the French authorities.

In Belgium, the regulatory body does in principle not accept the licensee to perform PMO. However, exemptions are allowed for safety systems with abundant redundancy, for PM activities with small intervals as required by the maintenance instructions and for PM of second level protection systems. In Canada, the CANDU system is designed with 4 special safety systems which are independent from process systems and from each other. Each system has triplicate independent channels for each parameter and function, and operates on 2 out of 3 principle. Canadian policy is the allowable unavailability of a special safety system during the year.

In Finland, Guide YVL 1.8 describes how the Radiation and Nuclear Safety Authority regulates the repairs, modifications and preventive maintenance of systems, components and structures at nuclear facilities during operation. Guide YVL 5.5 is for electrical and instrumentation equipment, and Guide YVL7.11 is for Radiation measuring systems.

In the US and in Spain, licensees are permitted to perform maintenance and testing during operation of reactor after they perform a risk assessment, providing they manage the increase in risk that may result from the proposed activities.

In Mexico, at this moment there is no PMO activity, however the regulatory body requires the licensee to develop the maintenance rule according to 10CFR 50.65. Also in the Czech Republic there is no PMO activity. Preventive maintenance and periodical testing is defined in the plants Limits and Conditions.

In Switzerland, there are two NPPs applying PMO. One NPP undertakes PMO at two systems per year, the Special Emergency and Heat Removal System and the Residual Heat Removal System at different times. Preventive maintenance during outage is done for the High and Low Pressure Core Spray Systems. Another NPP has four trains of safety injection and core cooling. PMO at these trains are undertaken once per year at different times.

3.2 Licensee's plans to further apply to perform maintenance during operation

In most countries, licensees wish that more preventive maintenance and testing currently performed during outage could be shifted to during operation. Especially, licensees in Mexico, Spain, UK and US have such plans for applying for PMO. In Sweden licensees are expected to perform more online testing and preventive maintenance at power after finalising ongoing modernisation and upgrading of nuclear plants. The CANDU-Reactors in Canada, however, are of a unique design to allow maintenance during operation due to its special redundancy, so that no additional requests from licensee are necessary.

In Belgium, there is no intention of the licensee to shift preventive maintenance to power operation, but they will accomplish the shortening of the outage duration by another way, such as improving the preparation and organisation of the outage and modifying some maintenance methods.

The only PWR in the UK has four trains in each safety related system and the questionnaire response is limited to this one reactor. The licensee's future proposal is expected to justify short periods of operation with three trains operable.

In the US, the licensees will perform increasing amounts of preventive maintenance and testing at power. They may apply for relief from technical specifications that currently prohibit certain maintenance activities at power.

3.3 Safety evaluation

In general, the licensee has the responsibility to comply with the Technical Specification (TS), which describes the rule in case of deviation from normal condition. The regulatory body in most countries assesses and reviews the TS and carries out inspections to confirm the compliance of the TS by the licensee.

In Belgium, in some few cases the licensee asks for approval by the regulatory body of a deviation to the TS to perform PMO. Such requests need always to be justified on a safety point of view. Acceptance by the RB is based mainly on engineering judgement. In France, if there is disagreement between the regulatory body and the licensee, they discuss with each other intensively. Should they not reach consensus, the regulatory body instructs the licensee to be more conservative. The licensee shall report to the regulatory body whenever the specific unavailability time for specific safety related system is exceeded by 25%.

In Germany, the licensees establish the TS for PMO in accordance with the above mentioned RSK recommendation. All safety evaluations are reviewed and approved by the regulatory body with support by Technical Inspection Agency TUV.

In the Netherlands, when the licensee wants to do preventive maintenance on a specific safety system not covered by the TS in this respect, the licensee must show the effect of the maintenance on the core melt frequency before approval of that maintenance can be obtained.

3.4 Deterministic and/or probabilistic requirements

To perform PMO, the licensee is required to present individual plant examination and safety review for approval by the regulatory body. Both deterministic and probabilistic safety reviews are used in most countries. The single failure criterion may no longer be met during the time one of the redundant safety system trains is taken out for maintenance.

3.5 Maximum unavailability time spans

In every country the licensee establishes the Technical Specification, in which maximum unavailability time spans are specified for safety related systems and components. If these time spans are exceeded the reactor has to be shut down. Within this framework of unavailability time spans the TS may also specify requirements for temporarily taking individual trains of safety systems out of service for maintenance purposes. (Not applicable for safety trains in Canadian reactors.)

In Hungary, for example, one train (out of three) of the electrical safety supply is allowed to be out of service for maximum 24 hours provided that the availability of the other two trains is certified.

In Finland, the licensees assess the safety of maximum unavailability time spans by PSA. The regulatory body does not require PSA calculation. In Spain, one NPP, for example, performs PMO only in those systems that the allowable outage time is at least 72 hours. Additionally, the actual maximum unavailability time span is only 60% of that defined in Technical Specification.

3.6 Regulatory procedure

A special regulatory procedure for defining PMO approaches seems not to be necessary in about two third of countries. There is an Internal Guide in the QA-manual of the regulatory body in Finland, in Spain this is contained in the Inspection Manual. The USNRC has recently established “The Reactor Oversight Program”, which takes care of inspection of preventive maintenance. In Germany, PMO approaches are licensed and inspected based on the mentioned recommendation of the RSK. In Spain, the regulatory body has the procedure PT.IV.24 “Inspection of the fulfilment of the Maintenance Rule”. This procedure is at this moment under revision to establish a clearer checklist and to state specific verifications about preventive maintenance and testing during operation.

3.7 Methods of verification for licensee’s performance

In most countries the regulatory body inspects preventive maintenance within the scope of the normal inspection programme. There are different types of inspection in each country. The regulatory bodies either carry out inspections and tests or monitor licensees results to verify that all tests on safety systems and components are performed as required.

In Finland, resident inspectors follow the tests done by licensee in such a manner as they attend some important tests (primary circuit tightness test, tests of safety valves and so on).

In the Netherlands, the licensee sends the monthly report to the regulatory body, in which the influence on the increase of the core melt frequency is described.

In Germany, experts of the Technical Inspection Agency are on the site on behalf of the regulatory body, and inspect safety relevant activities of the licensees.

In Spain, the licensee submits to the regulatory body an annual program with previsions of activities related to PMO. After the approval by the regulatory body, the adequacy of the activities carried out is verified both by routine scrutiny by resident inspectors and by specific inspection from headquarters inspectors on sampling basis.

In the US, under the new Reactor Oversight Process, resident inspectors review licensee activities in this area on a routine sampling basis. These activities are also reviewed in more depth by region-based inspections on periodic basis.

3.8 Difference of maintenance/testing methods between during outage and during operation

All countries answered that there are basically no essential differences of maintenance and testing methods between performing during outage and during operation. It is obvious that some tests cannot be performed during power operation. There are, of course, differences of test conditions in performing at power or during outage, such as temperature, pressure, and media contents regarding the operated systems.

In France, the principal difference is in the re-qualification of the system after maintenance. The licensee has to make sure that he will be able to demonstrate the operability of the system within the unavailability time limit of the technical specification.

In the US, some tests simply are not performed at power. Others are limited such as routine testing of Emergency Diesel Generators, which are limited to manual starting and loading.

3.9 Other safety requirements

Concerning inspection during operation, no other safety requirements were given in the answers.

3.10 Is this problem a major issue?

This is not a major issue yet, but in most countries the licensees are interested in performing preventive maintenance during operation in order to minimise outage time.

In Sweden, after ongoing modernisation and upgrading of nuclear plants, it is expected that licensees will perform more online testing and more preventive maintenance at power.

PMO is current practice at German NPPs.

In Spain, this is not a major problem. However, licensees are trying to have allowable time span for unavailability longer than currently specified in new technical specifications using probabilistic methods for justification. Discussion between the regulatory body and the licensees are ongoing in this issue with regards to the application of PSA results in each plant.

In the US, historically this has not been a major problem. However, under the deregulation of the electricity markets, utilities are forced to become more competitive. As a consequence, licensees are motivated to perform an increasing amount of maintenance and testing at power in order to minimise outage time.

4. CONCLUSION

1. In most countries, PMO is being carried out by the licensees according to plant specific Technical Specifications, which were approved by the regulatory body.
2. The regulatory bodies in Finland, Germany, Spain and US have special rules for PMO.
3. In every country, the maximum unavailability time spans for systems and components are specified in the TS.
4. To determine the maximum unavailability time span, most countries use deterministic and probabilistic analysis.
5. The regulatory bodies in most countries verify the results of PMO by routine base inspection.
6. In most countries, the PMO is not a current topic, however, under the conditions of deregulated electricity markets licensees are motivated to perform an increasing amount of PMO in order to minimise outage times.

5. COMMENDABLE PRACTICES

From the review of the country contributions within the previous chapters related to individual national approaches four commendable practices have been identified. They were discussed, commented and finally agreed by the members of the Working Group on Inspection Practices (WGIP).

The commendable practices are not international standards nor guidelines. Inspection practices should be determined by each country, considering its regulatory environment and practices as well as its social and cultural backgrounds. Commendable practices can be useful reference when each country improves its inspection practices.

The identified commendable practices are based on those regulatory practices that are already in use in order to give advice for further enhancement of the safety of nuclear power plants and their regulatory control.

1. The regulatory body requires licensees to perform safety review incorporating probabilistic analysis or both deterministic and probabilistic analysis before and during preventive maintenance during operation.
2. The regulatory inspection body inspects the maintenance plan presented by the operator and reviews the safety evaluation in regard to the implications of preventive maintenance to be performed during normal power operation of the NPP.
3. Provisions of the Technical Specifications, such as maximum allowable unavailability time spans for safety systems or components are reviewed by the regulatory inspection body. Both deterministic and probabilistic methods are tools to evaluate maximum allowable unavailability time spans for preventive maintenance during operation.
4. The regulatory inspection body verifies the results of preventive maintenance during operation by routine base inspection.
5. The possible influence on the safety of the NPP by performing preventive maintenance and functional tests during operation is regarded as an important item to be included in the regulator's inspection programme. It may become a future challenge arising from competition regarding the deregulated electricity market.

Tabulated abstracts of National Contributions

	Question	Belgium	Canada	Czech Republic	Finland	France
1	National policy for inspection during operation	In principle, PMO is not allowed	Allow unavailability of Safety System	Maintenance and periodical testing programme is part if Limits and Conditions, approved by RB	PMO is allowed only by a special permission of the regulatory body. Maximum unavailability time in the TS is not allowed to be used in PMO.	No specific rule. Allow the licensee to use Maximum Unavailable time in the TS.
2	Licensee's plan to further apply to maintenance during operation	No, Licensee accomplishes shortening of outage by another way.	No	No	No, Licensee carries out preventive maintenance during operation already so extensive.	Licensee provides a risk analysis.
3	Safety evaluation	No specific evaluation. The licensee has the responsibility to respect the TS.	Licensee evaluates TS, and regulatory body approves it.	Licensee evaluates, regulatory body approves in special cases	Licensee evaluates TS, and regulatory body approves it.	Licensee evaluates TS, and regulatory body approves it.
4	Deterministic and/or probabilistic requirements	See answers to Q1 and Q3.	Deterministic and probabilistic requirements	Request for exception of limits and conditions mainly by probabilistic calculation	Preventive maintenance in TS is based on deterministic requirement and probabilistic analysis	Deterministic and probabilistic analysis by licensee
5	Maximum unavailable time span	In the TS.	In the TS. Not applicable for trains	Defined in Limits and Conditions	Based on probabilistic analysis.	In the TS.
6	Regulatory procedure	None	None	Regulatory inspection of periodical testing	No written regulatory procedure, but there is an internal guide in the QA manual of RB.	None Surveillance program
7	Methods of verification for licensee's performance	Inspection programme, including review of documents	System routine testing	Regular (daily) inspections by site inspector	Resident inspectors carry out weekly inspections.	Periodic tests
8	Difference of maintenance/testing methods	None	None	None	None. But practically there are differences in test condition.	Re-qualification of system after maintenance; during outage
9	Other safety requirements	None	Maximum unavailability list is consulted	None	None	None
10	Is this problem a major issue?	No	No	Not at present	No	No

TS: Technical Specification

Tabulated abstracts of National Contributions

	Question	Germany	Hungary	Japan	Mexico	Netherlands
1	National policy for inspection during operation	RSK gave a recommendation, which allows preventive maintenance during operation (PMO).	No specific rule. Allow the licensee to use Maximum Unavailable time in the TS.	Not allowed practising regulatory periodical inspection during operation in principle. Allow the licensee to use Maximum Unavailable time in the TS	No specific rule. Allow the licensee to use Maximum Unavailable time in the TS.	No specific rule. Allow the licensee to use Maximum Unavailable time in the TS.
2	Licensee's plan to further apply to maintenance during operation	PMO recommendation defines the condition in detail, where licensee can perform PMO. PMO is common practice. No further license application.	---	Licensees are now studying the application.	It is expected that Licensee transfer preventive maintenance and tests from outages to power operation.	Licensee's requests were already adopted in TS.
3	Safety evaluation	Licensee and Technical Inspection Agency (TUV) evaluates TS, and TUV approves it.	Licensee evaluates TS, and regulatory body approves it.	Licensee evaluates TS, and regulatory body approves it.	Safety assessments for maintenance during operation using a Risk Monitor are required.	Licensee evaluates safety by using PSA, reviewed by the regulatory body.
4	Deterministic and/or probabilistic requirements	Deterministic and probabilistic analysis by licensee.	Deterministic analysis by licensee	Deterministic and probabilistic analysis by licensee	Deterministic and probabilistic analysis by licensee	Deterministic and probabilistic requirements
5	Maximum unavailable time span	In the TS.	In the TS.	In the TS.	Using the Risk Monitor (PSA)	In the TS.
6	Regulatory procedure	Licensees keep TS based on the recommendation by RSK.	Normal inspections	None	None	None
7	Methods of verification for licensee's performance	Independent experts are on the site on behalf of the regulatory authority.	A random-sample method inspection	Check of licensee's performance by witness / review.	Not applicable	Inspection Review of documents
8	Difference of maintenance/testing methods	None	None	Some tests can not be conducted at full power.	------	None
9	Other safety requirements	None	None	None	None	Checking allowable outage time with PSA gives new insights for optimisation
10	Is this problem a major issue?	For example, the licensees are interested to increase the allowed switch-off times per year.	Amend RB policy and inspection practices according to self-assessment.	No	The RB often discuss with the licensees about this issue.	No

Tabulated abstracts of National Contributions

	Question	Spain	Sweden	Switzerland	UK	USA
1	National policy for inspection during operation	The Maintenance Rule (10CFR50.65) Allow the licensee to use Maximum Unavailable time in the TS	PMO is allowed only for in TS specified systems and components.	No specific rule. Allow the licensee to use Maximum Unavailable time in the TS.	No specific rule. Allow the licensee to use Maximum Unavailable time in the TS.	In general, licensees are permitted to perform maintenance and testing during operation after they perform a risk assessment.
2	Licensee's plan to further apply to maintenance during operation	Yes, NPPs have already started to perform preventive maintenance during operation, one NPP announced to carry out more.	Maybe in the long run.	NPP, which has four trains, are undertaken once per year during operation at different times.	Yes, Further proposal is expected due to four trains safety related system.	Licensee will perform increasing amounts of preventive maintenance and testing at power.
3	Safety evaluation	Licensee evaluates Maintenance Rule, and regulatory body reviews it.	Licensee evaluates TS and regulatory body approves it.	RB evaluates the safety.	Licensee evaluates TS, and regulatory body approves it.	Licensee evaluates TS, and regulatory body approves it.
4	Deterministic and/or probabilistic requirements	Deterministic and probabilistic analysis by licensee	Deterministic and probabilistic analysis by licensee.	Deterministic requirements	Deterministic and probabilistic analysis by licensee	Deterministic and probabilistic analysis by licensee
5	Maximum unavailable time span	In the TS.	In the TS.	------	In the TS.	In the TS.
6	Regulatory procedure	Inspection Manual	Inspection process.	The existing rules and regulations.	None	Reactor Oversight Program
7	Methods of verification for licensee's performance	The RB monitors maintenance activities by routine base inspection and assesses the Licensee's report of preventive maintenance and test during operation.	Normal inspection process.	Basic Inspection Program	Regulatory body monitors maintenance and surveillance activities	Verified by routine scrutiny by resident inspectors on a sampling basis
8	Difference of maintenance/testing methods	None. But practically there are differences in test condition	Some test cannot be performed at power.	None	None	Some tests can not be conducted at full power.
9	Other safety requirements	None	No	None	None	None
10	Is this problem a major issue?	Not major problem. But the RB often discuss with the licensees about this issue	See Q2	No	No	Not so far. Licensee is interested in this issue

APPENDIX 1 - NATIONAL CONTRIBUTIONS

BELGIUM

1 What is your national policy for allowing performance of preventive maintenance and testing of safety systems during operation of the reactor?

- *Existing rules and regulations for preventive maintenance and testing of safety systems during operation of reactor*
- *Plans for future rules and regulations*

The RB does in principle not accept a licensee to perform preventive maintenance of safety systems during power operation (or, more precisely, during these operational modes in which the safety systems are required to be operable according to the Technical Specifications).

However, exemptions to this principle are allowed for:

- safety systems with abundant redundancy (e.g. internal AC power supply system designed with a spare diesel generator);
- preventive maintenance activities with small intervals in comparison to the fuel cycle length and that are necessary to maintain the reliability of the equipment according to the maintenance instructions provided by the manufacturer (e.g. change of lubricants on motor and pump bearings);
- preventive maintenance of second level protection systems. These protection systems are designed to cope with external hazards. The probability of these types of accidents is very low, and most of the second level protection systems needs to be operable in all operational modes.

In all cases, the minimum capacity of the system to fulfil the required safety function needs to be guaranteed (without taken into account a single failure). It is also required to limit as much as possible the period the safety system is inoperable, whatever the Completion Time specified in the Technical Specifications is.

This position is written down in the Bases of the Technical Specifications.

2 Is it expected that the licensees will further apply to perform preventive maintenance and testing during operation when such activities were previously performed during outages? If yes, give examples.

- *relevant safety systems*
- *relevant safety related systems*

For the moment being, the licensee is not intended to shift preventive maintenance of safety systems to power operation. However, shortening the outage duration remains an important objective for the licensee, but this will rather be accomplished by:

- improving the preparation and organisation of the outages;
- modifying some maintenance methods (e.g. augmented use of standard exchanges of equipment);
- eventually reducing the amount of preventive maintenance by reducing the scope of the maintenance programs and/or increasing the interval of the different preventive maintenance activities. This has to be done on the basis of a thorough evaluation of the actual maintenance programs. Implementation of hardware modifications is not excluded and will be based on a cost benefit analysis.

3 By what means is the safety level of the plant evaluated if individual trains of redundant safety systems are taken out of service?

- *Who evaluates this safety?*
- *How is it evaluated?*
- *Review by the inspection authority?*

4 Are there deterministic and/or probabilistic requirements to be fulfilled and to be presented to the inspection authority for approval?

- *Kind of calculation*

For Q 3 & 4

Up to now there is no specific evaluation of the safety level of the plant prior to taking out of service an individual train of a safety system.

In general, the licensee has the responsibility to respect the Technical Specifications, in particular to restore an inoperable system or component to the operable status as soon as possible and at least within the specified time limits (Completion Times). Other requirements related to the performance of preventive maintenance activities are listed in the answer to question 1.

In some few cases, the licensee asks for the approval by the RB of a deviation to the Technical Specifications to perform preventive maintenance. To be accepted this request is to be justified on a safety point of view and takes into account the following aspects:

- global positive effect on the safety of the installation;
- duration of the unavailability as compared to the completion time;
- low probability of occurrence of the events for which the equipment is foreseen;
- demonstration of the availability of redundant safety equipment and systems (in this case first and second level safety systems may be credited for);
- availability of alternate systems having not necessarily the same safety classification level;
- specific temporary procedures and instructions to the operators.

No formal evaluation process is used by the regulatory body to determine whether the proposal is acceptable or not. The acceptance is based mainly on engineering judgement.

5 Are maximum time spans specified for taking individual trains of safety systems out of service?

- *If yes, give examples: name of train, maximum time span*

Maximum periods for taking individual trains of safety systems out of service (i.e. Completion Times) are specified in the Technical Specifications.

Typical Completion Times are:

- for safety systems such as the Auxiliary Feedwater System, Component Cooling Water System, Emergency Core Cooling System, diesel generators, ... : 72 hours;
- for containment isolation valves: 4 hours;
- for second level protection systems: 61 days.

6 Is there a regulatory procedure for inspection of licensee's performance of preventive maintenance and testing during operation?

- *describe procedure, give example*

As already mentioned in the answer to question 1, the amount of preventive maintenance carried out during power operation is very limited.

As for corrective maintenance activities, special attention is paid to:

- the requalification (post maintenance testing) programs and results;
- the resulting period a train of a safety system has been inoperable.

These items are discussed during the periodic inspections of the different departments. Attention is paid to unavailability indicators (period unavailable as compared to the specific completion time).

7 How does the regulatory inspection authority verify that all tests on safety systems and components are performed as required?

- *Kind of inspection*

- *reporting by licensee*

This question seems no to be directly related to the scope of the questionnaire as presented in the introduction.

The RB verifies that tests on safety systems are performed according to the requirements of the Technical Specifications by performing periodic inspections during which tests for randomly safety equipment are verified. In addition the licensee is required to report each deviation from the test program as defined in the Technical Specifications.

8 Is there any difference on preventive maintenance methods and testing between performing during outage and during operation?

- *If yes, give examples:*
  systems, components, difference of tests, test condition and test methods

There are no differences between maintenance activities and testing performed during power operation or during the outages.

9 Are there other safety requirements, regulatory practices and inspection activities related to this subject?

Nil.

10 Is this problem a major issue in your country and how is it dealt with by the regulatory body?

- *plans of licensees*

- *approaches of the regulatory body*

- *future developments*

- *status of discussion.*

See answers to questions 1 and 2.

CANADA

Background:

The CANDU system is designed with 4 special safety systems which are independent from process systems and from each other. They are in a dormant mode, but they detect and monitor process parameters during normal operation to shutdown, cool and contain radionuclides in case of an accident and release.

Each system has triplicate independent channels for each parameter and function, and operates on a 2 out of 3 principle. That is, at least 2 channels must detect and trip in order to get the safe action (scram, inject... whatever).

The 2/3 principle also allows for one of the channels to be removed from service. Channels are removed from service (or opened) when the detection or other component is out of order, or unable to perform. The channel is placed in "the safe state", usually the tripped state meaning that now, the system operates on a 1 out of 2 (remaining) channel detection and action.

This features assures that operators can at any time during power operation, remove a channel out for maintenance, calibration or testing. The testing allows for the system to demonstrate reliability targets. In that sense, because of this feature of the CANDU, a lot of testing and calibration goes on at power, and there is no need to shut down for these tasks. Rules ensure that components are thoroughly tested before returning a channel to service.

Since there is a risk for spurious trip (scram) for the reactor when operating on a 1/2 channel rule compared to a 2/3 channel rule, the licensee chooses that risk in order to avoid a shut down for calibration or maintenance.

Generally, redundant components are installed that allows isolation of a faulty component for repair at power. Such is the case for 100 % valves in parallel, 100% diesels for emergency power.

But yes, there are components or systems that have no redundancy in all systems. Strict rules cover for these. See below.

1 What is your national policy for allowing performance of preventive maintenance and testing of safety systems during operation of the reactor?

The licensee presents a document describing its internal rules for availability of systems and components, including the guidelines for maintenance and testing, which will support the Canadian policy. The guidelines are submitted to ensure that the station remains in an analysed state, as described in the licensee' Safety Report.

Canadian policy is the allowable unavailability of a special safety system during the year, and the requirement to have special safety systems armed and ready for operation (before criticality, or high power, or system pressure, depending on the application).

- *Existing rules and regulations for preventive maintenance and testing of safety systems during operation of reactor.*

Special safety systems: These systems must be available while reactor at power.

Other safety related systems (basically systems which are not as important as special safety systems) : License support document states that corrective maintenance, testing and preventive maintenance is done with the objective to maintain required reliability of these systems.

Limits exist for the maximum time allowed in a failed mode for various components, in the license support document. When these limits are reached, the reactor must be placed in a safe mode (shutdown usually)

- *Plans for future rules and regulations*

Canadians are developing a maintenance standard but this should not affect this issue.

2 Is it expected that the licensees will further apply to perform preventive maintenance and testing during operation when such activities were previously performed during outages? If yes, give examples.

No. But current pressure from licensee is to shorten regulatory approval turnaround time (the time that we take to review and approve conditions while the licensee is waiting for approval to restart).

As much as possible, maintenance is to be performed during normal operation, so that system tests can demonstrate more realistically the operability of the component testing.

3 By what means is the safety level of the plant evaluated if individual trains of redundant safety systems are taken out of service?

Not applicable for trains of safety systems.

- *Who evaluates this safety?*

The licensee

- *How is it evaluated?*

Safety Design matrices (studies that combine fault trees with operator performance models) are referred to justify calculated maximum hours of unavailability)

- *Review by the inspection authority?*

Yes, and approval of principle with time at risk.

4 Are there deterministic and/or probabilistic requirements to be fulfilled and to be presented to the inspection authority for approval?

Deterministic, supported by probabilistic arguments, if available.

5 Are maximum time spans specified for taking individual trains of safety systems out of service?

Not applicable for trains in Canada. However, all safety related equipment at power have a maximum time during which they can be out for maintenance. Going beyond maximum time requires higher approval.

6 Is there a regulatory procedure for inspection of licensee's performance of preventive maintenance and testing during operation?

None. We evaluate the licensee with regards to its ability to meet its own objectives of maintenance, its completion ratio, its ratio of resources invested in preventive versus corrective.

Another point we inspect is the quality of the maintenance procedures (completeness of the procedure, precision, signature level, post-maintenance testing involved...) for each maintenance activity presented for authorisation, for pressure retaining components.

7 How does the regulatory inspection authority verify that all tests on safety systems and components are performed as required?

System routine testing is a license requirement.

- *Kind of inspection*

Verification of licensee records during system inspection.

- *reporting by licensee*

A requirement on licensees to report testing that was not done per schedule.

8 Is there any difference on preventive maintenance methods and testing between performing during outage and during operation?

No; the preventive maintenance methods are the same.

9 Are there other safety requirements, regulatory practices and inspection activities related to this subject?

The operators have a maximum unavailability list for components of the station. This document is consulted in cases of unavailabilities.

10 Is this problem a major issue in your country and how is it dealt with by the regulatory body?

No.

CZECH REPUBLIC

1 What is your national policy for allowing performance of preventive maintenance and testing of safety systems during operation of the reactor?

- *Existing rules and regulations for preventive maintenance and testing of safety systems during operation of reactor*

The program of periodical tests and the scope of the maintenance are part of the Limits and Conditions (LCO) and maintenance program, which are approved by RB. Regulatory body performs inspections at some systems periodically, at some systems only randomly.

- *Plans for future rules and regulations*

no specific plans for future rules and regulations

2 Is it expected that the licensees would further apply to perform preventive maintenance and testing during operation when such activities were previously performed during outages? If yes, give examples.

- *relevant safety systems*

- *relevant safety related systems*

Such an application has not been addressed to RB until now and also it is not expected in the near future.

3 By what means is the safety level of the plant evaluated if individual trains of redundant safety systems are taken out of service?

- *Who evaluates this safety?*

Licensee each case, RB in some special cases

- *How is it evaluated?*

Risk Monitor using

- *Review by the inspection authority?*

only in special cases

4 Are there deterministic and/or probabilistic requirements to be fulfilled and to be presented to the inspection authority for approval?

- *Kind of calculation*

Mainly the request for LCO exception must be verified by probabilistic calculation. This requirement is not included in the legislation.

5 Are maximum time spans specified for taking individual trains of safety systems out of service?

- *If yes, give examples: name of train, maximum time span*

There are defined maximum time spans for taking individual trains of safety systems out of service in LCO, e.g. one train (out of three) of the electrical safety supply is allowed to be out of service for

maximum 72 hours provided that the availability of the other two trains is certified. Similarly ECCS for maximum 72 hours and safety logic for 6-8 hours.

6 Is there a regulatory procedure for inspection of licensee's performance of preventive maintenance and testing during operation?

- *describe procedure, give example*

There is a procedure for inspection of testing. Each system availability should be inspected once per four years (the inspection includes observation of the periodical system testing).

7 How does the regulatory inspection authority verify that all tests on safety systems and components are performed as required?

- *Kind of inspection*
- *reporting by licensee*

Verification of adequate performance of all tests on safety systems and components is done by regular (daily) inspection of the site inspectors. It is prescribed to submit some specific reports to the RB.

8 Is there any difference on preventive maintenance methods and testing between performing during outage and during operation?

- *If yes, give examples: systems, components, difference of tests, test condition and test methods*

There is no difference on preventive maintenance methods and testing due to performing during outage or operation.

9 Are there other safety requirements, regulatory practices and inspection activities related to this subject?

There is no other regulatory practice and inspection activity beyond those described above.

10 Is this problem a major issue in your country and how is it dealt with by the regulatory body?

- *plans of licensees*
- *approaches of the regulatory body*
- *future developments*
- *status of discussion.*

Not major issue at present, maybe in future.

FINLAND

1 What is your national policy for allowing performance of preventive maintenance and testing of safety systems during operation of the reactor?

- *Existing rules and regulations for preventive maintenance and testing of safety systems during operation of reactor.*
- *Plans for future rules and regulations.*

Preventive maintenance and testing of safety systems during operation of the reactor is allowed at Finnish nuclear power plants.

Periodic tests, which have to be acceptably performed to find out equipment or a system serviceable, are defined in the Technical Specifications.

The general principles of preventive maintenance are defined in the Technical Specifications of the both nuclear power plants in Finland and accepted in connection to the approval of the Technical Specifications. The allowed preventive maintenance works during the operation are defined in the Technical Specifications of Loviisa Nuclear Power plant. In the case of Olkiluoto nuclear power plant a so-called preventive maintenance package practice is approved by a separate decision. In the Technical Specifications of Olkiluoto nuclear power plant there are given the provisions, which have to be found out to perform preventive maintenance, among other things for the removal of residual heat.

Guide YVL 1.8 presents how the Radiation and Nuclear Safety Authority (STUK) regulates the repairs, modifications and preventive maintenance of systems, components and structures at nuclear facilities during operation. More accurate requirements for the preventive maintenance of electrical and instrumentation equipment are given in Guide YVL 5.5. Radiation measuring systems are also addressed in Guide YVL 7.11.

The principles and requirements for testing after preventive maintenance operations of mechanical components and structures are presented in Guide YVL 1.8. Inspections of work and installations relating to the repairs of electrical and instrumentation equipment shall be performed according to the requirements of Guide YVL 5.5.

Guides, YVL 1.8 and YVL 5.5 are under revision and draft versions are on hand. Basic rules concerning the preventive maintenance and testing of safety systems remain unchanged.

2 Is it expected that the licensees will further apply to perform preventive maintenance and testing during operation when such activities were previously performed during outages? If yes, give examples.

- *relevant safety systems*
- *relevant safety related systems*

It has not come to STUK´s knowledge that power plants would be willing to increase the preventive maintenance during the operation.

It is assumed that the practice of preventive maintenance during operation is already so extensive, that there should not be a pronounced need to extend it from current. At Olkiluoto nuclear power plant the practice of diesel packages has taken its final form during the last few years.

Guide YVL 2.8 necessitates however, that the results of PSA have to be taken into account in planning future procedures. There are at least some individual changes in testing intervals, which have originated from the results of PSA.

The Technical Specifications of Loviisa nuclear power plant are supplemented to cover preventive maintenance during operation at both units in the same extend. The revisions of the Technical Specifications were approved for Loviisa NPP unit 1 (LO1) in 1995 and for unit 2 (LO2) this year (2000). The Technical Specifications of LO1 were changed in 1997 and it is in our knowledge, that there will be changes still this year based on the Technical Specifications of LO2.

Every once and then power plants present an application to STUK to deviate from the Technical Specifications to perform preventive maintenance of safety related systems during operation or move some inspections or maintenance work normally done during outage to be performed during operation to shorten the duration of an annual maintenance outage. As late examples of such exemptions are at Olkiluoto NPP the inspection of diesel fuel tanks (accepted) and the staking of the control room lightning system for seismic reasons (not accepted).

3 By what means is the safety level of the plant evaluated if individual trains of redundant safety systems are taken out of service?

- *Who evaluates the safety?*
- *How is it evaluated?*
- *Review by the inspection authority?*

The conditions for performing preventive maintenance are defined in the Technical Specifications of both power plants in Finland. Compliance with the Technical Specifications ensures that the safety level is maintained as high as practicable. The safety level and the principles of preventive maintenance are reviewed and accepted in accordance of the approval of the Technical Specifications and the safety level is assessed at power plants and in STUK.

The safety importance of the unusability of the system or a safety related system taken out of service has been calculated using the probabilistic safety analysis by the licensee and the authority when possible. PSA is also used in the assessment of alterations proposed to the Technical Specifications as well as in the risk assessment of an application to deviate from the Technical Specifications. The quality control group and the safety engineer of the licensee have to estimate the safety significance in the application.

Detailed instructions for the performance of preventive maintenance are given in the operational and maintenance procedures.

The shift supervisor of the plant unit is responsible to follow up the retention of safety and compliance with the Technical Specifications. During preventive maintenance the resident inspectors of STUK at the plant site supervise the work and operation.

4 Are there deterministic and/or probabilistic requirements to be fulfilled and to be presented to the inspection authority for approval?

- *Kind of calculation*

The conditions for preventive maintenance are defined in the Technical Specifications and they are based on deterministic requirements.

Licensees use probabilistic safety analysis as a justification of preventive maintenance during operation, but there are not any regulatory requirements for probabilistic calculations. The acceptable risk increase concerned about preventive maintenance shall be less than 1 % of the total risk.

The changes in intervals of periodic tests are based also on probabilistic calculations, but the changes of periodic test intervals defined in the Technical Specifications are not approved by STUK only on the bases of PSA. According to Guide YVL 2.8 in definition of preventive maintenance and periodic tests PSA shall be utilised.

5 Are maximum time spans specified for taking individual trains of safety systems out of service?

- If yes, give examples: name of train, maximum time span

Maximum time spans for taking individual trains of safety systems out of service are specified in the Technical Specifications (Loviisa NPP) and in operational procedures concerning preventive maintenance (Olkiluoto NPP).

The Technical Specifications of Loviisa nuclear power plant generally prerequisites, that unusabilities of equipment and systems caused by preventive maintenance shall be minimised, for example by grouping the works. The time spans defined in the Technical Specifications of Loviisa NPP vary from 8 hours to 21 days. There are also individual equipment and systems for which the time of unusability is not defined. The allowed time spans are presented in the table form. At Loviisa NPP there are still difference in the practice of the preventive maintenance between plant units. In the Technical Specifications of LO1 there will be changes concerning the preventive maintenance during operation based on the practice of LO2, which was approved this year (2000).

In the Technical Specifications of Olkiluoto NPP the preventive maintenance works during operation are defined generally. Parts of the works are grouped into packages to minimise the time span, which a safety system is out of service. The quality control group of the plant considers the principles of programmes and procedures concerning preventive maintenance. The provisions for starting the preventive maintenance are presented in the Technical Specifications.

For example in the Technical Specifications of Olkiluoto is presented, that the preventive maintenance of individual parts of system 321 (shut-down cooling system) according to the approved preventive maintenance programme is allowed on the presumption that the system is to be taken into service in five hours. At least one pump of the system 321 can be taken out of service according to the approved preventive maintenance programme for two days on the certain conditions presented in the Technical Specifications. The allowed time spans for unusability of individual trains of safety systems caused by preventive maintenance are not presented in the Technical Specifications as detailed as in the Technical Specifications of Loviisa NPP.

The allowed time spans at Olkiluoto NPP vary from 3 to 30 days depending on the safety system or safety related system and the content of the package of preventive maintenance. The time spans of safety systems for being out of service during operation are normally 3 days, for example containment vessel spray system, core spray system and auxiliary feed water system.

The time spans for preventive maintenance packages are presented in operational and maintenance procedures. For example the length of preventive maintenance packages of diesels at Olkiluoto NPP vary from one to 10 days. An allowed time for a basic maintenance of diesel generators is 10 days and the length of every year performed maintenance is one day.

Periodic tests, which are defined in the Technical Specifications of Olkiluoto NPP and performed according to the approved operational procedures, may cause occasional unusability of the tested system. The time of unusability of the system shall be kept as short as practicable. The advantage got by the periodic test shall be greater than the disadvantage caused from the unusability of the system. The time spans for unusability is not presented.

The intervals and schedules of periodic tests are presented in the Technical Specifications.

6 Is there a regulatory procedure for inspection of licensee's performance of preventive maintenance and testing during operation?

- describe procedure, give example

There are no written regulatory procedures to cover the inspection of licensee's performance of preventive maintenance during operation. For the supervision of modifications there is an internal YTV-guide in the QA Manual of the Department of Nuclear Reactor Regulation. The requirements for the licensee as well the testing after maintenance procedures are presented in the YVL guides.

Guide YVL 1.8 presents how the Radiation and Nuclear Safety Authority (STUK) regulates repairs, modifications and preventive maintenance of systems, components and structures at nuclear facilities during operation. More accurate requirements for the preventive maintenance of electrical and instrumentation equipment are given in Guide YVL 5.5. Radiation measuring systems are also addressed in Guide YVL 7.11.

The principles and requirements for testing the preventive maintenance operations of mechanical components and structures are presented in Guide YVL 1.8. Inspection of preventive maintenance shall be conducted also in compliance with Guide YVL 1.15. Inspections of work and installations relating to the repairs of electrical and instrumentation equipment shall be performed according to the requirements of Guide YVL 5.5.

7 How does the regulatory inspection authority verify that all tests on safety systems and components are performed as required?

- Kind of inspection

- reporting by licensee

STUK has defined by a separate decision the periodic test, which the licensee is responsible to inform STUK in advance by telefax (for example containment and primary circuit tightness tests, some valve tests and physical tests of the reactor). Resident inspectors follow the tests but they need not be present in most tests. The attendance of STUK's inspectors is required only in few tests at Loviisa NPP (primary circuit tightness tests and tests of the safety valves of the pressurising system and initial steam system). In some cases the licensee is responsible to send the results to the STUK headquarters, where the results are recorded and assessed. The results must be available at least at the plant. Resident inspectors go through the results in their weekly inspections and inform STUK about their findings. The results of periodic tests are followed also in connection with inspections of the periodic inspection programme of STUK.

8 Is there any difference on preventive maintenance methods and testing between performing during outage and during operation?

- *If yes, give examples: systems, components, difference of tests, test condition and test methods*

There is not any difference between preventive maintenance methods and testing performed during outages or operation. In practice, however, the tests are different during an outage and operation. For example pumping tests to the reactor can be performed only during outage.

Guide YVL 1.8 presents that after maintenance or modifications a component or a structure shall be subjected to a performance test, which corresponds to at least a periodic test and by which its operability is ensured. The performance test plan and its result documents shall be submitted to STUK for approval on request.

If the performance of a preventive maintenance operation has required a partial or full-scale dismantling of a component or structure, STUK's inspectors shall, where necessary, be presented with a record or any other document accounting for tests by which operability, leak tightness and/or load bearing capacity are assessed.

Inspections of work and installations relating to repairs of electrical and instrumentation equipment shall be performed according to the requirements of Guide YVL 5.5.

9 Are there other safety requirements, regulatory practices and inspection activities related to this subject?

There are not any other safety requirements, regulatory practices and inspection activities related to this subject that would not have already been mentioned

10 Is this problem a major issue in your country and how is it dealt with by the regulatory body?

- *plans of licensees*
- *approaches of the regulatory body*
- *future developments*
- *status of discussion.*

STUK has not identified inspection of the preventive maintenance and testing of safety systems and safety related systems as a problem, because the basic rules are defined in the Technical Specifications of the plant and regulated by YVL guides.

The International Regulatory Review Team (IRRT) of the IAEA in spring recommended that STUK should develop written inspection guidance for its inspections. In connection with that work also preventive maintenance could be included into new YTV guides.

FRANCE

1 What is your national policy for allowing performance of preventive maintenance and testing of safety systems during operation of the reactor?

- *Existing rules and regulations for preventive maintenance and testing of safety systems during operation of reactor*

There is no particular regulations for preventive maintenance and testing of safety systems during operation but, during any state of the reactor (operation or outage), the licensee have to cope with the "technical specifications" which predict which system is required or not and how long it can be out of service according to the considered state.

It can be noted that this document is proposed by the licensee and approved by the Safety Authority. It is the same case for "periodic testing".

The maintenance programs are also communicated to the Safety Authority for information. Without any reaction, they come into force two months after.

- *Plans for future rules and regulations*

At the present time, the French reactors are based on 2 redundant trains. Concerning future reactors, the licensee proposes a design based on four (4 x 50 %) lines. The principle has been accepted by the regulator. This new design will certainly offer more flexibility to the licensee for performing maintenance or testing in operation without being harmful to safety.

2 Is it expected that the licensees will further apply to perform preventive maintenance and testing during operation when such activities were previously performed during outages? If yes, give examples.

- *relevant safety systems*

- *relevant safety related systems*

We have no particular requirements concerning the state of the reactor while performing maintenance apart from complying with the technical specifications. Nevertheless, the licensee should also provide a risk analysis on the impact of the intervention on other systems connected to this one he is working on.

3 By what means is the safety level of the plant evaluated if individual trains of redundant safety systems are taken out of service?

- *Who evaluates this safety?*

- *How is it evaluated?*

- *Review by the inspection authority?*

The safety analysis is provided by the licensee when proposing new technical specifications. The justifications are examined by the Safety Authority and its technical support (IPSN). There are based on a deterministic approach concerning the design and capability of the systems and on a probabilistic one, to determine their maximum time of unavailability, for them to cope with accidents.

During inspections, the compliance to the technical specifications and the periodic testing are reviewed.

4 Are there deterministic and/or probabilistic requirements to be fulfilled and to be presented to the inspection authority for approval?

- Kind of calculation

See 3.

5 Are maximum time spans specified for taking individual trains of safety systems out of service?

- If yes, give examples: name of train, maximum time span

This is the typical information you can find in the technical specifications. They give the maximum times (see 3.) and what you have to do if you can not cope with it for each safety relevant system.
Example : when the auxiliary feedwater supply of steams generators is unavailable, you have to reach a safety state of the reactor (where this system is not required anymore) in an hour as a maximum.

6 Is there a regulatory procedure for inspection of licensee's performance of preventive maintenance and testing during operation?

- describe procedure, give example

There is no specific procedure, but these inspection enter in the scope of the surveillance program, that means, carried out on a sampling basis (the aim is not to supplant the licensee, solely responsible for the safety of his plant, but to ensure by sample-checking that the latter fully assumes his responsibilities in a technically satisfactory manner).

7 How does the regulatory inspection authority verify that all tests on safety systems and components are performed as required?

- Kind of inspection

There are two types of inspections can be separated : organisation of the implementation of periodic tests on the reactor (for different systems), or on a specific system (including preventive maintenance)

- *reporting by licensee*

The plant licensee informs the regulator of any problem or non conformance which occurs during the outage or in operation:

- phone calls ;
- filling a database ;
- sending non conformance reports ;
- event reporting ;
- meeting representatives of the Safety Authority.

The regulator may require its technical support to carry out studies on these information. On this basis, the Safety Authority may disagree on the solutions proposed by the licensee and discusses intensively with the plant management to reach an agreement. Should it not reached, DSIN imposes its way of thinking which is always more conservative.

Concerning the periodic testing, it can be noted that an event must be reported by the licensee, whenever the specific unavailability time for any specific safety related system is exceeded by 25 %.

8 Is there any difference on preventive maintenance methods and testing between performing during outage and during operation?

- If yes, give examples: systems, components, difference of tests, test condition and test methods

The principal difference is in the requalification of the system after maintenance. It can sometimes be only intrinsic and not functional because of the state of the reactor. The licensee has to make sure that he will be able to demonstrate the operability of the system within the unavailability time limit of the technical specifications.

9 Are there other safety requirements, regulatory practices and inspection activities related to this subject?

Not at the present time.

10 Is this problem a major issue in your country and how is it dealt with by the regulatory body?

No, because of upstream discussions on technical specifications.

GERMANY

1 What is your national policy for allowing performance of preventive maintenance and testing of safety systems during operation of the reactor?

The proceeding with regard to "Preventive maintenance activities at the safety system during plant operation - PMO" (vorbeugende Instandhaltungsarbeiten an Sicherheitssystemen während des Anlagenbetriebs (VIB)) is based on the recommendations of the German Reactor Safety Commission (RSK) at its 273rd Session from 9th December 1992.

The key requirements of these recommendations are.

- "PMO" is only allowed for one train at a time of stand by systems witch are listed in an special PMO maintenance plan or in the operation manual of the plant.
- The degree of redundancy must be equal or greater than n+2 (n+1 is allowed if the single failure criteria is not required for the system)
- "PMO" is not allowed during test, start-up, shut down or other deviations to the normal operation conditions.
- "PMO" is generally allowed
  - during plant operational states when the system or the components in view are not necessary for the safety actions or
  - if the redundancy is n+3.

Detailed requirements are stated plant-specifically in the Safety Specification, which is part of the operation manual of each plant.

2 Is it expected that the licensees will further apply to perform preventive maintenance and testing during operation when such activities were previously performed during outages? If yes, give examples.

Examples:

1300 MW PWR design Siemens KWU in the south of Germany:

The PMO is laid down in a special paragraph of the operation manual of the plant. This paragraph contains very detailed requirements for PMO (approx. 70 pages). It is part of the Safety Specifications which was reviewed by the regulatory authority.

In the operation manual there are, among other things, a maintenance list and a list of allowed switch-off times for safety-relevant components. The maintenance list marks explicitly whether PMO is allowed or not for the specific components. The list of switch-off times contains, among other things, the permissible switch-off time in relation to the remaining number of still available system trains.
PMO is generally <u>not</u> allowed for:

- Overpressure protection and isolation of the reactor coolant system.
- Overpressure protection and isolation of the secondary system.
- Reactor protection system.
- Limitation system.
- Reactor control system.

- Primary system and activity surveillance system.
- All I&C Systems important to safety except the I&C systems of the systems where the PMO is allowed.
- Instrumentation for Design Basis and Severe Accidents
- Switch gears, subdistribution boards, and transformers of the house load power system and emergency power system. PMO can be allowed case by case if the devices are explicitly correlated to one redundancy section and if it can be isolated.

PMO is allowed for one train of the following stand-by Safety Systems (inclusive all auxiliary systems witch are exclusively assigned to that involved train):

- The residual-heat removal chain (4 independent redundancy sections)
- Emergency residual-heat removal system for the fuel pool cooling system (2 independent redundancy section)
- Emergency feedwater system (4 independent redundancy sections)
- Emergency feedwater diesel system (4 independent redundancy sections) operates the feedwater pump and the generator of the 2. Emergency power supply system.
- Extra borating system (4 independent redundancy sections)
- Emergency diesel generator system (4 independent redundancy sections) 1. Emergency power supply system.

PMO is only allowed during normal operation. That means, it is not allowed during plant tests or if there are indications to difficulties or if there are other activities which increase the probability of the challenge of safety devices.

3 By what means is the safety level of the plant evaluated if individual trains of redundant safety systems are taken out of service?

It is a deterministic approach, which is based on the experience of large number of probabilistic evaluations (see key requirements of the RSK, answer to question 1). In addition a simplified PSA was made for some plants.

All evaluations have been reviewed and approved by the regulatory authority with support by their experts, e.g. the Technical Inspection Agency TUV.

4 Are there deterministic and/or probabilistic requirements to be fulfilled and to be presented to the inspection authority for approval?

Answer: see the other answers

5 Are maximum time spans specified for taking individual trains of safety systems out of service?

Yes. The requirements, however, are slightly different depending on the respective *Bundesland*, e.g.:

- Case 1
  PMO is permitted for two trains of a redundant system per year. Here, the unavailability of one train is limited to 14 days in series per year.
- Case 2
  Here, there is no limitation of the number of redundant trains per year, but unavailability for one redundant train is limited to 7 days in series per year.

6 Is there a regulatory procedure for inspection of licensee's performance of preventive maintenance and testing during operation?

The requirements are fixed in the Safety Specification which is part of the operation manual. These requirements have been approved by the regulatory authority.

Eight weeks before the planed PMO date, at the latest, the licensee has to submit a detailed programme of the PMO to the regulatory authority.

7 How does the regulatory inspection authority verify that all tests on safety systems and components are performed as required?

The licensee is responsible for the safe plant operation. Irrespective of this principle, independent experts are on the site on behalf of the regulatory inspection authority. These experts have to inspect safety-relevant activities of the licensee. Which activities are concerned is stated in the maintenance program.

8 Is there any difference on preventive maintenance methods and testing between performing during outage and during operation?

There is no difference.

9 Are there other safety requirements, regulatory practices and inspection activities related to this subject?

Not known

10 Is this problem a major issue in your country and how is it dealt with by the regulatory body?

PMO is current practice at German NPPs. The discussion is still ongoing, e.g. the licensees are interested to increase the allowed switch-off times per year.

HUNGARY

1 What is your national policy for allowing performance of preventive maintenance and testing of safety systems during operation of the reactor?

- *Existing rules and regulations for preventive maintenance and testing of safety systems during operation of reactor*
- *Plans for future rules and regulations*

In respect of inspection neither the program of periodical tests nor the maintenance programs are bound to regulatory approval currently. We participate in the maintenance of some parts of the safety systems occasionally, according to a random-sample-method described in each case in the regulatory resolution for the maintenance. The method of execution is described by the procedure regulating participation in periodical and start-up tests, respectively.

2 Is it expected that the licensees will further apply to perform preventive maintenance and testing during operation when such activities were previously performed during outages? If yes, give examples.

- *relevant safety systems*
- *relevant safety related systems*

In case of tests it is expected to perform testing regularly of different safety systems, e.g. reactor protection system, backup electrical energy supply, etc.

3 By what means is the safety level of the plant evaluated if individual trains of redundant safety systems are taken out of service?

- *Who evaluates this safety?*
- *How is it evaluated?*
- *Review by the inspection authority?*

The requirements are comprised in the Technical Specifications. The NPP staff or that of Technical Support Organisations will perform deterministic analysis of the safety level of the plant. The Authority shall approve the requirements.

4 Are there deterministic and/or probabilistic requirements to be fulfilled and to be presented to the inspection authority for approval?

- *Kind of calculation*

See point 1.

5 Are maximum time spans specified for taking individual trains of safety systems out of service?

- *If yes, give examples: name of train, maximum time span*

There are defined maximum time spans for taking individual trains of safety systems out of service, e.g. one train (out of three) of the electrical safety supply is allowed to be out of service for maximum 24 hours provided that the availability of the other two trains is certified.

6 Is there a regulatory procedure for inspection of licensee's performance of preventive maintenance and testing during operation?

- *describe procedure, give example*

The Authority performs inspections according to its regulatory procedures, see point 1.

7 How does the regulatory inspection authority verify that all tests on safety systems and components are performed as required?

- *Kind of inspection*
- *reporting by licensee*

Verification of adequate performance of all tests on safety systems and components is done by regular (daily) inspection of the regulatory staff and the periodic reports of the licensee.

8 Is there any difference on preventive maintenance methods and testing between performing during outage and during operation? If yes, give examples:

- *systems, components, difference of tests, test condition and test methods*

There is no difference on preventive maintenance methods and testing due to performing during outage or operation.

9 Are there other safety requirements, regulatory practices and inspection activities related to this subject?

There is no other regulatory practice and inspection activity beyond those described above.

10 Is this problem a major issue in your country and how is it dealt with by the regulatory body?

- *plans of licensees*
- *approaches of the regulatory body*
- *future developments*
- *status of discussion.*

Regulatory activity is continuously subjected to self-assessment. If self-assessment reveals that another approach should be applied in some area of regulatory inspection activities then the Authority will amend its policy, methods and inspection practices.

JAPAN

1 What is your national policy for allowing performance of preventive maintenance and testing of safety systems during operation of the reactor?

- *Existing rules and regulations for preventive maintenance and testing of safety systems during operation of reactor*
- *Plans for future rules and regulations*

The Electrical Utilities Industry Law stipulates that Periodical Inspection for nuclear reactor and its facilities shall be conducted within 13 months from the end of previous Periodical Inspection. Periodical Inspection based on EUIL is carried out during shutdown.

On the other hand, according to Law on the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors, the licensee shall establish their self-safety regulation (Technical Spec), one of which describes surveillance testing during operation. This self-safety regulation has to be approved by Agency for Nuclear and Industrial Safety (ANIS).

2 Is it expected that the licensees will further apply to perform preventive maintenance and testing during operation when such activities were previously performed during outages? If yes, give examples.

- *relevant safety systems*
- *relevant safety related systems*

Licensees hope outage time more shorten, so that they are studying to apply to maintenance and testing during operation.

3 By what means is the safety level of the plant evaluated if individual trains of redundant safety systems are taken out of service?

- *Who evaluates this safety?*
- *How is it evaluated?*
- *Review by the inspection authority?*

The self-safety regulation describes the maximum unavailable time spans (MUT). The safety levels of MUT are evaluated by Licensees, and reviewed by ANIS.

4 Are there deterministic and/or probabilistic requirements to be fulfilled and to be presented to the inspection authority for approval?

- *Kind of calculation*

Licensees submit the self- safety regulation to ANIS with deterministic and probabilistic approach.

5 Are maximum time spans specified for taking individual trains of safety systems out of service?

- *If yes, give examples: name of train, maximum time span*

Yes. Self-safety regulation contains maximum time span.

Example; Low Pressure Core Spray System - 10 days, Reactor Core Isolation Cooling System – 10 days

6 Is there a regulatory procedure for inspection of licensee's performance of preventive maintenance and testing during operation?

- describe procedure, give example

None

7 How does the regulatory inspection authority verify that all tests on safety systems and components are performed as required?

Licensee performs periodical examination and measurement during operation according to the self-safety regulation. Nuclear Safety Inspector stays in site and confirms the test completion and adequacy.

- Kind of inspection

Witness for test / Review of record

- reporting by licensee

If some trouble defined in Law is found, Licensee shall report to ANIS.

8 Is there any difference on preventive maintenance methods and testing between performing during outage and during operation?

- If yes, give examples:
systems, components, difference of tests, test condition and test methods

Yes. Some tests can not be conducted at full power, so that those are performed with restricted condition.

9 Are there other safety requirements, regulatory practices and inspection activities related to this subject?

None

10 Is this problem a major issue in your country and how is it dealt with by the regulatory body?

It is not a major issue yet, however ANIS and licensees are studying to shorten outage period.

MEXICO

1 What is your national policy for allowing performance of preventive maintenance and testing of safety systems during operation of the reactor?

- *Existing rules and regulations for preventive maintenance and testing of safety systems during operation of reactor.*
- *Plans for future rules and regulations.*

As regulatory authority, at this time we do not have specific rules and regulations for performing preventive maintenance and testing of systems during power operations of the reactor. The most important point in this matter is that we have required to the Laguna Verde licensee the implementation of the Maintenance Rule regulation. Within this regulation the section 10CFR50.65(a)(4) requires an assessment and management of the risk/safety derived from planned maintenance activities (including equipment tests), i.e., this assessment and management is required to be done previously to die performance of the maintenance activities.

2 Is it expected that the licensees will further apply to perform preventive maintenance and testing during operation when such activities were previously performed during outages? If yes, give examples,

- *relevant safety systems*
- *relevant safety related systems*

The tools and methods to allow the assessment and management of risk/safety (as -required by 10CFR50.65(a)(4) are being developed by the licensee, and we expect that one of the purposes is to transfer preventive maintenance and testing activities from. outages to power operations. At this moment, we do not have any example.

3 By what means is the safety level of the plant evaluated if individual trains of redundant safety systems are taken out of service?

- *Who evaluates this safety?*

In Laguna Verde, the areas, of Operation and Planning & Programming have the responsibility to perform the safety evaluations, according to the implementation of the requirements of 10CFR50.65(a)(4).

- *How is it evaluated?*

The required safety assessments are to be performed with two different methods. The first one is focused on safety, assessments for maintenance activities during power operations using a Risk Monitor that is in development process with the use of the specific Laguna Verde PSA. The second method is focused on activities during outages, using a procedure based on the defence in depth philosophy.

- *Review by the inspection authority!*

As part, of the assessment and inspection of the maintenance rule regulation, our regulatory staff has the responsibility to verify, and evaluate the safety evaluations done by the licensee, considering the strategies used in the management of risk.

4 Are there deterministic and/or probabilistic requirements to be fulfilled and presented to the inspection authority for approval?

- *Kind of calculations*

In the deterministic case, with the use of specific procedures, the licensee is expected to comply with minimum, required equipment and systems to fulfil the different safety functions established through the defence in depth philosophy.

In the probabilistic case used for safety assessments during power operations, specific quantitative risk criteria need to be adjusted and established as requirements, which need to be fulfilled for the different plant configurations.

5 Are maximum time spans specified for taking individual trains of safety systems out of service?

- *If yes, give examples, name of train, maximum time span.*

At least, in the Risk Monitor a maximum allowed time for the performance of maintenance activities can be calculated using specific risk criteria. It is expected that with the definition of these risk criteria, the licensee will try to use the related time to develop maintenance activities.

6 Is there a regulatory procedure for inspection of licensee's performance of preventive maintenance and testing during operation?

- *describe procedure, give example*

Not applicable.

7 How does the regulatory inspection authority, verify that all tests on safety systems and components are performed as required?

- *Kind of inspection*

- *Reporting by licensee*

Not applicable.

8 Is there any difference on preventive Maintenance methods and testing between performing during outage and during operation? If yes, give examples: systems, components, difference of test, test conditions and test methods.

We are in the process of defining the type of system that could be taken out of service during power operations, and we do not have any example now.

9 Are there other safety requirements, regulatory practices and inspection activities related to this subject?

There are no more requirements.

10 Is this problem a major issue in your country and how is it dealt with by the regulatory body?

- *plans of licensees*
- *approaches of the regulatory body*
- *future developments*
- *status of condition*

Within the next two months it is planned to have one or more meetings with personnel from the plant to discuss specific points about tools, methods, safety/risk criteria, risk management, and plans of the licensee for the performance of maintenance and testing of equipment and systems. The objectives and the scope in fulfilment of the regulations and expected/derived maintenance practices are to be discussed.

THE NETHERLANDS

1 Policy for allowing performance of preventive maintenance and testing of safety systems during operation of the reactor.

In general it is not allowed to perform preventive maintenance on relevant safety systems during operation of the reactor other than specific mentioned in the Technical Specifications (TS; "License Operating Conditions"). All safety systems are addressed in the Technical Specifications. When a (part of a) system appears to be inoperable repair must be successful within a certain time frame: AOT (Allowable Outage Time). When this it not possible the plant must be set in a specified reactor mode.
Testing of redundant safety systems is allowed during normal operation as long as the test will not interfere with the normal process and the correctness of the redundancy matrix (example: diesel operated emergency power supply, bunkered emergency water injection and decay heat removal system). The unavailability of a system due to testing is well below the AOT.

2 Requests of licensees to shift such activities from normal outage to normal operation. (give examples)

In the past there were several requests of the licensee to perform maintenance on a relevant safety related system during normal operation. When granted it was described in the TS (for examples see question 5).

3 Evaluation of safety level of plant if individual trains of redundant safety systems are taken out of service (Who, how and review?).

When a system is planned to be taken out of service the redundancy matrix will be checked in order to see if it is possible.

Basically the redundancy matrix is set up by evaluating the (deterministic) necessary total of redundant systems. The evaluation is carried out by checking if the increase of the core melt frequency (using a living PSA) is acceptable. The living PSA is in control by the licensee and was evaluated and reviewed by the KFD (Nuclear Safety Department).

Maintenance at a redundant safety system is reported in the monthly report and the influence on the increase of the core melt frequency is shown. The report is sent to the KFD.

4 Deterministic/probabilistic requirements to obtain approval by inspection.

An automatic approval is in place when maintenance is planned on the in the TS specified safety systems (see 1). The evaluation of the hazard is already done by the redundancy matrix / living PSA. When the licensee wants to do preventive maintenance on a not specific mentioned system of the TS the licensee must show the effect of the maintenance on de core melt frequency before approval of that maintenance can be obtained.

5 Maximum time spans for systems taken out of service.

For PSA-calculation planned time spans of maintenance periods (unavailability) for components and systems have to be used. These periods have to be less then the AOT-time frame as specified in the TS. (Remind: when the actual period appeared to be longer than specified the plant must be set in a specified safe reactor mode (see question 1)).

Examples of allowed preventive maintenance and period of unavailability as specified in the TS are:

1 out of 4 high pressure injection pumps (single component)	72	hours
1 out of 2 bunkered emergency high pressure injection systems	14	days
1 out of 2 bunkered emergency steam generator feedwater systems	7	days
1 out of 2 bunkered emergency 380V power generators (single component)	72	hours
1 out of 2 fuel storage pool cooling systems (not during outage!)	72	hours

6. Inspection procedures for maintenance and testing.

No special procedures has been (or will be) made to inspect preventive maintenance of relevant safety (related) systems during AOT. The normal procedures will be followed with extra attention that the maintenance period is within time span as used in the PSA-calculation.

7 Verification that all tests on safety systems are performed as required.

In the Technical Specifications the (frequency of the) required tests are mentioned

A computerised system automatically generates work-orders to carry out these tests on safety systems (checked by inspection). In the monthly report of the NPP is stated how many tests are performed and how many were successful. The causes of the unsuccessful tests are reported (i.e. test was not carried out).

At the “safety system inspections” (like the US-NRC procedure 71710) also the documentation around testing and (preventive) maintenance is assessed

8 Different methods on preventive maintenance / test during outage and during operation.

Basically none, see also question 6. The time pressure is in most cases the same (stay within the assumed PSA-time span versus reduction of the outage time).

9 Other activities related to this subject.

It appears that checking of the (deterministic) AOT's with the PSA gives new insights. The KFD plans to optimise the AOT's by analysing the effects on core melt frequency when allowable repair times and test frequency of systems are changed. This will be done system by system. Afterwards an integral optimisation of all AOT's and test frequencies could take place.

10 Major issue? How it dealt with by the regulatory body?

Although the licensee continuously tries to reduce its outage time (planning for October 2000: 14 days) no further requests for preventive maintenance activities on safety related systems/components during normal operation are asked. So up to now the policy as stated in question 1 will be still valid.

SPAIN

1 What is your national policy for allowing performance of preventive maintenance and testing of safety systems during operation of the reactor?

- *Existing rules and regulations for preventive maintenance and testing of safety systems during operation of reactor.*
- *Plans for future rules and regulations.*

The performance of preventive maintenance and testing of safety systems during operation is permitted in the Spanish plants.

The maintenance and testing allowed to each plant is managed by a general principle: the licensees have to cope with the plant-specific technical specifications.

Additionally, the Maintenance Rule (10CFR50.65) from U.S.NRC is required to the Spanish plants. Then, it is necessary to carry out safety analysis to take out of service systems and components that are considered relevant safety systems according to 10CFR50.65.

There is no previsions for new rules and regulations related to this subject in the near future.

2 Is it expected that the licensees will further apply to perform preventive maintenance and testing during operation when such activities were previously performed during outages? If yes, give examples

- *relevant safety systems*
- *relevant safety related systems*

Yes. Actually, one Spanish plant has already started to perform preventive maintenance and testing during operation and another one has announced to the regulatory body that has the intention of carrying out activities that were previously performed during outages.

It has not come to CSN at this moment knowledge that the other plants would be willing to increase the preventive maintenance during operation.

Examples of relevant safety systems would be the Emergency Diesel Generator System, LPCS, LPCI, PCI and SGTS of Cofrentes NPP (BWR).

3 By what means is the safety level of the plant evaluated if individual trains of redundant safety systems are taken out of service?

- *Who evaluates this safety?*
- *How is it evaluated?*
- *Review by the inspection authority?*

Both deterministic and probabilistic methods are used. The Maintenance and Operational Departments of the licensee carry out a deterministic assessment to ensure that taking into account the redundancy of the safety systems, an individual train can be taken out of service for maintenance or test and cope with

technical specification requirements. Also it is necessary to ensure that the safety function of the system is fulfilled with a train out of service.

In the other hand, the licensee perform an Individual Plant Examination of risk, based on probabilistic risk analysis of the plant, and individual maintenance activities are assessed in terms of their contribution to plan risk due to take out of service one train or system.

The risk associated with this maintenance is assessing according to 10CFR50.65 criteria.

Another key point used to take a decision is when a safety system or safety function is more important to be available during operation or during an outage.

The licensees are responsible to perform the safety assessment and the results are reviewed by the regulatory body.

4 Are there deterministic and/or probabilistic requirements to be fulfilled and to be present o the inspection authority for approval?

The deterministic requirements for preventive maintenance are defined in the Technical Specifications and are approved by the Regulatory Body.

Probabilistic calculations are carried out by licensees (see answer 3) and reviewed by the CSN.
Both deterministic and probabilistic assessments are combined in a safety report and is submitted by licensees to the CSN.

5 Are maximum time spans specified for taking individual trains of safety systems out of service?

Yes. The maximum time spans for taking individual trains of safety systems out of service (inoperable) are defined in the Technical Specifications of each plant. Nevertheless, for allowing performance of preventive maintenance and testing of safety systems during operation the time spans are more restrictive than usual in T.S. These restrictions are to assure that an extension in the period programmed to carry out the maintenance activities will be inside the maximum allowable outage times.

For example, Cofrentes NPP performs preventive maintenance only in those systems that the allowable outage time is at least 72 hours ($\geq$ 72 hours). Additionally, the maximum time span allowable to take out of service a train or a system to perform preventive maintenance is only a 60% of the maximum allowable outage time defined in Technical Specification for the system.

6 Is there a regulatory procedure for inspection of licensee's performance of preventive maintenance and testing during operation?

Yes. The Inspection Manual of the CSN has the procedure PT.IV.24 "Inspection of the fulfilment of the Maintenance Rule". This procedure is at this moment under revision to establish more clearly the checklist related to paragraph (a) (4) of 10CFR50.65 and to state specific verifications about the preventive maintenance and testing during operation.

7 How does the regulatory inspection authority verify that all test on safety systems and components are performed as required?

The licensee submit to the CSN an annual program with previsions of activities related to preventive maintenance and testing of safety systems during operation. This report is assessed and approved by the

CSN. After that, the adequacy of the activities carried out is verified both by routine scrutiny by resident inspectors and by specifics inspections from CSN headquarters inspectors on a sample basis.

Specific reports by licensees are only submitted to the CSN when a deviation from Technical Specifications requirements has happened.

8 Is there any difference on preventive maintenance methods and testing between performing during outage and during operation?

There is not any significant difference between preventive maintenance methods performed during outage and operation. The main differences are related to test conditions when to perform a real test is necessary to be in a cold shut down situation or outage. For example electrical tests and tests where pumping water to the reactor vessel is needed.

9 Are there other safety requirements, regulatory practices and inspection activities related to this subject?

No.

10 Is this problem a major issue in your country and how is it dealt with by the regulatory body?

At this moment it is not a major problem. A regulatory framework for approval requirements and verify the performance is established.

However, under deregulation, licensees try to become more competitive and the number of test and preventive maintenance performed during operation should be increased in order to get an outage shorter. In the other hand, licensees are trying to have allowable time spans longer in new technical specifications using probabilistic methods. Discussions between regulatory body and licensees are ongoing in this issue as application of the PSA results in each plant.

SWEDEN

1 What is your national policy for allowing performance of preventive maintenance and testing of safety systems during operation of the reactor?

The allowed preventive maintenance during operation are defined in plant specific technical specifications. What testing is allowed is also governed by plant technical specifications which are part of the stations operating license. For a 2-train station a very limited number of components are allowed for preventive maintenance. For a 4-train station can in principle one train be taken out of service for preventive maintenance.

The general requirements for testing and maintenance can be find in The Swedish Nuclear Inspectorate´s regulations concerning safety in certain nuclear facilities, SKIFS 1998:1.

2 Is it expected that the licensees will further apply to perform preventive maintenance and testing during operation when such activities were previously performed during outages? If yes, give examples.

It is not expected that licensees today will increase the amount of preventive maintenance and testing at power. After ongoing modernisation and upgrading of the nuclear plants it is expected that licensees will perform more online testing and more preventive maintenance at power.

3 By what means is the safety level of the plant evaluated if individual trains of redundant safety systems are taken out of service?

The condition for performing preventive maintenance are defined in technical specifications. The licensee evaluates the safety, with probabilistic and/or deterministic methods. The regulatory body approves the technical specifications.

4 Are there deterministic and/or probabilistic requirements to be fulfilled and to be present o the inspection authority for approval?

The deterministic requirements preventive maintenance are defined in technical specifications and approved by the regulatory body. Probabilistic assessment are carried out by licensees and reviewed by regulatory body.

5 Are maximum time spans specified for taking individual trains of safety systems out of service?

Plant technical specifications regulate allowable outage times for certain safety systems or trains.

6 Is there a regulatory procedure for inspection of licensee's performance of preventive maintenance and testing during operation?

There is no specific procedure. The normal inspection process can cover it.

7 How does the regulatory inspection authority verify that all test on safety systems and components are performed as required?

Regulating body monitors maintenance and testing activities as part of the inspection activities. The licensee must report when they deviate from technical specifications.

8 Is there any difference on preventive maintenance methods and testing between performing during outage and during operation?

Some test cannot be performed at power.

9 Are there other safety requirements, regulatory practices and inspection activities related to this subject?

No.

10 Is this problem a major issue in your country and how is it dealt with by the regulatory body?

See answer to question number 2.

SWITZERLAND

1 What is your national policy for allowing performance of preventive maintenance and testing of safety systems during operation of the reactor?

- *Existing rules and regulations for preventive maintenance and testing of safety systems during operation of reactor*
- *Plans for future rules and regulations*

The existing rules and regulations are applied. There are no plans for modifications.

2 Is it expected that the licensees will further apply to perform preventive maintenance and testing during operation when such activities were previously performed during outages? If yes, give examples.

- *relevant safety systems*
- *relevant safety related systems*

Up to now there are two NPP in Switzerland (NPP Leibstadt and Gösgen) applying preventive maintenance and testing (PMT) during operation.

NPP Leibstadt undertakes PMT at two systems per year, the Special Emergency and Heat Removal System and the Residual Heat Removal System during operation at different times. PMT at the High and Low Pressure Core Spray Systems HCPS and LCPS are done during outage.

NPP Gösgen has four trains of safety injection and core cooling. PMT at these trains are undertaken once per year during operation at different times.

3 By what means is the safety level of the plant evaluated if individual trains of redundant safety systems are taken out of service?

- *Who evaluates this safety?*
- *How is it evaluated?*
- *Review by the inspection authority?*

- HSK evaluates this safety.
- On basis of safety analyses 1 PSA for NPP Gösgen
- Yes, HSK

4 Are there deterministic and/or probabilistic requirements to be fulfilled and to be presented to the inspection authority for approval?

- *Kind of calculation*

Deterministic requirements had to be fulfilled at the times of licensing.

5 Are maximum time spans specified for taking individual trains of safety systems out of service?

- *If yes, give examples: name of train, maximum time span*

In the case of NPP Leibstadt:

- Special Emergency and Heat Removal System in spring for one month maximum.
- Residual Heat Removal System in autumn for one month maximum.

In the case of NIPP Gösgen:

- Each of the four trains of safety injection and core cooling once per year for one month maximum at different times.

6 Is there a regulatory procedure for inspection of licensee's performance of preventive maintenance and testing during operation?

- *describe procedure, give example*

Yes. This is part of the Basic Inspection Program which is transformed into the annually planned inspection program.

7 How does the regulatory inspection authority verify that all tests on safety systems and components are performed as required?

- *Kind of inspection*
- *reporting by licensee*

The functional tests and the operational safety are inspected. The licensee reports the results according to an HSK-Guideline.

8 Is there any difference on preventive maintenance methods and testing between performing during outage and during operation? If yes, give examples:

- *systems, components, difference of tests, test condition and test methods*

No differences.

9 Are there other safety requirements, regulatory practices and inspection activities related to this subject?

No.

10 Is this problem a major issue in your country and how is it dealt with by the regulatory body?

No major issue.
No further plans.

UNITED KINGDOM

(Note that the UK has only one PWR - Sizewell B)

1 What is your national policy for allowing performance of preventive maintenance and testing of safety systems during operation of the reactor?

No regulatory policy. Licensee has a policy of not doing on-load maintenance. On-load surveillances are carried out.

- *Existing rules and regulations for preventive maintenance and testing of safety systems during operation of reactor.*

None.

2 Is it expected that the licensees will further apply to perform preventive maintenance and testing during operation when such activities were previously performed during outages?

Yes

- *If yes, give examples: relevant safety systems, relevant safety related systems.*

Sizewell B has four trains in each safety related system. Their future proposal is expected to justify short periods of operation with three trains operable.

3 By what means is the safety level of the plant evaluated if individual trains of redundant safety systems are taken out of service?

- *Who evaluates this safety?*

- *How is it evaluated?*

It is expected that the safety level of all possible outages will be determined in advance by the operator's headquarters staff.

- *Review by the inspection authority?*

It is anticipated that the regulator will require that the operators informs it of periods of inoperability.

4 Are there deterministic and/or probabilistic requirements to be fulfilled and to be presented to the inspection authority for approval?

- *Kind of calculation*

It is expected that operators will be required to justify their proposals by both deterministic and probabilistic analysis.

5 Are maximum time spans specified for taking individual trains of safety systems out of service?

Yes it is expected that operator's proposals will determine time spans.

- *If yes, give examples: name of train, maximum time span*

No proposals made yet.

6 Is there a regulatory procedure for inspection of licensee's performance of preventive maintenance and testing during operation?

- describe procedure, give example

No proposals made yet.

7 How does the regulatory inspection authority verify that all tests on safety systems and components are performed as required?

- Kind of inspection

- reporting by licensee?

Regulator monitors maintenance and surveillance activities as part of its normal regulatory business - it is one of the inspection activities required by the planned inspection against the requirements of the licence conditions.

8 Is there any difference on preventive maintenance methods and testing between performing during outage and during operation?

- If yes, give examples: systems, components, difference of tests, test condition and test methods

No proposals made yet.

9 Are there other safety requirements, regulatory practices and inspection activities related to this subject?

No

10 Is this problem a major issue in your country and how is it dealt with by the regulatory body? - plans of licensees, approaches of the regulatory body, future developments, status of discussion?

No proposals made yet. When they are it is not envisaged that there will be any difficulties in formulating regulatory requirements.

UNITED STATES

1 What is your national policy for allowing performance of preventive maintenance and testing of safety systems during operation of the reactor?

Exactly what maintenance and testing is allowed is governed, in part, by plant technical specifications, which are part of the plant's operating license. Beyond that, in general, licensees are permitted to perform maintenance and testing during operation of the reactor after they perform a risk assessment, providing they manage the increase in risk that may result from the proposed activities.

- *Existing rules and regulations for preventive maintenance and testing of safety systems during operation of the reactor.*

Plant-specific technical specifications; 10 CFR 50.65, Requirements for monitoring the effectiveness of maintenance at nuclear power plants; Regulatory Guides 1.160 and 1.182.

- *Plans for future rules and regulations.*

Risk-informing 10 CFR Part 50

2 Is it expected that the licensees will further apply to perform preventive maintenance and testing during operation when such activities were previously performed during outages? If yes, give examples.

It is expected that licensees will perform increasing amounts of preventive maintenance and testing at power. Licensees may apply for relief from technical specifications that currently prohibit certain maintenance activities at power.

- *relevant safety systems*
- *relevant safety related systems*

An example of a relevant safety system would be the Emergency Diesel generator System. The distinction between "safety systems" and "safety-related systems" is unclear.

3 By what means is the safety level of the plant evaluated if individual trains of redundant safety systems are taken out of service?

Assessing and managing the risk associated with maintenance is governed by 10 CFR 50.65(a)(4).

- *Who evaluates this safety?*

Licensees themselves.

- *How is it evaluated?*

Probabilistic and/or deterministic methods.

- *Review by the inspection authority*

Under the new Reactor Oversight Process, resident NRC inspectors review licensee activities in this area on a routine sampling basis. These activities are also reviewed in more depth by region-based inspectors on a periodic basis.

4 Are there deterministic and/or probabilistic requirements to be fulfilled and to be presented to the inspection authority for approval?

All licensees performed an Individual Plant Examination (IPE) of risk, most of which were based on probabilistic risk analysis. Those IPEs were presented to the NRC for approval. Individual maintenance activities are assessed on a real time basis in terms of their contribution to plant risk without NRC prior approval but with NRC routine oversight.

- *Kind of calculation*

Typically, licensees use a blended probabilistic and deterministic approach. The probabilistic calculations are typically performed using computer risk models.

5 Are maximum time spans specified for taking individual trains of safety systems out of service?

Yes. Plant technical specifications (part of the plant's operating license) prescribe maximum allowable outage times for certain safety systems/trains.

- *If yes, give examples: name of train, maximum time span.*

Maximum allowable outage times for various pieces of equipment are specified for different modes of plant operation on a plant-specific basis. At some plants, for example, one of the plant□s multiple emergency diesel generators may be removed from service for up to 7 days at power.

6 Is there a regulatory procedure for inspection of licensee□s performance of preventive maintenance and testing during operation?

Yes. The new Reactor Oversight Program provides for direct inspection of preventive maintenance as well of monitoring the effectiveness of that maintenance. There are individual inspection procedures covering key maintenance activities.

- *describe procedure, give example.*

The Reactor Oversight Program contains eight procedures, including In-Service Inspection of Reactor Coolant Systems and Components, Technical Specification-Mandated Surveillance Testing, and Large Containment Isolation Valve Leak Rate and Status Verification.

7 How does the regulatory inspection authority verify that all tests on safety systems and components are performed as required?

Test completion and adequacy is verified by routine scrutiny by resident inspectors on a sample basis.

- *Kind of inspection.*

Direct observation of test and review of records.

- *reporting by licensee.*

Reports must make reports when they deviate from technical specifications requirements, including safety system testing requirements, for example, tests not performed when required, and equipment failures.

8 Is there any difference on preventive maintenance methods and testing between performing during outage and operation?

- *If yes, give examples: systems, components, difference of tests, test condition and test methods*

Yes. Some tests simply are not performed at power. Others are limited. For example, routine testing of Emergency Diesel Generators with the plant at power is limited to manual starting and loading; whereas, when the plant is shut down, a full automatic start-up and load sequence test, which involves deenergising a vital electrical bus, is permitted.

9 Are there other safety requirements, regulatory practices and inspection activities related to this subject?

No.

10 Is this problem a major issue in your country and how is it dealt with by the regulatory body?

Historically, this has not been a major problem. However, under deregulation, utilities are forced to become more competitive. As a consequence, licensees are motivated to perform an increasing amount of maintenance and testing at power in order to minimise outage time.

- *plans of licensees.*

Continue finding ways to reduce outage time.

- *approaches of the regulatory body.*

Heightened sensitivity and attention to maintenance and testing during reactor operations.

- *future developments.*

There may be improvements in test methods and equipment to allow safer on-line maintenance and testing. The NRC is continuing to adapt its oversight programs to address emerging trends.

- *status of discussion.*

Ongoing.