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REGULATORY INSPECTION ACTIVITIES
RELATED TO
INSPECTION PLANNING, PLANT MAINTENANCE AND ASSESSMENT OF SAFETY

Proceedings of an International Workshop
Chester, United Kingdom, 19-23 May 1996

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Paris

52088

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Pursuant to Article I of the Convention signed in Paris on 14th December 1960, and which came into force on 30th September 1961, the Organisation for Economic Co-operation and Development (OECD) shall promote policies designed:

- to achieve the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;
- to contribute to sound economic expansion in Member as well as non-member countries in the process of economic development; and
- to contribute to the expansion of world trade on a multilateral. non-discriminatory basis in accordance with international obligations.

The original Member countries of the OECD are Austria, Belgium, Canada, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The following countries became Members subsequently through accession at the dates indicated hereafter: Japan (28th April 1964), Finland (28th January 1969), Australia (7th June 1971), New Zealand (29th May 1973), Mexico (18th May 1994), the Czech Republic (21st December 1995), Hungary (7th May 1996), Poland (22nd November 1996) and the Republic of Korea (12th December 1996). The Commission of the European Communities takes part in the work of the OECD (Article 13 of the OECD Convention).

NUCLEAR ENERGY AGENCY

The OECD Nuclear Energy Agency (NEA) was established on 1st February, 1958 under the name of the OEEC European Nuclear Energy Agency. It received its present designation on 20th April 1972, when Japan became its first non-European full Member. NEA membership today consists of all OECD Member countries, with the exception of New Zealand and Poland. The Commission of the European Communities takes part in the work of the Agency.

The primary objective of NEA is to promote co-operation among the governments of its participating countries in furthering the development of nuclear power as a safe, environmentally acceptable and economic energy source.

This is achieved by:

- *encouraging harmonization of national regulatory policies and practices, with particular reference to the safety of nuclear installations, protection of man against ionising radiation and preservation of the environment, radioactive waste management, and nuclear third party liability and insurance;*
- *assessing the contribution of nuclear power to the overall energy supply by keeping under review the technical and economic aspects of nuclear power growth and forecasting demand and supply for the different phases of the nuclear fuel cycle;*
- *developing exchanges of scientific and technical information particularly through participation in common services;*
- *setting up international research and development programmes and joint undertakings.*

In these and related tasks, NEA works in close collaboration with the International Atomic Energy Agency in Vienna, with which it has concluded 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 coordinating 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

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...".

This was the 3rd international workshop held by WGIP on regulatory inspection activities. The focus of this workshop was on 3 main topics; Inspection Planning, Plant Maintenance and Assessment of Safety. This document presents the proceedings from the workshop, including: workshop programme, results and conclusions, papers and presentations and the list of participants.

FOREWORD

The main purpose of the Workshop is to provide a forum of exchange of information on the regulatory inspection activities. Participants will have the opportunity to meet with their counterparts from other countries and organisations to discuss current and future issues on the selected topics. They will develop conclusions regarding these issues and hopefully, identify methods to help improve their own inspection programmes.

The NEA Committee on Nuclear Regulatory Activities (CNRA) believes that safety inspections are a major element in the regulatory authority's efforts to ensure the safe operation of nuclear facilities. Considering the importance of these issues, the Committee has established a special Working Group on Inspection Practices (WGIP). The purpose of WGIP, is to facilitate the exchange of information and experience related to regulatory safety inspections between CNRA Member countries. This Workshop, which is the third in a series, along with many other activities performed by the Working Group, is directed towards this goal. The consensus from participants at previous Workshops, noted that the value of meeting with people from other inspection organisations was the most important achievement.

The Workshop addressed the following three (3) main topics concerning inspection activities:

- INSPECTION PLANNING
- PLANT MAINTENANCE
- ASSESSMENT OF SAFETY

The Workshop was held in Chester, United Kingdom from 20 to 24 May 1996 and hosted by Health & Safety Executive (HSE) Nuclear Installations Inspectorate (NII). Members of Organising Committee wish to acknowledge the excellent planning and arrangements made by the staff of HSE NII.

These proceedings were prepared under the guidance of the workshop facilitators and recorders. The Group included: Dr. J.J. Van Binnebeek, Chairman WGIP (AIB Vinçotte), Mr. R. Aubrey (AECB), Mr. M. Grandame (AECB), Mr. I. Aro (STUK), M. Y. Balloffet (DRIRE), Dr. H. Klonk (BfS), Mr. P. Manzella (ANPA), Mr. H. Koizumi (JAPEIC), Mr. E. C. des Bouvrie (KFD), Mr. S. Forsberg (SKI), Mr. H.-G. Lang (HSK), Mr. R. Mehew NII), Mr. T. Warren, Workshop Chairman (NII), Mr. P. Woodhouse (NII), Mr. R.M. Gallo (USNRC), and Mr. R. Campbell (IAEA).

The Workshop Committee also wishes to acknowledge the contributions made by Mrs Consuelo Perez del Moral (CSN).

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1. EXECUTIVE SUMMARY

1.1 OBJECTIVES

The main objectives of the Workshop were as follows:

- To meet with inspectors from other organisations.
- To exchange information regarding regulatory inspection practices.
- To discuss selected topics; Inspection planning, plant maintenance and assessment of safety.
- To discuss current issues.
- To develop conclusions on selected topics.

1.2 WORKSHOP TOPICS

Topics for discussion were proposed by the workshop committee, reviewed by WGIP members and approved by the CNRA. The main focus for all topic discussions were regulatory inspections activities. The topics selected were:

- Inspection Planning
- Plant Maintenance
- Assessment of Safety

1.3 WORKSHOP PARTICIPATION

Fifty-five (55) participants from twenty-one (21) different countries and two (2) international organisations took part in the workshop (see Appendix III). OECD Member countries included: Belgium, Canada, Finland, France, Germany, Italy, Japan, Korea, Mexico, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom and the United States. Non-member countries included: Argentina, Czech Republic, Hungary, Rumania, Russia, Slovak Republic and the Ukraine. Throughout the sessions and the entire workshop, participants met with each other and exchanged information.

1.4 WORKSHOP DISCUSSION GROUPS

Six (6) discussion groups, two for each topic were established for the working group sessions. Each group was organised of inspectors from different countries, to ensure diversity of views for each of the topics. Discussions groups met for 3 separate sessions to review the various topics.

Exchange between participants was active and the groups formulated conclusions on the various issues selected for the discussion topics.

1.5 WORKSHOP EVALUATION

Evaluation of the results, based on the questionnaire responses from participants showed, as in the past workshops, the highest value perceived, was in meeting and exchanging information with inspectors from other organisations. Responses also showed that the format selected was highly favoured and that more workshops of this type are supported in the future.

1.6 CONCLUSIONS

Overall discussions between the various participants both in discussion group sessions and throughout the workshop where extensive and meaningful. Ideas and practices regarding regulatory inspection activities were exchanged and it can be foreseen that these ideas will provide improved expertise when being applied in the future. Basic elements on the various topics covered can be summarised as follows:

1.6.1 Inspection Planning

The Inspection Planning discussion groups selected 5 main issues relating to the topic. These were: resources, programme content, routine and reactive or special inspections, inspection findings, and management assessments. The groups were able to derive conclusions for each of these elements.

1.6.2 Plant Maintenance

Both groups on inspection of plant maintenance activities addressed 3 major factors: Regulatory maintenance requirements and measures, assessment of maintenance programmes, and inspecting for maintenance quality and effectiveness. The groups were able to establish a list of essential elements required for quality maintenance and acceptance criteria.

1.6.3 Assessment of Safety

The 2 groups on assessment of safety each looked at a slightly different area of the topic. One group selected specific issues: evaluation of the management of safety including the role of safety performance indicators, evaluation criteria used by regulators, and the use of PSA by regulators for safety assessment. The other group looked at the specific process for assessing the management of safety. They broke this down into 4 phases: development of safety management programme criteria, identifying licensee programme, programme assessment, and evaluation of programme effectiveness.

2. PLANNING / ORGANISATION

2.1 PLANNING

Preliminary planning for this, the third in a series, of International Workshops on Regulatory Inspection Activities started following the conclusion of the last workshop in Helsinki, in May 1994. Formal planning started following approval by the CNRA at its annual meeting in November 1994.

2.2 LOCATION

The Health & Safety Executive NII offered to host this workshop in the United Kingdom. The location selected was in Chester, United Kingdom.

2.3 TOPICS

Participants at the last workshop in Helsinki (reference OCDE/GD/(95)14) suggested numerous topics for discussion at a future workshop. The first formal meeting of the Workshop Committee was held in November 1994. The Committee reviewed various proposals on topics to be selected and format be to used at the workshop. A short list of topics were developed and proposed to the CNRA. Consensus and approval was reached at the June 1995 CNRA meeting on the following topics to be addressed concerning inspection related activities:

- INSPECTION PLANNING
- PLANT MAINTENANCE
- ASSESSMENT OF SAFETY

Members of the workshop committee further defined the issues to be discussed under each of these topics as summarised in the following paragraphs:

2.3.1 INSPECTION PLANNING

Regulatory Agency guidelines and practices related to overall inspection planning differ from country to country. Differences may be the result of various factors, such as, resource constraints including staff size and expertise, regulatory agency goals and objectives, and maturity of the country's reactor operators/licensees.

Topics to be discussed in this area include; Management assessments, systematic assessment of licensee performance, periodic staff level reviews of licensee performance, planned versus reactive inspection assumptions, core inspections (those conducted at all plants), areas of technical concern, recent plant events, performance indicators, notification to the licensee of inspection plans, resident inspection versus regional office or headquarters inspector conducted inspections, documentation of individual inspection plans, distribution of inspection resources among technical areas (e.g., operations, maintenance, engineering, and plant support functions) and consideration of previous inspection findings.

2.3.2 PLANT MAINTENANCE

From an organisational point of view, plant maintenance and allied component and system inspection and testing are very complex issues and good programmes are essential to handle necessary activities with continuity and endurance. Maintenance programmes are designed to provide personnel with the necessary skills, knowledge, resources, and support to properly perform their tasks (e.g., corrective, preventive and condition based activities). This involves support and involvement from a number of disciplines including: staffing, qualification and training, design specification, procedures, procurement, planning, scheduling (between maintenance and operations) tools and services, material storage, etc. Experience feedback loops into every element and regularly performed QA audits is highly important.

As systems and components degrade over time and with use, maintenance requirements tend to increase. At the same time licensees have limited financial resources available to address the consequences of ageing degradation. One important issue to be discussed is, Which elements are essential in the maintenance programme and where the Regulatory Authority should focus its inspection resource. Other issues include: regulatory requirements for elements in the maintenance programme, the extent to which the Regulatory Authority measures the standard and quality of maintenance activities, where the balance should be struck between preventive and breakdown maintenance and the regulatory control and permissible use of predictive maintenance methods.

2.3.3 ASSESSMENT OF SAFETY

Obviously, the prime responsibility for ensuring “safety” in nuclear power plants lies with the licensee. One of the keys to reaching this objective, is the organisation (e.g., the management of safety), which is set up by the licensee. This perspective focuses on the processes within organisations and each organisation’s ability to: recognise when a problem exists, accurately characterise the nature of the problem, develop solutions, implement the solutions with appropriate support and resources, and monitor the effects and make necessary adjustments.

The focus of this topic is essentially about the role of the inspector in assessing the management of safety in a licensee’s organisation and how this assessment is achieved. Various types of safety performance measures exist and each have a use in particular circumstances. The objective is to discuss different practices aiming to understand and identify aspects which can be utilised to evaluate effectiveness in relation to plant safety. Some of the issues to be discussed may include ; requirements and responsibilities for the management of safety, evaluation methods utilised in assessing safety performance, safety targets and objectives, monitoring (both proactive and reactive), criteria used by licensees and regulators in assessing safety performance, how individuals (both licensee and inspectors) know and understand their responsibilities for safety, etc.

2.4 ANNOUNCEMENT

A preliminary announcement of the workshop was transmitted in June 1995. The Announcement and Call for Participation was issued a few months later. As part of the registration form, participants were requested to submit issues of particular interest in regard to the selected topics to be addressed at the Workshop. These issues were used to prepare the scope and the schedule for the group discussions. Additionally, participants were asked to provide a short paper describing practices within their own countries on the various topics for inclusion as pre-workshop information. A compilation of these papers is included as Appendix I.

2.5 FORMAT

Members of the Workshop Committee reviewed comments and suggestions made at previous workshop and considered opinions made during WGIP meeting on ways to improve the format of the workshop. Two key areas included the need to improve communication between participants (during the discussion sessions) and the necessity to provide advance information on the technical issues and country practices.

In order to improve communication between participants several new steps were taken. In preparing the programme the committee scheduled the agenda such that participants had several social opportunities prior to the start of formal sessions. A pre-workshop document was transmitted to each participant (Appendix I) describing country practices in the 3 workshop topics. This also proved helpful, but due to various problems (e.g., delayed submittals) the transmittal of this document did not reach all participants in time. Further improvements were suggested (see Conclusions and Evaluation) for future workshops. The final format for the workshop programme included:

2.6 PRE-WORKSHOP (Facilitator / Recorder training session and Reception /Dinner)

A training session for all facilitators and recorders was held in advance of the workshop on 19 May. This session was used to introduce methods on leading group discussions and for planning and organising the main issues to be discussed under each topic. An evening reception was held on 19 May.

2.7 WORKSHOP (Sessions were divided into an Opening Session, Discussion Sessions and a Closing Session)

2.7.1 Opening Session (Appendix II)

This session consisted of presentations by invited speakers from both regulatory and other organisations. These speakers introduced the main topics to be addressed during the Workshop.

2.7.2 Discussion Sessions (3 half-day sessions).

Participants were divided into smaller groups to discuss one of the main topics. A trained facilitator and recorder worked with each group to stimulate and encourage discussions.

2.7.3 Closing Session.

Facilitators presented conclusions and recommendations that were developed by their respective groups and answered questions of the audience. Following the presentations an open panel discussion on the results of the Workshop was held.

2.8 Post-Workshop (Facilitator /Recorder meeting to finalise reports, Site tour and regular meeting of WGIP)

Following completion of the workshop, facilitators for each topic met to evaluate results and formulate final reports.

A site tour was arranged on Thursday, 23 May. Participants were invited on a tour of the Wylfa Power Station.

On Friday, 24 May, a regular meeting of the WGIP was held. As part of the agenda discussions were held on the results of the workshop.

3. WORKSHOP

3.1 FACILITATOR TRAINING

Prior to the start of the workshop, facilitators and recorders attended a training session. This session was chaired by Dr. Van Binnebeek.

Dr. Van Binnebeek reviewed the general objectives of the workshop and outlined the various characteristics required of a good facilitator and recorder. He noted the importance of their role in guiding the group and the methods required to manage an effective discussion.

Facilitators and recorders for each topic broke out in separate groups to review the various issues transmitted by the participants and to outline the major points to be covered in the discussion sessions.

3.2 RECEPTION / DINNER

A reception and dinner was held following delegate registration at the workshop hotel. Participants were given the opportunity to socialise and exchange information in an informal setting in order to familiarise themselves with each other. Dr. Harbison, Chief Inspector HMNII, presented a few short remarks welcoming participants to the Workshop.

3.3 OPENING PLENARY SESSION

Dr. Van Binnebeek opened the workshop by welcoming the participants and introducing Dr. S. Harbison, Chief Inspector HMNII. Dr. Harbison welcomed the participants to Chester. He noted the importance ands relevance of this type of workshop and the excellent opportunity it presented to both inspectors from OECD Member countries and non-member countries to meet and exchange information on important issues. He noted the excellent participation and expressed his hope for meaningful discussions and successful workshop. Mr. Warren, Workshop Chairman and Mr. Kaufer, NEA Secretariat also welcomed the participants.

3.3.1 PRESENTATIONS (See Appendix X)

Dr. Van Binnebeek provided a presentation on the main objectives of the workshop and basic information on the set-up of the programme, the expected products and different roles of both facilitators, recorders and participants.

Professor Terry Lee of the Environmental Psychology & Policy Research Unit, School of Psychology at the University of St. Andrews provided the main presentation on The Role of Perceptions and Attitudes in the Assessment of Safety Culture.

Mr. Robert Gallo of the US Nuclear Regulatory Commission made a presentation on the aspects of Inspection Planning

Mr. Tom Ungi of Nuclear Electric provided a presentation on Plant Maintenance, The Licensee's Viewpoint.

Mr. Rick Correia presented a report on Performance Based Regulation - The Maintenance Rule.

4. DISCUSSION GROUPS - SUMMARY OF RESULTS

4.1 INSPECTION PLANNING

Group 1	**Group 2**
Caruso, G. - Argentina	Koutaniemi, P. - Finland
Van de Walle, A. - Belgium	Delgado-Guardado - Mexico
Aubrey, R. - Canada*	Viorel-Petru, B. - Romania
Kopiloff, P. - Finland	Gil, J. - Spain
Durel, J.-Y. - France	Sutovsky, M. - Swizterland
Boettger, P. - Germany	Walker, A. - United Kingdom
Manzella, P. - Italy*	Gallo, R.M. - United States*
Misumi, I. - Japan	Klonk, H. - Germany*
Dumitru, S. - Romania	
De La Vega, R. - Spain	
* Facilitators/Recorders	

4.1.1 RESOURCES

All regulatory authorities have limited resources to deal with inspection matters. Nevertheless, it is important to note that there have to be sufficient resources to cover important inspection work. As all resources are limited, allocation has to be according to safety significance.

The total resources available to the regulatory authorities represented ranged from 3 inspectors per unit up to as much as 35 person-years per unit, including site inspectors and assessors. This figures also includes the use of outside experts or expert organisations.

Typically, 1-2 inspectors from the regulatory inspection authority are dedicated to one specific site. They may be resident inspectors, as required in some countries, or normally located at the head office of the authority but spending typically 30% of their working time at the plant itself. In all regulatory inspection authorities, there is technical support from additional personnel for safety assessment work.

Although routine inspection work gives the base working load, a reactive inspection may be given priority according to it's particular safety significance. This may give rise to problems in determining the required personnel resources. Routine inspections must not be neglected in favour of reactive inspections, however, as there is a fundamental need to be pro-active in verifying licensee compliance with legal requirements.

Some countries find it difficult to maintain regulatory independence when contracting outside expertise. However, specialist expertise may not be available within the regulatory authority in every case. Extended inspection and assessment capacity can be contracted if necessary. In the end, inspection resources can come from within the regulators own resources or from outside experts. The use of outside experts offers the chance of extended specialist expertise where this is not already available, but may give rise to some regulatory vulnerability. No conclusion could be drawn as to whether the size of a country's nuclear programme is a determining factor in the use of outside experts.

It is evident that the qualification of inspectors has to be at least at a level that mutual respect is guaranteed and that the licensee's safety arguments can be understood and evaluated. Qualification, experience and training of inspectors and assessors assure the relevant technical competence to effectively challenge the licensee's safety arguments.

4.1.2 PROGRAMME CONTENT

The overall content of the inspection programmes is generally consistent among countries. Some areas, such as safeguards, were outside the scope of a few regulatory authorities' mandate. Other than those few examples, inspection programme content includes all safety significant aspects of the licensee's activities including management of safety, which together form the boundary of the safe working envelope for the facility. Inspection topics are not limited to safety-related systems. Examples of inspection programme content include the following:

- operations - operating practices and procedures, licensing or authorisation of reactor operators;
- engineering - plant modifications, core physics testing;
- maintenance - preventive and corrective activities;
- plant support - emergency planning exercises;
- decommissioning - radiological controls.

Documented programmes of inspection are normally site specific to address the particular issues and needs of each site, but in addition to these types of reactive and special inspections, a number are conducted routinely. In some cases, probabilistic safety analysis techniques are used to define or focus inspections.

Site specific plans are reviewed periodically for continued validity and effectiveness. Most regulators review their site specific inspection plans on an annual basis. An example of a more frequent review is the plant performance review conducted by some countries at approximate six month intervals. Some regulators also conduct periodic reviews of the overall inspection programme effectiveness.

None of the programmes in place require that licensees be notified in advance of all upcoming inspections. However, licensees are notified as general practice for most routine inspections, depending on their nature.

4.1.3 ROUTINE and REACTIVE/SPECIAL INSPECTIONS

Most regulators have a set of routine inspections that include activities such as system walkdowns, interviews, and document reviews. Their primary purpose is to monitor normal licensee operations.

Some of these operations involve in-service inspections, maintenance and plant modifications. It was also noted that the intensity of inspection activity increases during shutdowns, and that licensee outage plans assist inspection planning. Project-oriented inspections may be required whenever a licensee is planning to modify or change the plant or its operation in such areas as procedures, staffing or management.

Items inspected at some minimum frequency typically come from licence conditions, regulatory documents and related standards. The frequency depends on the scope of the inspection, its aim, the resources necessary to carry it out, the safety significance of the item being inspected, and history.

Use of standardised checklists in the conduct of inspections has some clear advantages, but there are also disadvantages. On the positive side, a detailed checklist provides for consistency and homogeneity. It also serves as a useful memory aid, helping the inspector to ensure nothing is forgotten. The difficulty is that detail may introduce inflexibility, and discourage curiosity. To address this difficulty, general guides or procedures could be used, as there would be more flexibility and some level of consistency. Both of these attributes were viewed as being important in conducting inspections. Periodic staff meetings to discuss inspection plan implementation are an additional means that assists in the achievement of consistency.

Reactive or special inspections respond to particular issues and are tailored to address them. These issues may arise from a combination of performance indicator trends, events, safety assessments or issues, safety significant modifications, and routine inspection results. There are no pre-defined criteria to meet for the initiation of such inspections. Most countries expressed the desire to maintain flexibility. Depending on definition, some also expressed the view that reactive inspections have priority over routine inspections.

4.1.4 FINDINGS

The findings generated from inspections are fed back to licensees as requirements for action or as requests for additional information. In addition to this use, regulators take inspection findings into consideration when reporting on licensee performance. They are used too for initiating reactive or special inspections.

To ensure the results of inspection work receive appropriate follow-up, regulatory authorities establish a recording system or database to keep track of requirements, depending on significance.

4.1.5 MANAGEMENT ASSESSMENTS

Most countries perform periodic assessments of management, typically on a yearly basis. While only a few use a systematic process and most others assess through discussion or inspection, it was noted that assessing through discussion could lead to a more subjective assessment. Only qualitative criteria are used by most countries. Some offered the view that there should be an auditable trail of information supporting the assessments made.

Performance Indicators generally are used to investigate trends and provide assistance in the assessment process, but are not used to directly assess management. Further to this, no single PI was identified that could be used alone to carry out this type assessment.

Evidence of the management of safety is obtained through the regulator’s inspection programme. The totality of inspection results is a measure of the adequacy of the management of safety.

Another tool to assess management is quality assurance. To this end, most regulators use the results of their own QA audits together with reviews of the licensee's QA programme for effectiveness.

4.1.6 FACILITATOR PRESENTATIONS

Presentations made by the facilitators on Inspection Planning, summarising the findings of their discussion groups are provided in the following pages.

INSPECTION PLANNING

GROUP 1

TOPICS COVERED

- **MANAGEMENT ASSESSMENTS**
- **ROUTINE INSPECTIONS**
- **REACTIVE/SPECIAL INSPECTIONS**
- **PROGRAMME CONTENT**
- **FINDINGS**

MANAGEMENT ASSESSMENTS

- **PERFORMANCE ASSESSMENT PROGRAMMES**
  - **most perform periodic assessments of plant management, typically every year**
    - **one regulator has adopted the SALP process**
    - **others also periodically assess management, but do so through discussion or inspection**

MANAGEMENT ASSESSMENTS

- **OBJECTIVES/CRITERIA**
  - **a disadvantage of assessing through discussion is subjectivity**
  - **some felt there is a need for an auditable trail**
  - **although qualitative criteria are in use, none are pre-defined**
- **PERFORMANCE INDICATORS (PIs)**
  - **many regulators use PIs to investigate trends, but not directly to asses management**
  - **there is no single PI used for management assessment, nor does a need exist**
  - **sets of indicators provide assistance**

MANAGEMENT ASSESSMENTS

- **QUALITY ASSURANCE (QA) REVIEWS**
  - **results of QA reviews by regulators help**
  - **review of the effectiveness of a licensee's QA programme is also useful**

ROUTINE INSPECTIONS

- **INSPECTION ACTIVITIES**
  - **most have a set of routine inspections that include activities like system walkdowns, interviews, document reviews**
  - **in-service inspections, ,maintenance and plant modifications receive attention**
- **FREQUENCIES**
  - **items inspected at some minimum frequency typically come from licensee conditions, regulatory documents and related standards**
  - **the frequency depends on scope, aim, resources, safety significance and history**

ROUTINE INSPECTIONS

- **STANDARDISED CHECKLISTS**
  - **a detailed checklist provides for consistency and homogeneity**
  - **it serves as an "aide-memoire", to ensure nothing if forgotten**
  - **a disadvantage is inflexibility, as curiosity may be discouraged**
  - **general guides and procedures are an option**
  - **there would be some level of consistency**
  - **periodic staff meetings also are helpful**
  - **conclusion is that both consistency and flexibility are important**

ROUTINE INSPECTIONS

- **SHUTDOWNS**
  - **in addition to other activities, the intensity of inspections increases**
  - **outage plans submitted usually 1 - 3 months in advance assist inspection planning**

REACTIVE/SPECIAL INSPECTIONS

- **TRIGGERS**
  - **most initiate inspections based on a combination of PI trends, events, safety assessments/issues, safety significant modifications and routine inspection results**
- **CRITERIA**
  - **none are pre-defined**
  - **there is a need to maintain flexibility**

INSPECTION PROGRAMME CONTENT

- **INSPECTION TYPES**
  - **in some cases, PSA results are used to define inspections that complement the routine, reactive and special inspections that make up the programme**
- **TOPIC SELECTION**
  - **inspection programmes are not limited to safety-related systems only**

INSPECTION PROGRAMME CONTENT

- **ADVANCE NOTICE**
  - **no legal requirements**
  - **licensees are notified as general practice for most inspections**
- **REVIEW/EVALUATION**
  - **most regulators establish their inspection plans on a yearly basis**
  - **there is no formal review process in place to evaluate overall performance effectiveness**

NOTE: The Group also identified several RESOURCE-related issues that warrant consideration when planning inspections

- **the number of inspectors**
- **resident vs. regional vs. headquarters**
- **training**
- **team composition and expertise**
- **cost**
- **technical support**

INSPECTION PLANNING

GROUP 2

TOPICS COVERED

- **RESOURCES**
- **PROGRAMME CONTENT**
- **REACTIVE INSPECTIONS**
- **PERIODIC INSPECTIONS**
- **ASSESSMENT OF THE MANAGEMENT OF SAFETY**

RESOURCES

- **CONCLUSIONS**
  - **Resources have to be sufficient to cover all safety significant inspection work.**
  - **As all resources are limited, allocation has to be according to safety significance.**
  - **Inspection resources can come from within the regulator or from outside experts.**
  - **The use of outside experts offers the chance of extended specialist expertise where this is not already available, but may give some regulatory vulnerability.**
  - **Qualification, experience and training of inspectors and assessors assure the relevant technical competence to effectively challenge licensee's safety arguments**

PROGRAMME CONTENT

- **CONCLUSIONS**
  - **Programme content should include all safety significant aspects of the licensee's activities including management of safety, which together form the boundary of the safe working envelope of the nuclear installation.**
  - **Documented programmes of inspection should be site specific to address the particular problems and needs of each site.**
  - **Inspection programmes should be reviewed periodically for continued validity and effectiveness**

REACTIVE AND PERIODIC INSPECTIONS

- **CONCLUSIONS**
  - **Reactive inspections respond to particular issues and are tailored to address the situation.**
  - **Periodic or routine inspections monitor normal operations and may give rise to reactive inspections.**
  - **Project inspections may be required whenever the licensee is planning to modify or change the plant(s) or its operation (procedures, staffing, management)**

ASSESSMENT OF THE MANAGEMENT OF SAFETY

- **CONCLUSION**
  - **Evidence of the management of safety is obtained through the regulator's inspection programme. The totality of inspection results is a measure of the adequacy of the management of safety.**

4.1.7 COMPILATION OF ISSUES

Each participant was requested to submit, as part of the registration process, a list of issues determined to be of particular interest in the related topics. Facilitators utilised these lists in structuring the various group discussion sessions. While not all issues were able to be considered, a major majority were covered. The complete listing[1] submitted for Inspection Planning follows as reference to the reader.

- Management assessments
- Organisation assessments
- Assuring consistency in scope depth, analysis and follow-up of inspections at different plants.
- Consideration of core inspection findings, events and performance indicators in reactive inspections/investigations.
- Contents of a complete special inspection plan.
- Choice of inspection resources among technical areas.
- Utilisation of inspection findings.
- Periodic inspections in operation.
- Inspection of research reactors.
- Systematic assessment of licensee performance.
- Performance Indicators.
- Resident Inspections vs. Head Quarters Inspections.
- How to handle the development of an integral inspection programme (short and long term), which criteria are used in this process and what period is covered by the plan.
- What kind of tests should be witnessed by the regulatory body during the normal operation period of the NPP?
- Distribution of inspection resources among technical areas.
- Consideration of previous inspection findings.
- Systematic assessment of licensee performance.

[1] The listing provided is unedited and may contain duplications or similarly phrased topics. No deletions were made in order to provide facilitators a good understanding of what participants wanted to discuss at the workshop.

- Filed/Detailed Inspections vs. Document/Generic Inspections.
- Scheduling and planning of an annual overall inspection programme.
- Planning and preparing special inspections, e.g., of modification, events, etc.
- Planning and preparing of reactive inspections.
- Planned vs. Reactive inspection assumptions.
- Inspections of areas of technical concern.
- Recent plant events.
- How many planned inspections are performed at NPPs during a year?
- For which period does the regulatory body communicate to NPPs about the planning of inspections?
- Assessment of licensee performance.
- Selection of inspection items.
- Competence (training and qualification) of NPP personnel.
- Routine Inspection planning.
- Results and checklists.

4.2 PLANT MAINTENANCE

Group 1	**Group 2**
Goedertier, P. - Belgium	Grandame, M. - Canada*
Douglas, J. - Canada	Balloffet, Y. - France*
Kerekes, A. - Hungary	Song, S.H. - Korea
Koizumi, H.- Japan*	Coella-Ortega, A. - Spain
Gutierrez-Ruiz, L.M., Mexico	Sanden, P.O. - Sweden
Simoncic, A. - Slovak Republic	Konoenco, A. - Ukraine
Forsberg, S. - Sweden*	Anderson, D. - United Kingdom
Pape, M. - United Kingdom	Correia, R.P. - United States
* Facilitators/Recorders	

4.2.1 INTRODUCTION

Two groups, comprising altogether 16 persons representing 13 countries addressed the following topics:

- Regulatory maintenance requirements and measures
- Assessing maintenance programmes
- Inspecting for maintenance quality and effectiveness

The main developments included:

- The elements for effective regulatory inspection programmes
- The systematic process for assessing maintenance quality and performance subjects

There was a comprehensive development of maintenance acceptance criteria for both regulators and licensees. The essential elements for quality maintenance were presented and expanded upon. There was some, but limited discussion on preventative maintenance. Participants' conclusions on maintenance issues were summarised:

- control of subcontractors
- interfaces between maintenance and reactor operation
- increased focus on maintenance during reactor operation
- need for test re-evaluation and qualification after important modernisation
- obsolescence of spare parts
- transparency between safety cases and maintenance schedules
- loss of margins due to neutron flux on reactor vessel

Besides, most countries indicated that focus was now more on the organisational and management related issues than on pure technical ones.

4.2.2 TOPICS ADDRESSED

1. Regulatory Maintenance Requirements and Measures
2. Assessing Maintenance Programmes
3. Inspecting for Maintenance Quality and Effectiveness

The key factors concluded to be important when inspecting in the area of Regulatory Maintenance Requirements (Topic 1) are:

- Regulatory Requirements, Standards and Codes
- Regulatory Checks for compliance, and
- Selection of Inspection items

The major topics in assessing Maintenance Programmes (Topic 2) are concluded to be:

- Training and Qualifications of Maintainers and Supervisors
- Experience Feedback Plant Performance and System Reliability
- Preventative Maintenance Programme, and
- Corrective Maintenance Control

Inspecting for Maintenance Quality and Effectiveness (Topic 3) requires the use of:

- Effective Inspection Methods and Techniques
- Performance Indicators, and
- Acceptance Criteria

4.2.3 EFFECTIVE INSPECTION METHODS AND TECHNIQUES

It was concluded that Regulatory Maintenance Inspection Programmes, to be complete, would include the following Methods and Techniques. The numbers shown are the total number of countries out of eight that currently include all or part of these activities in their programmes.

• Review of plant performance, system reliability's, non-conformance's, incident reports, etc.	8
• Review of quality control reports for major repairs and modifications	8
• Review of utility quality assurance and self assessment reports	6
• Meet and discuss with utility staff and sub-contractors at different levels the implementation of their maintenance plans	4
• Review of maintenance plans for selection of tests and hold points	5
• Review of test and surveillance results for major repairs	6
• Post maintenance walkdown of system	5
• Check of effectiveness of committed corrective actions resulting from major non-conformance's	2
• Monitoring of pressure boundary (weld inspection) (primary and secondary circuits) pressure tests. Erosion/corrosion monitoring	In some countries
• Ensuring in-service testing, functional tests of valves, snubbers, etc.	All countries
• Checking for monitoring of neutron fluency	All countries/
• Lift-off tests on reinforcing tendon in concrete structures strip-down examination	some countries
• Assessing results of inspection against criteria from safety report or analyses	All countries
• Check for extent of temporary modifications or "work arounds"	4
• Review of control room logs and conditions	7
• Review of maintenance schedule/plan status and outstanding items	5
• Field observation during the maintenance work	7
• Team inspections for cause from maintenance issues	8
• Review of maintenance procedures for major activities	4
• Witness of tests for major jobs and new techniques	4
• Assessment of management involvement in maintenance planning and	7

implementation	
• Application of risk-based approach for prioritisation/ targeting of inspection according to the significance of plant on the overall risk (either on the basis of consideration of the PSA or by judgement which may include consideration of the PSA)	Some countries

4.2.4 SYSTEMATIC PROCESS FOR ASSESSING MAINTENANCE QUALITY AND EFFECTIVENESS

- Inspection Plan, including Assessing of Utilities, Self monitoring Plan, standards/goals
- Inspection of Aspects of maintenance by Specialists
- Inspection of Compliance with Maintenance rule Audits

4.2.5 PERFORMANCE INDICATORS

- Availability (e.g. by comparison with technical specialists' requirements)
- Deficiency reports - Trending of Numbers (i.e. plant defects)
- Non-conformance's with the maintenance plan (e.g. numbers of suspensions)
- Reliability data (e.g. reliability of diesel generators, shutdown systems, containment)
- Post-maintenance testing
- Number of events with poor maintenance as a cause

4.2.6 ACCEPTANCE CRITERIA

Maintenance inspection acceptance criteria under different levels of jurisdiction was reviewed and the results are recorded below:

a. State Regulatory Requirements

- For most countries represented, there are general laws and acts for nuclear installations with only very broad statements on the operation and state of equipment.
- Few countries have true maintenance regulations like US CFR-50-65 (dedicated to commercial reactors).
- Most countries have pressure vessel regulations, and also quality assurance regulations.
- One country has recently enacted regulations on training requirements

b. Industry codes and standards

These codes and standards define the criteria for design, but also apply to repair work.

They are mainly directed to mechanical equipment (e.g. standards for welding, non-destructive testing, etc.), electrical equipment and containment. Many are derived from US ASME and IEEE codes.

c. Plant regulation

Most NPPs have their own technical specifications within their operating rules which specify inoperability conditions for safety related systems. The operating rules include time limits for operating if repair is delayed or not possible while operating (therefore dealing with corrective maintenance rather than preventative maintenance.)

d. Specific Regulatory Requirements

In most countries, the regulatory bodies issue "generic letters" on important safety related problems (including maintenance), where new actions or tasks are required. Sometimes these letters can be prescriptive and even precursors to prosecution, in particular when outstanding non conformance's are found.

e. Quality Assurance in Field Work

The QA standards and principles are derived from state QA requirements. Several important issues addressed were:

- analysis of risk of common mode failure
- work hazard analysis
- quality control
- improvement of QA systems (handbooks, methods, etc.) through feedback loops

Acceptance criteria for the licensee's maintenance programmes should be identified in advance:

- Criteria for performance indicators
- Auditabililty
- Clearly stated goals
- Defined key responsibilities
- Long-term strategy (plan ageing, higher standards)
- Effective organisation
- ALARA (dose reduction)
- Pro-active approach

4.2.7 ESSENTIAL ELEMENTS FOR QUALITY MAINTENANCE

It was conducted that the following functions, when effectively addressed by a utility in its maintenance programme, will assist in providing a high level of assurance that quality maintenance will occur. It was also concluded that regulators checking for these in their inspection programmes would be able to predict performances.

a. People Function

- staffing and maintenance organisation
- qualifications and certification
- safety culture
- human factor evaluation

b. Material Function

- procurement
- receipt and inspection
- storage and issuance
- availability of parts
- relationship with supplier

c. Tool Resource Function

- availability
- control
- calibration
- maintaining the facilities

d. Co-ordination Function

- supervision
- work control

e. Information Function

- procedure
- up-date

4.2.8 FACILITATOR PRESENTATIONS

Presentations made by the facilitators on Plant Maintenance, summarising the findings of their discussion groups are provided in the following pages.

PLANT MAINTENANCE

GROUP 1

ESSENTIAL ELEMENTS OF MAINTENANCE

Found in 5 Functions

- **PEOPLE**
  - **Training and Qualifications**
  - **Safety Culture**
- **Material**
  - **Mostly availability of parts**
- **Tool Resource**
- **Information**
  - **Verified Procedures**
  - **Databases**
  - **Safety Classification**
- **Co-ordination**
  - **Prioritising**
  - **Operations Involvement**

CURRENT MAINTENANCE ISSUES

- **GROUP CONCLUSIONS**
  - **Control of Sub-Contractors**
  - **Interfaces between maintenance and reactor operation**
  - **Increase of maintenance during reactor operation**
  - **Need for re-evaluation of tests and qualification after important modernisation**
  - **Obsolescence of spare parts**
  - **Transparency between safety cases and maintenance schedules**

ACCEPTANCE CRITERIA

- **Found at different levels:**
  - **STATE REGULATORY REQUIREMENTS**
    - **Maintenance Regulations)**
    - **Pressure Vessel Regulations) For most**
    - **Q/A) Countries**
    - **Training)**
  - **INDUSTRY CODES AND STANDARDS**
    - **Mechanical Equipment (Ex: ASME Code)**
    - **Electrical Equipment**
    - **etc.**
  - **PLANT REGULATIONS**
    - **Technical Specifications**
  - **SPECIFIC REGULATORY REQUIREMENTS**
    - **Generic Letters in many Countries**
  - **Q/A IN FIELD WORKS**
  - **ESSENTIAL ELEMENTS ON MAINTENANCE (For 5 functions)**

ACCEPTANCE CRITERIA

- **MAINTENANCE PROGRAMMES SHALL HAVE ALL ESSENTIAL ELEMENTS**
- **FORMAL AND INFORMAL LINKAGES ARE IN PLACE**
- **THERE ARE CLEAR GOALS AND IMPROVEMENT PLANS**

PLANT MAINTENANCE

GROUP 2

TOPICS ADDRESSED

- **REGULATORY MAINTENANCE REQUIREMENTS AND MEASURES**
- **ASSESSING MAINTENANCE PROGRAMMES**
- **INSPECTING FOR MAINTENANCE QUALITY AND EFFECTIVENESS**

REGULATORY MAINTENANCE REQUIREMENTS

- REGULATORY REQUIREMENTS, STANDARDS AND CODES
- REGULATORY CHECKS
- SELECTION FOR INSPECTION

ASSESSING MAINTENANCE PROGRAMMES

- TRAINING AND QUALIFICATIONS
- EXPERIENCE FEEDBACK
- MINIMUM ELEMENTS
- PREVENTIVE MAINTENANCE PLAN
- CORRECTIVE MAINTENANCE CONTROL

INSPECTING FOR MAINTENANCE QUALITY AND EFFECTIVENESS

- METHODS AND TECHNIQUES
- PERFORMANCE INDICATORS
- ACCEPTANCE CRITERIA

REGULATORY MAINTENANCE INSPECTION PROGRAMME ELEMENTS

METHODS AND TECHNIQUES

- **Review of plant performance, system reliabilities, non-conformances, incident reports, etc. (8)**
- **Review of quality control reports for major repairs and modifications (8)**
- **Review of utility quality assurance and self assessment reports (6)**
- **Meet and discuss with utility staff and sub-contractors at different levels (4)**
- **Review of maintenance plans for selection of tests and hold points (5)**
- **Review of test and surveillance results for major repairs (6)**
- **Post maintenance walkdown of system (5)**
- **Check for effectiveness of committed corrective actions resulting from major non-conformances (2)**

REGULATORY MAINTENANCE INSPECTION PROGRAMME ELEMENTS

METHODS AND TECHNIQUES (cont’d)

- **Check for extent of temporary modifications or “work arounds”(4)**
- **Review of control room logs and conditions (7)**
- **Review of maintenance schedule/plan status and outstanding items (5)**
- **Field observation during the maintenance work (7)**
- **Team inspections for cause from maintenance issues (8)**
- **Review of maintenance procedures for major activities (4)**
- **Witness of tests for major jobs and new technologies (7)**
- **Assessment of management involvement in maintenance planning and implementation (4)**

4.2.9 COMPILATION OF ISSUES

Each participant was requested to submit, as part of the registration process, a list of issues determined to be of particular interest in the related topics. Facilitators utilised these lists in structuring the various group discussion sessions. While not all issues were able to be considered, a major majority were covered. The complete listing[1] submitted for Plant Maintenance follows as reference to the reader.

- Methods for assessment of maintenance quality.
- Qualification of sub-contractors.
- Regulatory standards for maintenance.
- Performance Indicators.
- Assessing/inspecting extent of preventive maintenance programme.
- Assessing/inspecting maintenance procedures, drawings and calibration documents.
- Surveillance of subcontractors (by licensee).
- Relationship between reactor operation and steam/generator tubes ageing.
- Inspection of modification during maintenance period.
- Scheduling of maintenance.
- How does the regulatory body establish the rules for maintenance, such as the frequency or scope of overhaul and replacement of equipment
- How does the regulatory body apply these rules (see 11) to nuclear plants and evaluate the results.
- Risk-based inspection guides.
- Staffing, qualification and training.
- Maintenance Rule.
- What should be the special attention points of the regulatory inspection in the frame work of plant maintenance.
- Regulatory requirements for elements in the maintenance programme.

[1] The listing provided is unedited and may contain duplications or similarly phrased topics. No deletions were made in order to provide facilitators a good understanding of what participants wanted to discuss at the workshop.

- The extent to which the regulatory authority measures the standard and quality of maintenance activities.

- Balance preventive/corrective maintenance (reliability/availability).

- Maintenance effectiveness surveillance.

- Reliability centred maintenance.

- What do we mean by: Systematic assessment of maintenance programmes?

- What do we mean by effective and safe maintenance programme?

- Is it possible to develop acceptance criteria in this field.? If so, what would they look like?

- Maintenance during plant operation and during refuelling outages.

- Maintenance concepts, e.g., preventive, condition based and corrective.

- Elements essential in the maintenance programme.

- Regulatory requirements for elements in the maintenance programme.

- Maintenance programmes for check valves.

- Is there any procedure on the work permissions at NPPs to which the operating organisation obtains permissions to starting-up after preventive maintenance?

- How the regulatory authority measures the standards and quality of maintenance activities.

- Start-up routines after refuelling outage

- Regulatory point of view in connection with the follow-up maintenance in safety related systems.

4.3 ASSESSMENT OF SAFETY

Group 1	**Group 2**
Swab, M. - Czech Republic	Rico, M. - France
Aro, I. - Finland*	des Bouvrie, E.C. - Netherlands*
Baded, - France	Lang, H.-G. - Switzerland*
Wanlund, H. - Sweden	Mahew, R. - United Kingdom
Derbeyshire, D. - United Kingdom	Woodhouse, P. - United Kingdom*
Butcher, E. - United States	Caruso, M. - United States
Rae, A. - United Kingdom	Britten, I. - United Kingdom
Campbell, R. - IAEA*	McDermott, C. - Canada
Rohar, S. - Slovak Republic	
* Facilitators/Recorders	

4.3.1 ASSESSING A LICENSEE

The prime responsibility for ensuring “safety” in nuclear power plants lies with the licensee. One of the keys to reaching this objective, is the management of safety programme. An effective programme could contain elements such as its ability to: a clear safety policy, an organisation with clear safety responsibilities for competent staff, safety plans, safety performance measurement and review and audit processes. This will allow the organisation to recognise when a problem exists, accurately characterise the nature of the problem, develop solutions, implement the solutions with appropriate support and resources, and monitor the effects and make necessary adjustments.

The focus of this topic is essentially about the role of the inspector in assessing the management of safety in a licensee’s organisation and how this assessment is achieved. Various types of safety performance measures exist and each have a use in particular circumstances. The objective was to discuss different practices aiming to understand and identify aspects which can be utilised to evaluate effectiveness in relation to the management of safety. Some of the issues discussed included: the phases in introducing a safety management process, the use of management models to structure the process, responsibilities for the management of safety, safety targets and objectives, how individuals (both licensee and inspectors) know and understand their responsibilities for safety, evaluation methods utilised in assessing safety performance, criteria used by regulators in assessing safety performance.

All activities on a plant can be said to provide a regulator with some indication of a licensee’s management of safety process. Current inspection and assessment techniques in the various countries do not generally however focus upon the overall safety management system. The advantages of this approach is considered to be that both a licensee and a regulator can obtain a clear picture, based upon a chosen management model, of how safety is being addressed, both across the board and in specific areas. Figures 1 and 2 show this approach.

4.3.2 APPROACHES TAKEN

In order to develop and implement such a process, a phased approach is advocated. The phases would typically include:

a. The development of safety management program criteria to identify standards, skills and competencies in this area.

b. Identification of a licensee’s programme through documented evidence, a presentation or by inspection.

c. Assessment of a licensee’s management of safety programme against the identified criteria, and

d. Evaluation of the programme effectiveness.

Phase 4 would build upon current inspection activities but would focus upon what reports, events etc. are telling the licensee and regulator about the effectiveness of the management systems.

With this information the overall system can be evaluated and concerns fed back and discussed with licensee’s.

4.3.3 DISCUSSION ISSUES

Before the workshop the participants presented the following issues to be covered during the discussions grouped under the four categories:

a. Overall picture

- management of safety
- NPP documentation for defining safety management
- evaluation of safety performance

b Criteria

- evaluation criteria used by regulators
- safety targets and objectives

c. Methods

- use of safety criteria
- evaluation methods and practices
- regulatory audits

d. Specific tools

- role of safety performance indicators
- incident studies
- use of PSA
- use of ageing studies
- classification of systems

During the discussions different approaches to the assessment of safety management within the various countries were compared and analysed. Discussions were carried out in an open atmosphere and participants identified experiences. A number of ideas and practices which it was considered could assist them in addressing the topic of management of safety within the respective countries.

The topic was handled in two separate discussion groups. One of the groups selected the following specific topics for more detailed discussion.

- Evaluation of the Management of Safety including the role of safety performance indicators.
- Evaluation criteria used by regulators.
- Use of PSA by regulators for safety assessment.

The other group selected the following specific topic:

A process for assessing the Management of Safety in 4 phases.

- Development of Safety Management Program Criteria.
- Identifying Licensee Program.
- Program Assessment.
- Evaluation of Programme Effectiveness.

4.3.4 FINDINGS

a. TOPIC 1

Evaluation of the Management of Safety including the role of safety performance indicators.

Similarities

1. Most countries do periodic assessments of the Management of Safety.
2. Periodic assessments are fairly comprehensive; these make judgements on the actual implementation of these arrangements.
3. They are generally qualitative in nature.
4. The assessments are based on a snapshot or sample.
5. General acceptance that the assessment is a combination of deterministic and probabilistic approaches.
6. In most countries some indicators are used but these act as background information.

Differences

1. There are differences in regulatory approaches reflecting the degree of acceptance of quantitative methods.
2. There is no uniformity in reporting practices.
3. The degree of formalisation of assessment methodology is variable.

b. TOPIC 2

Evaluation criteria used by regulators.

1. The criteria are mainly qualitative.
2. Numerical scoring, where adopted, is based on subjective judgement.
3. There is a trend to formalising the criteria and its use.

4. There is a feeling that the evaluation should be more objective.

c. TOPIC 3

Use of PSA by regulators for Safety Assessment.

1. Some form of PSA is carried out for almost all reactors whether demanded by the regulator or not.

2. In some countries they are exploring the expansion of the use of PSA into the “operational” phase to inform the regulatory process.

3. There are international activities attempting to find whether a consensus exists on how regulators can use PSA e.g. CNRA 1997 “special issues topic”.

d. TOPIC 4

1. Focusing on a licensee’s management of safety programme is seen as an important additional tool in evaluating plant safety.

2. The group identified a number of phases for assessing management of safety which could be developed into a structured framework for use by regulators in their respective countries.

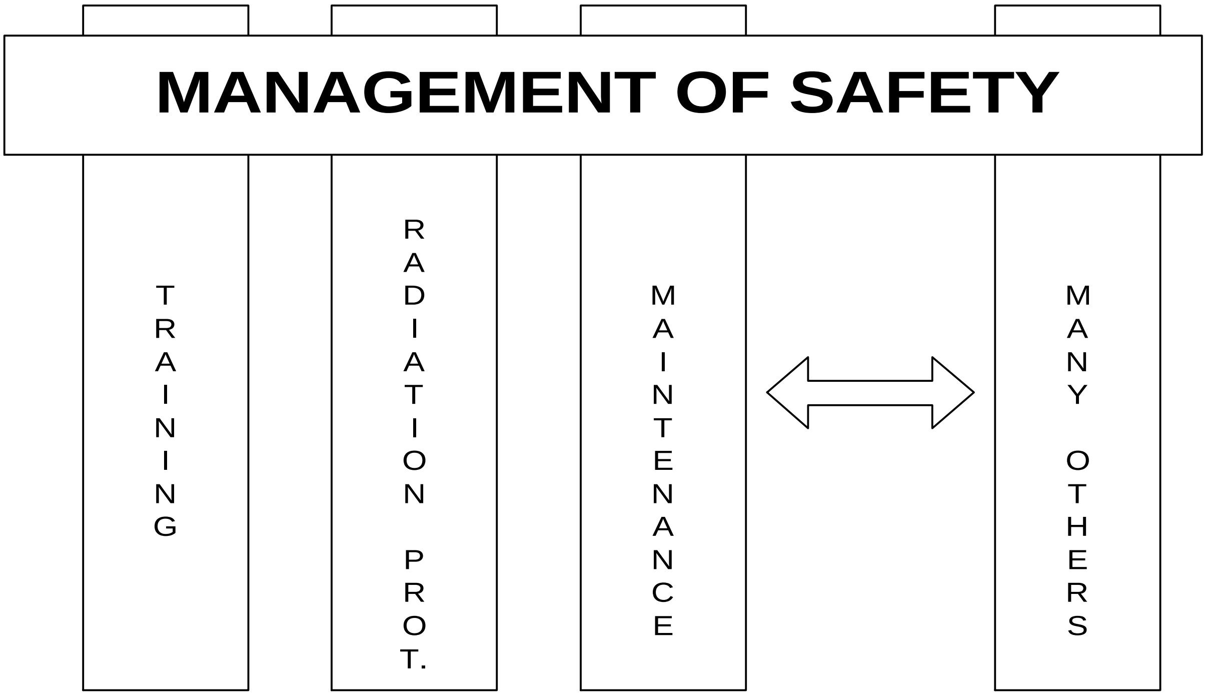

Figure 1

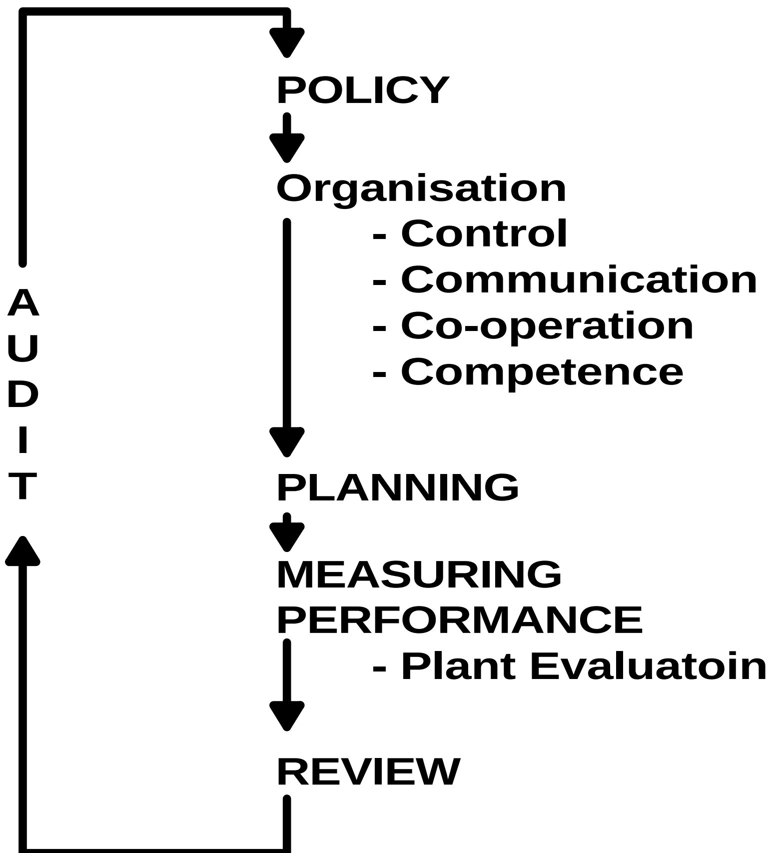

Figure 2

4.3.5 FACILITATOR PRESENTATIONS

Presentations made by the facilitators on Assessment of Safety, summarising the findings of their discussion groups are provided in the following pages.

ASSESSMENT OF SAFETY

GROUP 1

EVALUATION OF THE MANAGEMENT OF SAFETY INCLUDING THE ROLE OF SAFETY PERFORMANCE INDICATORS

SIMILARITIES

- **Most countries do periodic assessments of the management of safety**
- **Periodic assessments are fairly comprehensive; these make judgements on the actual implementation of these arrangements**
- **They are generally qualitative in nature**
- **The assessments are based on a snapshot or sample**
- **General acceptance that the assessment is a combination of deterministic and probabilistic approaches**
- **In most countries some indicators are used but these act as background information**

EVALUATION CRITERIA USED BY REGULATORS

- **THE CRITERIA ARE MAINLY QUALITATIVE**
- **NUMERICAL SCORING, WHERE ADOPTED IS BASED ON SUBJECTIVE JUDGEMENT**
- **THERE IS A TREND TO FORMALISING THE CRITERIA AND ITS USE**
- **FEELING THAT THE EVALUATION SHOULD BE MORE OBJECTIVE**

DIFFERENCES

- **THERE ARE DIFFERENCES IN REGULATORY APPROACHES REFLECTING ACCEPTANCE OF QUANTITATIVE METHODS**

- **THERE IS NO UNIFORMITY IN REPORTING PRACTICES**

- **THE DEGREE OF FORMALISATION OF ASSESSMENT METHODOLOGY IS VARIABLE**

USE OF PSA BY REGULATORS FOR SAFETY ASSESSMENT

- **SOME FORM OF PSA IS CARRIED OUT FOR ALMOST ALL REACTORS WHETHER DEMANDED BY THE REGULATOR OR NOT**
- **IN SOME COUNTRIES THEY ARE EXPLORING THE EXPANSION OF THE USE OF PSA INTO THE "OPERATIONAL" PHASE TO INFORM THE REGULATORY PROCESS**
- **THERE ARE INTERNATIONAL ACTIVITIES ATTEMPTING TO FIND WHETHER A CONSENSUS EXISTS ON HOW REGULATORS CAN USE PSA (e.g., CNRA 1997 'SPECIAL ISSUES TOPIC')**

ASSESSMENT OF SAFETY

GROUP 2

PHASE 1

- **RECOGNITION/ACCEPTANCE THAT MANAGEMENT OF SAFETY(MOS) IS A PROCESS IN ADDITION TO OTHER SAFEGUARDS (E.G., GOOD DESIGN)**
- **CRITERIA/LEGISLATION/GUIDANCE EXISTS IN SOME COUNTRIES AND IN IAEA/NEA GUIDES AND REPORTS (MODELS FOR MOS)**
- **CREDIBILITY WILL DEPEND UPON COMPETENCE IN THE AREAS OF ASSESSING AND INSPECTING MOS SYSTEMS (TRAINING)**
- **LICSENING/UTILITIES ARE RESPONSIBLE FOR SAFETY AND IDENTIFYING APPROPRIATE MANAGEMENT SYSTEM**
- **LICENSEE SHOULD HAVE A SUMMARY DESCRIPTION OF THIER MANAGEMENT SYSTEM**
- **ALL INSPECTION ACTIVIITES SAY SOMETHING ABOUT MANAGMENT - BUT REGULATORS NOT FOCUSED SPECIFICALLY UPON IT.**

PHASE 2

- **LICNESEE SHOULD DESCRIBE HIS SAFETY MANAGEMENT PROGRAMME INCLUDING DESCRIPTION OF HOW TO ACHIEVE / MAINTAIN A GOOD SAFETY CULTURE (AT STAGES IN PLANT LIFE**

- **LOOK FOR IT**

- **[DESCRIPOTION] COMPATIBLE WITH SAFETY REPORTS/REGULATOR APPROVED PROCEDURES**

- **PRIORITISATION**

PHASE 3

- **ASSESSMENT AGAINST STANDARDS/CRITERIA/MODEL (e.g. SAFETY GUIDES, RULES, CODES, ISO 9001, MANAGEMENT MODEL (ASCOT, OSART, ASSET))**
- **CONSISTENT WITH OTHER SAFETY REPORTS**
- **HOW DOES OEF COVER SAFETY MANAGEMENT ISSUES**
- **INDEPENDENT COMPONENT IN AUDITING SAFETY**
- **SENIOR MANAGEMENT HAVE A SYSTEM FOR MONITORING SAFETY**
- **DOES IT INCLUDE CONTINUOUS IMPROVEMENT PROCESS**
- **THERE IS A SYSTEM FOR CORRECTIONS**

PHASE 4

- **INSPECTIONS/AUDITS CARRIED OUT BY BOTH LICENSEE AND REGULATOR. ALL ACTIVITIES SAY SOMETHING ABOUNT MANAGEMENT**
- **REPORTING NORMAL OPERATION [AS AN INDOCATOR OF SUCCESS]**
- **USE OF REPORTING**
- **CHECKS ON**
  - **DAILY LOGS** - **MINOR EVENTS**
  - **MINUTES OF MEETINGS** - **CLOSE OUT ACTIONS**
  - **RESOURCES** - **RESPONSE TO EVENTS AT OTHER PLANTS**
  - **MANAGEMENT WALKABOUTS** - **TRAINING**
  - **CONTRACOTR MOS** - **UNDERSTANDING OF DESIGN BY STAFF**
- **INDENTIFY AND FOCUS ON AREAS OF PLANT WHICH USE MANAGEMENT TO REINFORCE SAFETY (PSA0**
- **DO ALL PLANT STAFF HAVE SAME MESSAGE ABOUT SAFETY CULTURE**
- **AWARENESS OF EXTERNAL PRESSURES**
- **USE OF TECHNIQUES IN ANALYSING SIGNIFICANCE OF EVENTS (e.g. PSA)**

4.3.6 COMPILATION OF ISSUES

Each participant was requested to submit, as part of the registration process, a list of issues determined to be of particular interest in the related topics. Facilitators utilised these lists in structuring the various group discussion sessions. While not all issues were able to be considered, a major majority were covered. The complete listing[1] submitted for Assessment of Safety follows as reference to the reader.

- Role of performance indicators in the assessment of a licensee's management of safety.
- Inspector qualifications.
- Declaration of incidents.
- Number of waivers.
- Classification method of systems, structures and components.
- Exploitation of ageing management's results in assessment of safety.
- Safety targets and objectives.
- Criteria used by licensee and regulators in assessing safety performance.
- Management of safety.
- What criteria are (being) used in the assessment of safety. The following should be covered: the technical, organisational, administrative and personnel provisions of the NPP.
- Is it necessary to perform audits by the regulatory body? If yes, should it be done using a basic audit checklist.
- Various types of safety performance measures exist and each have a use in particular circumstances.
- Evaluation methods utilised in assessing safety performance.
- How individuals know and understand their responsibilities for safety.
- Diverse safety performance evaluation tools.
- Evaluation methods used in assessing safety performance.
- Practices for assessing safety management, safety performance and safety culture.
- Criteria and training in assessing (see 18) above issues.

[1] The listing provided is unedited and may contain duplications or similarly phrased topics. No deletions were made in order to provide facilitators a good understanding of what participants wanted to discuss at the workshop.

- Indicators for plant’s safety management, safety performance and safety culture.
- Requirements and responsibilities for the management of safety.
- Evaluation methods utilised in assessing safety performance.
- What general documents determine safety performance at NPPs?
- Requirements for the management of safety.
- Evaluation methods to measure safety performance.
- Tools for periodic safety assessment.
- Evaluation of the Safety Performance of Licensee’s.
- Use of safety criteria.
- Use of PSA in making regulatory decisions.

5. CLOSING PLENARY SESSION

5.1 NII PRESENTATION / POSTER SESSION

During the morning session the facilitators met to review the work of the groups and prepare reports for the final workshop presentations. Participants were offered the opportunity to attend a special session prepared by the NII. The first part consisted of 3 presentations as follows:

- The Work of the Nuclear Installations Inspectorate - Bill Ross, Deputy Chief Inspector
- Periodic Safety Reviews - Dick Howard, T/Superintending Inspector
- Sizewell B Commissioning - Bill Ascroft-Hutton, Superintending Inspector

These presentations were followed by a poster session which was also put together by NII on the following topics:

- Maintenance
- Inspection Planning
- Assessment of Safety
- Plant Commissioning / Sizewell B
- Periodic Safety Reviews
- Decommissioning / Radwaste
- Emergency Arrangements
- HSE - NII Structure and the work of NII

5.2 PRESENTATION OF TOPICS

Prior to the presentations made by the facilitators for each of the discussion groups, the session Chairman, Dr. Van Binnebeek, provided brief impressions on the overall issues covered by the participants during workshop. These views are outlined in the following paragraphs.

This conference dealt with two rather technical issues (Inspection Planning; Maintenance), and a more human related issue (Management of Safety).

The technical issues were handled relatively easily by the groups, who faced only some communication problems when dealing with the definition of some concepts. It is worthwhile to be mentioned that the coverage of the groups dealing with the same topic was rather diverse and complementary.

The aspect “management of safety” was not only handled in the frame of the third topic of this conference, but it was also tackled indirectly in the framework of the two other topics. As an example, when a group on Plant Maintenance concludes that the utilities have to strive for continuous improvement, they actually tackle their management of safety.

The management of safety is clearly a concern to every Regulatory Body in the world. It is a subjective matter and its importance is enhanced by the economical, political and legal contexts in each country.

5.3 PRESENTATIONS BY FACILITATORS

Each of the facilitators for the 6 discussion groups made a short presentation describing the work performed by the group, the nature of the discussions and the conclusions which were derived. The floor was open for questions from all participants following these presentations.

5.4 CLOSING REMARKS

In closing the workshop, Dr. Van Binnebeek offered the following remarks:

I come now to the conclusion of this conference, which assembled about 60 participants from OECD and non OECD countries.

From the impression I got during the group discussions and from the facilitators’ presentations, it is obvious that the exchanges were everywhere dense and fruitful. A lot of ideas and practices have been uncovered for the benefit of all of us, and could be used with some adjustments in our own country.

The basic function of such a workshop - meeting with others doing the same job and confronted with the same problems - was undoubtedly reached. The exchange of ideas has continued outside the group discussions and has led to relationships between individuals that could lead later to further bilateral contacts.

All this makes this conference a success and YOU are the ones who made it by your dynamism, your curiosity and your capacity to understand the others. I thank all of you for that. I wish especially to thank the facilitators and the recorders for the work they have produced: most of you are perhaps not aware that, on Sunday afternoon , after receiving a training refreshment, they worked hard to set up the sub-topics to be presented at the first group sessions.

For the organisation:

First, I want to thank the UK, and especially the Health & Safety Executive, NII for the great organisation of this meeting. We were provided with the most appropriate environment to be able to work efficiently: this hotel was a very convenient place with all the necessary accommodations, not speaking of its very agreeable location.

I wish to express my thanks to Dr. Sam Harbison, NII chief Inspector, for having hosted this conference. Also my thanks to Tom Warren who took the trouble to organise all this, pushing the professional conscience to check the public transportation features. I know he had some hard time.

I want to express a special thank, in the name of all the participants, to what I call the underground contributors to this conference: Mrs. Wendy Cooper, Mrs. Margaret Bracken and Mrs. Linda Eckersall. They made a lot of the detailed organisation and delivered us all the help we needed on a timely manner. As they are not here, I will ask Tom Warren to pass them the expression of our gratitude.

Finally once more I thank everybody for his/her contribution to this meeting.

5.5 SITE VISIT

Participants were invited to visit the Wylfa Power Station, located in Northern Wales, on the day following the conclusion of the workshop. Those attending were provided a presentation by plant staff and tour of the site.

6. EVALUATION

6.1 EVALUATION FORM

All participants at the workshop were requested to complete an evaluation form (see Appendix VI). The results of this questionnaire summarised below, will be utilised by WGIP in setting up future workshops and to look at key issues for in the programme of work over the next few years. Of the 55 total participants 51 responses were received.

The evaluation form, which was similar to ones issued at previous workshops, asked questions in 4 areas: general - workshop objectives, workshop format, workshop topics and future workshops. Participants were asked to rate the various questions on a scale of 1 to 5 (with 1 being a low (poor) score and 5 being a high (excellent) score. Responses were received from all workshop (52) participants.

Results are provided in the following tables (which also reflect scores from the 2nd workshop - for comparison purposes) along with a brief written summary.

6.2 GENERAL - How well were the following objectives met?

		1996	**1994**
1.	**Exchange of information on Regulatory Issues.**	**3.92**	**3.81**
2.	**Discussions on Current and Future Inspection Issues (with counterparts from other countries).**	**3.65**	**3.44**
3.	**Development of Conclusions on the Workshop topics.**	**3.54**	**3.69**
4.	**Identification of methods (new or different) to improve Inspection programmes in your country.**	**3.22**	**3.16**
5.	**Value of meeting with inspectors from other Organisations.**	**4.27**	**4.42**

Results were generally in-line with the results of the last workshop. Comparison of the individual questions with those from the last workshop show improvement in objectives 1, 2 and 4, while a slight decrease occurred in 3 and 5. The changes do not appear to be significant and the overall scores indicate that the inspectors gain significant insight from attending these workshops.

These figures also show that participants regard the value obtained from meeting with inspectors from other organisations to be the most beneficial objective of these workshops. One noted improvement from the previous workshops, the addition of more social events (especially the dinners arranged in which groups sat together) was mentioned as extremely successful. these events helped participants get to know each other early on, which enabled the technical discussions to proceed much quicker. Other comments made by participants was the need to make pre-workshop material available at an earlier date and provide more time to discuss different countries practices.

6.3 WORKSHOP FORMAT - How effective were the following?

		1996	1994
6.	**Opening Session (presentation of workshop topics).**	**3.67**	**3.93**
7.	**Discussion Group Sessions (thoroughness of discussions, sufficient time, etc.).**	**3.84**	**3.70**
8.	**Type of format (teams with facilitators and recorders)**	**4.22**	**4.01**
9.	**Participation by team members in discussions (All participants involved or only a few).**	**4.12**	**3.76**
10.	**Size of group adequate.**	**4.35**	**3.97**
11.	**Closing Session (Facilitator reports, panel discussion and evaluation).**	**3.43**	**4.00**

The workshop format was basically the same as used in previous workshop. Ratings in comparison to the last workshop showed improvement in the discussion group sessions while a noted decline in both the opening and closing sessions.

Part of the improvements in the discussions groups can be related to the fact that many of the facilitators have now gained experience from past workshops. More important was through lessons learned, the workshop committee was able to better co-ordinate the groups, e.g., as previously mentioned through more social events, ensuring that groups were set up to include diversity in membership, and most important, the size of groups was kept small in order to facilitate better communication.

The addition of a poster session on the third morning was noted in many of the comments made by the participants, as a very welcome and informative item. The added opportunity to meet and discuss informally in such a setting was rated very high. For a future workshop, this poster session could well be an ideal location to present the “flip chart” work of the individual discussion groups to all the participants of the workshop.

The decline in ratings for the opening session, while not overly significant, appears to reflect the need to more adequately address the topics in the way they will be discussed at the workshop, instead of the broader aspects. The closing session rating declined notably from the previous workshop. This may in part be based on the complexity of the topics chosen. Nonetheless, good conclusions were obtained form the discussions, although it was apparent that changes in the way results are presented and the need for more time discussing these conclusions is necessary. The WGIP will focus on this aspect in regard to future workshops.

6.4 WORKSHOP TOPICS - Were the topics adequately addressed?

12.	**Inspection Planning.**	**4.00**
13.	**Plant Maintenance.**	**3.98**
14.	**Assessment of Safety.**	**3.71**

Participants were satisfied with how the topics were addressed during the workshop. Most mentioned in the comments was the difficulty presented in discussing the assessment of safety. A few suggestions noted that it may be helpful to have more discussion time allotted during the workshop. Again, these scores were very comparable to those received by the topics discussed at the last workshop.

6.5 FUTURE WORKSHOPS

<table>
<tr><td>15.</td><td colspan="4">Should another Inspection Workshop be held?
If yes, please answer the following.</td><td colspan="2">1996
Yes 47
No 3</td><td>1994
Yes 46
No 2</td></tr>
<tr><td>16.</td><td>How many topics should be covered?</td><td><u>Topics</u>
1996
1994</td><td><u>1</u>
3
2.5</td><td><u>2</u>
10.5
6.5</td><td colspan="2"><u>3</u>
29.5
37</td><td><u>More</u>
5
0</td></tr>
<tr><td>17.</td><td colspan="4">Length of workshop (days) - Working sessions only - not including site visit (e.g., currently 3 days)</td><td><u>Days</u>
1996
1994</td><td><u>3</u>
28.5
26</td><td><u>4</u>
17
19</td></tr>
<tr><td>18.</td><td colspan="4">Should the format be similar (discussion groups with facilitators and recorders)</td><td colspan="2">1996
Yes 47
No 0</td><td>1994
Yes 46
No 2</td></tr>
</table>

Participants were asked whether additional workshops of this type should be held in the future. The response shows that 94% answered yes. When asked about the number of topics, type of format, and length workshop, participants supported the same format presently used: e.g., 61.5% for 3 discussion topics, 60 % for 3 day workshop and 100% of respondees to maintain the present format.

6.6 FUTURE TOPICS

(Participants were given a choice of 6 different topics or could elect to suggest other topics and then asked to prioritise 1,2,3, etc. (final basis was a scale of 1 thru 6, with 1 being the highest). These responses were weighted (e.g., 1 equals 6 pts, 2 equals 5 pts, ... , no response equals 0 pts). The highest possible score is 300 pts (highest rating of 6 times 50 responses). The results were as follows:

A.	**Inspection activities of licensee actions in emergency planning.**	**110**
B.	**Inspection activities related to core reload issues.**	**96**
C.	**Future of regulatory organisations and inspection practices.**	**183.5**
D.	**Probabilistic Safety Assessment (PSA) use in inspection activities.**	**138**
E.	**Operator training and licensing.**	**93**
F.	**Inspection of operational licensing basis.**	**124**

Other suggested inspection related topics suggested:

1. Resources
2. Contractorisation
3. Chemical plant regulation
4. Safety performance indicators
5. Management of regulatory activities
6. Development of organisational performance indicators for regulatory needs
7. Periodic safety reviews (2)
8. Inspector qualification & training
9. Assessment of management of safety
10. Inspection of technical safety
11. Evaluation of inspection effectiveness
12. Performance based inspection system (2)
13. Assurance of correct plant configuration
14. Inspection of safety case
15. Inspection activities related to human factors
16. Waste management
17. Ageing management
18. Regulatory safety assessment function
19. Inspection activities during shutdown
20. Quality assurance
21. Different types of criteria and performance indicators
22. Use of on-line safety monitors for operational safety management (PSA based computer programmes running in real time)
23. Control, maintenance planning and outage management
24. Management of safety evaluations
25. On-line maintenance
26. Human error evaluation
27. Standardisation of inspection terminology
28. Assessment of safety
29. Management of inspection activities
30. Prescription vs. Non-prescription
31. Inspection needs of old operating plants
32. Inspections needs of decommissioning plants
33. Inspection needs of radioactive waste hazards

As shown the highest rated topics were: Future of Regulatory Organisations and Inspection Practices, Use of Probabilistic Safety Assessment in Inspection Activities, and Inspection of Operational Licensing Basis. The WGIP will look closely at these as well as the other suggestions in regard to scheduling a future workshop.

6.7 GENERAL COMMENTS

Below are listed some of the general comments made by participants of the workshop:

- Agreeing on definitions issues and the like, take up a good portion of the first discussion session. Perhaps setting up a small working group (by WGIP) in advance, for each topic, to prepare the work for the discussion groups would be beneficial.

- It may be interesting to organise a ‘training seminar on a specific topic, in conjunction with the workshop.

- The workshop was very valuable to help improve inspection programmes in my country.

- The format was excellent in terms of providing many opportunities for one-on-one exchanges. This is very important and should be a feature of all working groups activities.

- This was one of the best international workshops I have experienced in terms of developing a good understanding of the different regulatory philosophies and inspection approaches.

- More time should be given to the final discussion group presentations and subsequent discussions. I believe many good ideas raised in the groups were not covered.

- The first and second night formal dinners, with discussion groups seated together was a very good idea. People got to know each other in a pleasant setting and were then able to ‘hit the ground running’ when the technical work began.

- Consider assigning 3 facilitators per group. In this way one can be used part time as a recorder allowing each one of the primary facilitators an opportunity to be a participant.

- The facilitator meetings were essential to keeping the workshop on course.

- I consider it to have been a very successful conference. The participants were open, dedicated, authentic and also tolerant.

7. CONCLUSIONS

The following conclusions were formulated based on the results of the workshop:

- As the third workshop on regulatory inspection practices held by the CNRA Working Group on Inspection Practices, this venue continues to provide one of the few opportunities in which inspectors of nuclear power plants can get together to share and exchange ideas.

- Exchange of information on regulatory inspection issues, such as the topics focused on at this workshop provides the chance for inspectors from different countries and backgrounds, the chance to learn and understand new or different inspection methods and applications. This aids in the improvement and development of inspection practices throughout the many countries involved.

- Even with a diverse group of participants, from countries in which different cultures and languages exist, it is possible for people to communicate and exchange ideas. Providing the correct environment, with not only interesting technical sessions, but also, planned social events, allows people the opportunity to get to know each other which in turn produces a successful meeting.

- The results of discussion groups provided within this report provides the basic elements which can be utilised by the participants to develop more detailed information and programmes.

- As has been noted in the previous workshops, in spite of differences that exist, whether it be organisational, cultural, economic, etc., all countries represented at the workshop share a common understanding of nuclear safety principles. While it is inherently the utility or licensee who has responsibility for safety, it is apparent that the regulatory body constitutes a defacto safety barrier.

- The Inspection Planning discussion groups selected 5 main issues relating to the topic. These were: resources, programme content, routine and reactive or special inspections, inspection findings, and management assessments. Within these issues, discussions focused on various topics such as: types of assessment programmes, use of performance indicators, QA reviews, inspection frequencies, etc. Further details of these discussions are covered in Chapter 4. Both groups were able to derive general conclusions for the 5 main elements.

- Both groups on inspection of plant maintenance activities addressed 3 major factors: Regulatory maintenance requirements and measures, assessment of maintenance programmes, and inspecting for maintenance quality and effectiveness. The groups were able to establish a list of essential elements required for quality maintenance and acceptance criteria. Additionally the groups discussed various methods and techniques used by countries for inspecting maintenance programmes and developed a list of essential elements needed to provide a high level of assurance that quality maintenance will result.

- On the assessment of safety topic, the each group looked at a slightly different area of the topic. One group selected specific issues: evaluation of the management of safety including the role of safety performance indicators, evaluation criteria used by regulators, and the use of PSA by regulators for safety assessment. The other group looked at the specific process for assessing the management of safety. They broke this down into 4 phases: development of safety management programme criteria, identifying licensee programme, programme assessment, and evaluation of programme effectiveness. The focus of this topic is essentially about the role of the inspector in assessing the management of safety in a licensee's organisation and how this assessment is achieved. Various types of safety performance measures exist and each have a use in particular circumstances. The objective was to discuss different practices aiming to understand and identify aspects which can be utilised to evaluate effectiveness in relation to the management of safety.

- Results of the evaluation showed that participants agreed that the main workshop objectives were met. Discussion group sessions were greatly improved from previous workshops, while further study needs to be accomplished to provide better opening and closing sessions.

APPENDIX I - COMPILATION OF COUNTRY PRACTICES

INSPECTION PLANNING

ARGENTINA

Presently, Argentina has two NPPs - Atucha I (PHWR, 340 MWe, natural uranium, heavy water and pressure vessel) and Embalse (CANDU 640 MWe, natural uranium heavy water and pressure tubes) which have been in commercial operation since 1974 and 1984 respectively. A third NPP is presently in an advanced stage of construction, Atucha II (same as Atucha I, but 650 MWe).

The regulatory activities in Argentina include: Inspections and audits performed to verify compliance with both operation and construction licenses; independent safety analysis and assessments; the issuance of formal standards and guidelines; analysis of incidents; and personnel training, both for those responsible for safety in practices submitted to control and for those performing regulatory activities. Concerning NPPs, the National Board of Nuclear Regulation (ENREN), has established a set of minimal requirements that are mainly based on fundamental safety objectives. The regulatory approach is probabilistic in nature and involves a criterion for risk acceptance in NPPs based on the concept of individual risk and using the philosophy underlying the ICRPs dose limitation system.

Regulatory inspections are carried out through the programme on a routine and non-routine basis. Routine inspections are related to routine plant activities: they involve monitoring the process and verifying compliance with the applicable regulations (Operation/Construction Licenses) and standards. They are usually performed by an on-site resident inspector who applies the regulatory criteria and acts as a direct liaison between the ENREN and the NPP. Non-routine inspections are performed when specialised expertise is required for monitoring specific activities. They are carried out by other ENREN inspectors and serve to support and supplement the on-site resident's activities.

Basically, overall inspections involve: the assessment of hardware-availability; hardware challenges; administrative controls and operators actions; and the verification of certain items, through carefully selected sampling, to determine whether processes are within the acceptable tolerances. The inspection programme does include matters that specific for each installation, as described in the operating license, basically taking into account the type of installation and operational experience.

NPP safety assessments include a systematic review of the ways in which structures, systems and components might fail and an identification of the consequences of such failures. Several methods have been developed for assessing whether safety objectives are met or not. These methods are applied during the design and construction stages, as well as during operation - on the basis of operational experience - and when evaluating modifications in the plant configuration. Both a deterministic and a probabilistic method are currently being used - supplementary - in safety assessments. The former involves: thermohydraulic analysis, reactor physics, structural integrity, control systems and human factors, so as to ensure that the appropriate safety margins are attained. The latter, in which PSA is applied, serves to ensure a sufficiently low global risk and sufficiently high and well-balanced reliability in safety-related functions.

The ENREN pays close attention to relevant events occurring at domestic plants - which must be reported in accordance with the license - as well as those occurring at foreign plants, whose details are obtained through various information channels, such as the IAEA IRS. Every relevant event which occurs in a domestic plant is submitted to an independent in-depth analysis, in which both the deterministic and the probabilistic methods are applied so as to minimise recurrence. In the case of relevant events occurring in foreign plants, an in-depth analysis is carried out to determine whether a similar event could be expected to occur in a local plant.

PSAs constitute an analytical technique aimed at integrating diverse matters related to design and operation, so as to assess risks in a particular NPP and develop a data base that allows for analysing both plant-specific and generic issues. The ENREN requires a full scope PSA as part of its regulatory philosophy. Furthermore, PSAs are used by the ENREN as a regulatory tool for the analysis of reliability, human actions and precursors. In the future, they will also be applied to risk-based inspections.

Reliability analysis serves to identify safety significant components and their failure modes and, in order to achieve the reliability targets in safety systems, an a analysis is performed of preventive and corrective maintenance, as well as of downtime (excessive or insufficient), of high component failure frequencies and of surveillance - under the light of reliability.

Human actions involved in the analysed accident sequences, the most important pre- and post-accidental errors and the major human error contributors are identified and inspected, as well as recovery actions.

Precursors are operational events or plant conditions constituting an important part of a postulated core-damaging accident sequence. Their analysis provides a systematic evaluation of events and a probabilistic estimate of how close was the plant to core damage and of plant vulnerabilities.

Risk-based inspections aid inspectors in selecting safety systems or components to be inspected on the basis of their ranking and of their failure modes, as established in the plant's PSA. Consequently, among the regulatory applications of the PSA, plant specific risk-based inspection guides (RIGs) are going to be issued for the NPPs in operation. Furthermore, risk-based inspections shall provide a system walkdown including a checklist containing only items related to dominant failure modes. RIGs, will contain the dominant accident sequences, a system priority list and the identification of the risk significant items by system, with accompanying inspection recommendations, common cause or dependent failures and important human errors.

BELGIUM

Belgium has seven power reactors on two sites. Under the Belgian nuclear regulation, the Belgian state delegates the inspection in the nuclear power plants to a Licensed Inspection organisation (LIO), AV Nuclear (AVN). The inspectors within the LIO are themselves personally licensed by the responsible Ministries.

The basic inspection team consists of one inspector per nuclear unit, with a supervising staff. Support is provided by various experts. As an average, the inspectors are present in each unit about twice a week.

The inspection programme consists of different type of inspections:

1.1 Periodic Monitoring of predefined activities (quarterly for each topic)

It covers all the following activities:

- Radioactive releases

- Effluents and waste treatment
- Chemistry and Radiochemistry
- Radiation Protection
- Conventional safety
- Operation
- Tests
- Nuclear support
- Mechanical maintenance
- Electrical maintenance
- Quality assurance
- Management
- Health Physics department (Legal aspects)
- Training centres

1.2 Specific inspections

- Licensing exams of control room operators
- Incidents
- Modifications or periodic reassessments
- On request

1.3 Unannounced inspections

They are performed at any time, in any field of activity, for specific tasks.

CANADA

The Atomic Energy Control Board (AECB) of Canada has resident inspectors at each of 6 stations. The number of inspectors varies between 3 and 9, depending on the number of reactor units at the station. These inspectors report to a head office.

Although the senior inspectors from each resident office typically meet every 5 or 6 weeks to discuss current issues, compare experiences and to co-ordinate approaches, inconsistencies have arisen. One of the areas that has been most susceptible to divergence relates to inspections, where frequencies, depth and coverage have differed to some degree from office to office.

To address this problem, the AECB carried out a study in 1993 and 1994 that redesigned the way inspections are planned and carried out. Emerging form this study were the following:

- a programme of 31 core inspections.
- minimum frequencies for each of these inspections, varying from monthly to tri-annually.
- a policy governing implementation of the inspection programme.
- procedures for each type of inspection.
- a standard for the development of inspection checklists
- an estimate of resource requirements, both at resident offices and from head office specialists.
- a procedure covering periodic reviews of findings.

Although the project was aimed at the establishment of a pro-active inspection programme to verify to consistent depth and coverage each station's compliance with regulatory requirements, it recognised also the need for reactive inspections. These inspections are prompted by such things as core inspection findings or events. They are discretionary but important, and complement the core programme. Whereas the core inspections are broad in nature, reactive inspections usually have a deeper focus.

Under the policy on programme implementation, each resident office must submit to head office a plan covering inspections over the ensuing 12 months. The policy requires that 15 to 20% of the resources from a resident office be allocated to the core inspections. Head office is responsible for monitoring and producing periodic reports on the uniformity, results and effectiveness of the inspections. To assist in this endeavour, head office management together with senior resident inspectors meet towards year-end with specialists in areas such as quality assurance and radiation protection to establish specific inspection goals and to agree upon a schedule. Resident offices are accountable to head office management for executing the programme in accordance with the schedule and procedures.

The procedures include standards that apply to checklist development and to the way AECB staff conducts inspections. At present, work on the development of the inspection checklists is in progress. The underlying objective of this work is inspection consistency - in scope and in depth. The checklists are not to resemble those used by licensee operators, but rather be designed to verify that operators have completed their checks effectively.

The approach encompassed by the programme does not assess individual inspections using criteria such as 'pass/fail' or 'satisfactory/needs improvement'. Most inspections alone do not gather enough information to make this assessment. Instead, resident inspectors meet every 3 to 4 months specifically to review findings and identify trends or the need for a deeper reactive-type inspection in a particular area.

At the end of each year, resident offices produce an annual assessment report on station performance against legal requirements, including compliance with the conditions of the operating license. To do this assessment, staff reviews all aspects of the station's operation and management. The results of inspections, investigations, event reviews and a set of performance indicators provide the source material for this assessment. Work is being done currently to develop a common set of indicators for single and multi-unit CANDU reactors.

FINLAND

Inspection planning for controlling nuclear safety of nuclear power plants is based on YVL Guide 1.1 in which general organisation of inspection activities is presented. There are two kinds of inspections namely periodic inspections and special inspections which are listed in Annex 1.

The programme for periodic inspections contain 48 different inspections covering the most organisational and technical issues in the nuclear power plant. The special inspections originate mainly from plant modifications and outage control as well as event inspections etc.

Annually the need for carrying out the whole inspection programme is considered and some of the inspections may be skipped. However, most of the inspections are carried out annually once, some of them more often. There are guidelines written for each inspection. Inspectors, however, have a possibility to take up those organisational and technical issues they consider as important which means that a routine-like inspection programme actually provides a large amount of flexibility.

For each inspection an inspection plan is prepared in advance. After the inspection an inspection report is written. Also a protocol and its appendix containing possible remarks are given to the power company counterpart. It is not obligatory to forward the inspection report to the power company but it is anyway a recommendable practice.

ANNEX 1

4. Regulatory control of operation

Regulatory control of operating nuclear power plants contains reviews and inspections which can be divided into three categories as follows:

- periodic inspections are specified and registered by STUK in a plant-specific programme,
- inspections which the power company is obliged to request in connection with measures carried out at the plant or which STUK conducts at its discretion, and
- safety assessment based on operating experience and on safety research as well as other information obtained after the granting of the operating licence.

For the purposes of regulatory control, STUK requires the submission of both fixed-term and event-specific reports. The requirements for reporting are presented in Guide YVL 1.5. The reports are used, on the one hand, for preparation of inspections and, on the other, for evaluation of safety enhancing measures and overall monitoring of the safety level.

In addition to the regulatory control of nuclear power plant operation, STUK maintains its preparedness to act in plant emergencies. In an emergency, STUK is the authority controlling accident management and an expert body providing assistance to the authorities in charge of the rescue services.

4.1 Periodic inspection programme

Inspections contained in the periodic inspection programme are focused at the power company's activities important to safety. The control aims at ensuring compliance with the regulations and the plans and programmes approved by STUK and at assessing the appropriateness of the power company's activities. In preparation for the assessment, examples of the implementation and results of the activities in question are reviewed in connection with each inspection.

The periodic inspection programme is drawn up by STUK and its contents are reviewed annually. The programme and the procedures to be followed in its execution are set out in an internal guide of STUK. The guide in question and the necessary amendments thereto are forwarded to the nuclear power plants under control for information.

The inspection programme covers the following main areas which are further divided into several, specific inspections:

- operating organisation, conduct of management and quality assurance,
- training of personnel, conduct of operations, maintenance,
- technical support functions, fire protection,
- radiation protection and chemistry, radiological safety of the environment, nuclear waste management,
- physical protection, and
- emergency response arrangements.

The inspection period for each item is defined in the periodic inspections programme. The inspection period usually is one year.

4.2 Special inspections

Special inspections are inspections which the power company is obliged to request in connection with the measures conducted at the plant, or which STUK conducts at its discretion.

Nuclear power plant operation includes activities which may be started only after STUK's approval of the activity has been granted. The execution of certain duties and the use of pressure retaining devices is tied to STUK's decisions. STUK's decisions are required also in connection with any changes to be made at the plants. An essential part of each decision is an inspection conducted prior to the making of the decision to justify it or to ensure afterwards the realisation of the proposed plans and of the decision's conditions. Requirements and obligations which apply to special inspections are presented in the YVL guides.

Inspection procedures and reference to the relevant YVL guides are presented in an internal guide of STUK. The guide in question and the necessary amendments thereto are forwarded to the nuclear power plants under control for information.

Special inspections cover the following items:

- documents concerning operation,
- competence of personnel,
- inspections concerning operational events,
- outage planning and execution,
- refuelling of reactor,
- in-service inspections,
- in-service inspections as referred to in the Decree on pressure vessels,
- repairs, modifications and preventive maintenance,
- post-outage plant start-up,
- procurement of nuclear fuel,
- safeguards, and
- exemption of nuclear waste from regulatory control.

The requirements for and control of nuclear power plant refuelling outages and repairs, modifications and preventive maintenance are addressed in Guide YVL 1.8 and WL 1.13.

4.3 Safety assessment

Assessment of nuclear power plant safety does not end in the granting of the operating licence but continues also during operation. This is necessary for the following reasons:

- Operational experience brings up issues to which adequate attention has not been paid.
- Safety research increases understanding of the effects of plant ageing and facilitates more accurate evaluation of transient and accident sequences.
- With the continuous development of nuclear power plant technology, it is appropriate to replace out-of-date components with new, improved ones.

– General views of the safety level to he sought after, and, accordingly, the safety requirements, change.

The need for and possibilities of improving safety are considered on the basis of a safety assessment made during operation.

4.3.1 Monitoring and analysis of operational events

Nuclear power plant operational events may be single transients or observations but also recurrent or common cause failures. On the basis of the reports submitted by the operating organisation and STUK's own inspection findings, STUK sets up an investigation team to analyse an event, if necessary. It is the team's specific duty to disclose the event's root causes and to come forth with objectives for corrective measures.

4.3.2 Operating experience abroad

In addition to operational events at the domestic nuclear power plants, STUK follows events at plants abroad. Event reports are received from international organisations (IAEA, OECD) and direct from the regulatory authorities of various countries. The reports are reviewed systematically and it is separately assessed for each domestic facility whether safety enhancing measures should be taken based on the lessons learned. Furthermore, STUK follows the measures taken by the power companies to review and assess operational experiences abroad.

4.3.3 Re-assessment of issues reviewed for an operating licence

STUK annually draws up a plan for the reassessment of the issues reviewed for an operating licence. The plan is made to contain items whose improvement might be well-grounded on the basis of new information yielded by safe research, the advancement of technology in general or changed safety requirements.

FRANCE

INSPECTION PROGRAMME FOR BASIC NUCLEAR INSTALLATIONS IN FRANCE

REGULATORY FRAMEWORK

The decree dated December I 1, 1963, relative to basic nuclear installations, states that nuclear installations are to be inspected (art. 11). The inspectors of basic nuclear installations are selected among the inspectors of "classified installations" by a joint order of both the minister in charge of environment and the minister in charge of industry. They operate under the authority of the head of the Nuclear Installation Safety Directorate (DSIN). The inspectors take an oath and are bound to professional secrecy.

GENERAL PRINCIPLES OF SURVEILLANCE

First, it's important to remind that a nuclear operator has the prime responsibility for safety. The French nuclear regulator, DSIN, performs safety inspections.

The safety authority sets out general safety objectives and the operators suggest terms and conditions for achieving these objectives. The DSIN, as the safety authority, checks that these terms and conditions will allow the objectives to be met. The operators implement the approved measures and the safety authority checks that these measures have been taken.

In order to perform these controls, an annual inspection programme is established by the DSIN, in concertation with the Regional Directorates (its local representatives) and the inspectors themselves.

Inspections take place at the plant site, at the operator's head office or in the workshops or design offices of a sub-contractor. In this case, it is still the plant operator of the nuclear installation who is the subject of the inspection. All these inspections constitute a source of know-how and an exceptional tool for safety problem assessment.

These surveillance visits enable the DSIN to ensure that the regulatory provisions are fulfilled by the operators and that plants are built and operated in compliance with their safety analysis reports.

INSPECTION ORGANISATION

THE INSPECTION PROGRAMME

Title annual inspection programme is established in advance between September to December of the previous year.

In a first step, the sub-directorates of the DSIN define the main themes which have to be examined. These themes may be grouped according to the following categories:

- general themes or technical aspects such as fire protection, training, reactor outages, on site emergency plan,
- priority themes for the year. For example, in 1996, it had been decided to put emphasis on EdF policy with sub-contractors, on radioprotection, on containment,
- specific inspections to some commissioning stages which are the subject of ministerial authorisations.

All these data are circulated to the inspectors, the IPSN Safety Assessment Department and the Regional Directorates to make their proposals for each basic nuclear installation.

The inspection programme is established by gathering all the proposals. It is then discussed between the DSIN sub-directorates. The aim of this programme is both to satisfy the requirements of an efficient surveillance of all nuclear installations and to focus attention on specific aspects. For 1996, the inspection programme contains about 700 inspections, among which about 6% are not announced in advance to the operators. In addition, subsequent to significant incidents, the DSIN can order, if necessary, an inspection of the plant.

The inspectors

The basic nuclear installation inspectors are generally recruited from:

- Administrative technical departments: the inspectors are experienced in the performance of technical tests and examinations in the nuclear or non-nuclear industries.

- The CEA: some inspectors have spent much of their professional life at CEA production or research units, thereby acquiring an extensive practical experience of nuclear installations. These inspectors often are specialists in specific fields such as instrumentation and control, chemistry of uranium compounds, fire-protection, radioactivity measurements, ...

From the administrative standpoint, inspectors are attached directly to the DSIN (about 40%) or to one of the nine regional DRIRE's nuclear divisions.

INSPECTIONS

The inspector's task

The inspector's task is to ensure that the installations are in accordance with the provisions laid down in regulatory documents (plant authorisation decrees, requirements accompanying commissioning authorisations, general operating rules), in operator's documents approved by the DSIN and in other commitments.

As the operator has the prime responsibility for safety, inspectors only carry out sampling checks. Inspectors do not systematically examine all the premises, all the circuits and all nuclear installation's problems, which would weaken the operator's responsibility. A sampling method is systematically used for DSIN inspections.

The inspection development

Very often, a surveillance visit is made by a team of two or three inspectors. For most of the inspections, the inspectors are accompanied by experts from the IPSN Safety Assessment Department (DES). These experts either are in charge of the follow-up of the inspected site, or specialists of a topic covered during the inspection. DES experts also participate in the preparation of the inspections.

An important step is the preliminary work. Inspectors have to look at previous reports on the same theme on other plants, to precisely select the subjects which will be examined. Inspectors can also use the inspection guides. These guides are established by a team of inspectors. They are only an assistance tool and they are not an exhaustive inspection outline. Right now, there are about twenty inspection guides such as sub-contractor surveillance, nuclear fuel, reactor outages, fire protection, in-service inspections, etc.

Except inspections without notice, the operator receives due notice, so that documents and the competent staff members can be made available on the day indicated.

Inspection and follow-up

Each inspection gives rise to a form signed by the inspectors and by the appointed representative of the operator. The inspectors record on the form their main observations. At the meeting held at the end of the inspection, they hand the form to the operator, who may add his own preliminary observations.

After the inspection, the inspectors send a report to the DSIN, indicating their observations and remarks. This usually gives rise to a notification or even injunctions sent to the operators as a letter from the DSIN, or from the DRIRE. Injunctions can extend up to ordering a shut-down of the installation. Particularly important problems are the subject of in-depth analysis by the DSIN and its technical support bodies.

Moreover, the inspection reports are used to issue synthetic reports on special subjects. These reports can give indications for other inspections on the subject concerned or for new inspectors. They are also useful in case the DSIN would decide to request further actions from the operator's head offices, such as a specific safety analysis or a review of the on-site practices.

GERMANY

The Constitution of the Federal Republic of Germany contains detailed provisions on the legislative and administrative competencies of the Federal (Bund) and the individual states (Länder). According to the Federal Atomic Energy Act, the supreme authorities of the Länder acting on behalf of the Federation, are responsible for granting licenses and for exercising supervisory and control functions.

Under the Atomic Energy Act, any person who constructs and operates or who substantially modifies a nuclear power plant or its operation must obtain a license. The licensing prerequisites are laid down in this act. Important prerequisites are:

- Reliability and qualification of the responsible personnel.
- Necessary knowledge of the operating personnel with respect to safe operation, possible hazards and safety measures.
- Necessary precautions in the light of the status of science and technology to prevent damage resulting from construction and operation of the plant.

The construction, operation and possession of nuclear installations are subject to continuous supervision. The supreme authorities of the Länder are responsible for exercising supervisory and control functions which they may delegate to subordinate agencies, in individual cases. In general, the Technical Inspection Agencies (TÜV) are involved as experts.

Regulatory Inspections and Surveillance, Inspection Planning

The inspection programmes cover all activities of the licensee related to the legal requirements and to the provisions of the Construction and Operational License of the plant.

During the construction of a nuclear installation or during implementation of modifications so-called accompanying controls are carried out, which are designed to ensure that the fabrication, construction and testing of all safety systems and components comply with the requirements of the permit. After start of operation, inspections are carried out at regular intervals.

The supervisory programme during the plant's service life includes:

- monitoring compliance with legal regulations and licensing notifications, adherence to safety regulations and guidelines,
- compliance with physical security regulations,
- inspection of safety deficits,
- safety reviews, assessment of Periodic Safety Reviews (PSR),
- plant operation, recurrent inspections and in-service testing,
- evaluation of abnormal occurrences,
- approval of minor modifications,
- control of radioactive discharges,
- control of nuclear waste management,
- operating the KFÜ-System (automatic transfer and recording system of important NPP-status, operation data, emission and immission data),
- radiation protection monitoring of personnel and environment, independent control of radioactive immissions,
- control of personnel qualification and training programmes.

On-site visits of regulatory authority personnel at the plant take place typically once a week. Contacts made at different levels (plant manager, shift manager, RP manager, section heads). There are no resident inspectors at the site. In many fields, the Technical Inspection Agencies (TÜV) are involved as experts.

ITALY

The Regulatory Agency has the task to verify the consistency of the safety envelope adopted for nuclear plants and the compliance of the construction and operation to the established safety requirements.

This means that an extensive inspection activity is necessary; more precisely a licensee 'inspection programme' and a regulatory 'verification programme' shall be carried out with the design goals.

The main objective of inspection activities translated into inspection planing, is to verify not only the strictly technical aspects, but also the organisation and management of the licensee.

These activities are performed on the basis of an annual surveillance programme which, also takes into account inspection results in previous years, and defines the checks for each plant.

The surveillance programme includes 2 main types of inspections: ordinary and extraordinary inspections.

The ordinary surveillance programme is always scheduled by means of internal criteria and procedures which define frequency and type of check; usually routine checks are devoted to verify the operating compliance with the accomplishments and duties which the licensee performs.

In extraordinary inspections the following can be performed:

- surveillance on particular tests
- surveillance on design, construction and final testing of new systems to be installed in connection with a review or a modification of the plant.
- surveillance on application of corrective actions due to previous inspections or as a result of an operating experience.

JAPAN

Commercial nuclear reactors in Japan are periodically inspected in accordance with the Electric Utilities Industry Law (research reactors and reactors under development are regulated by the Law on Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors.) The discussion here focuses primarily on commercial reactors while inspections and examinations carried out based on self-safety management by licensees are respected. Inspection planning are basically prepared by the licensees, and confirmed by the regulatory body with instructions being given as necessary. Before the inspections are carried out, the inspection planning of licensees are examined with regard to such items as the organisation, inspection system, quality control, measures to cope with accidents, education and training of personnel, qualifications, items to be inspected, and the frequency of inspections. These factors are confirmed not only in terms of checking prior to periodical inspection but also with respect to various aspects set forth by the regulatory body as described below:

(1) Review of overall Safety Management

The regulatory body periodically dispatches a project team to each power station to confirm the observance of the self-safety management manuals of licensees.

(2) The Resident Senior Specialist for NPP operation

The daily operation management by the licensee is confirmed by a Resident Senior Specialist. Statutory periodical inspections are not conducted by the resident senior specialist but by inspectors from the head office or regional branch offices of the regulatory body.

(3) Operation program (Shutdown program)

Licensees are required to submit their operation program for the fiscal year to the regulatory body by the end of January of the previous fiscal year for review.

The licensees explain their plan for periodical inspections to the regulatory body prior to shutdown, and the inspection system, frequency of inspection of equipment based on the long-term plan, inspection manuals and similar items of the licensee are confirmed by the regulatory body. The procedures for performing legally stipulated inspection are prepared for the individual licensee in the form of inspection manuals. Preparations for inspections to be witnessed by the regulatory body are made for individual plants by the licensee based on standard inspection manuals which are established beforehand taking into consideration the contents outlined below. The regulatory body mainly examines the contents for a specific plant.

1. Maintenance and Operation regarding the functions and performance of facilities based on the application for permission or the report of plant construction plans (including alterations) and technical standards.

2. Maintenance and Operation regarding the functions and performance of facilities based on the application for permission of installation or alteration of reactors.

3. The construction on the trouble shooting, inspections, etc. by the Technical Advisory Committee on Nuclear Power Generation of the regulatory body.

4. Prevention of the re-occurrence of major accidents and failures in the light of past experience.

The regulatory body inspects the reactor, facilities of the reactor cooling system, facilities of the instrumentation and control system, facilities of the waste disposal system and five other facilities in accordance with inspection manuals for 70 items. These inspections are based on the standard inspection manual, and are applicable to any plant. However, specific difficulties which arise individually are discussed at the Technical Advisory Committee on Nuclear Power Generation in order to examine and consider the causes of such difficulties and measures that should be taken, as well as the possibility of horizontal development to total plants.

In preparing for an inspection, the licensee discusses the inspection method, inspection system, and other pertinent matters with the regulatory body in advance and confirms the inspection manuals referring to past data. Reference is also made to other difficulties among the relevant parties such as the maintenance section, operation section and technical section within each power station, who carry out rehearsal inspections, as necessary.

Licensees wishing to implement any modification and repairs of the major facilities must first apply for the plant construction plans (alterations) again. The regulatory body then examines the appropriateness of such modifications and repairs and grants approval accordingly.

SPAIN

1. General Objectives and Policies Definition:

By the Commissioners

- Establishing long term priorities and corporate goals.

2. Technical Level Planning (General)

By the Technical Director

- Defining, in different areas of interest from the regulatory point of view. The most significant activities to be covered by the inspection programmes.

- Establishing short and medium term priorities and criteria for inspection planning.

3. Department/Project Level

By the different organisation department heads and project managers

- Generic Inspection programmes are defined, including inspections to be conducted in all plants. Exceptions, for individual plants, to these generic programmes are defined on a case-by-case basis. Typically, these generic inspections include areas such as:

Plant Operations - Inspection in this area are carried out mainly by resident inspectors Operators Training

Radiological Controls - Including; routine radiological controls (inspections on this subject are performed mainly by resident Inspectors), Effluent control, ALARA activities (mainly in refuelling outages), Solid waste generation and storage, and Environmental monitoring.

Maintenance and Surveillance Programmes - Including; Surveillance requirements (technical specifications) (This area covered mainly by resident inspectors), Maintenance programmes, Maintenance activities execution (inspections in this area are carried out mainly by resident inspectors), In-service Inspection activities (mainly in refuelling outages), Containment leak tests, Chemistry controls, and Environmental qualification.

Emergency Preparedness and Fire Protection Activities - Including; Emergency and fire drills, Emergency organisation and resources, and Fire protection activities.

Technical Support - Including; Design modification (mainly in refuelling outages), Personnel training and qualification, Operating experience review (both internal and external), Quality assurance activities, and Core design and performance.

- For every specific plant, inspections are also defined on an **individual basis**, including:

  - Relevant specific licensing issues.

Reactive inspections are generally anticipated for; Relevant reportable events and operating incidents and Poor or clearly declining licensee performance (e.g., high collective doses, repetitive events, safety systems low availability or reliability, enforcement actions recent history, etc.

- There are several auxiliary tools to improve inspection planning efficiency and objectivity:

Performance Indicators programme is available (2 year ago).

Pilot programme on **Systematic Assessment of Licensee Performance**, started this year. Expected to be a meaningful tool for future inspection planning improvements.

UNITED KINGDOM

1. In the UK, the regulation of safety at civil nuclear installations is undertaken through a licensing regime. The licenses are granted by the Health and Safety Executive (HSE) upon receipt of an adequate safety case, and each license granted has thirty five standard conditions attached to it in the interests of safety.

2. The conditions cover the proper control of all aspects of operations which may affect safety on or off a nuclear licensed site including design, construction, commissioning, operation, maintenance and decommissioning. As with other health and safety legislation, the operators of civil nuclear installations must comply with the requirements of the conditions or face prosecution.

3. The licenses are administered by HSE's Nuclear Safety Division (NSD). Inspectors from that division's enforcement arm, the Nuclear Installations Inspectorate (NII), monitor the management of safety on the site and enforce compliance with the licence, its conditions and other health and safety legislation both through safety case assessment and through a series of routine, planned inspections.

4. Historically, inspections have been planned according to a standard programme of 'basic' inspection which sets out target inspection frequencies against each one of the licence conditions together with other relevant health and safety legislation. NII site inspectors have then been required to complete their basic inspection programmes through the course of the year and to attend to all other matters associated with the regulation of the particular site they inspect. Such matters include dealing with safety case proposals for modifications, reactive work following incidents and general licence administration.

5. In line with current HSE views, NII will soon be modifying its approach to inspection planning so that the process will be based more on considerations of relative safety significance than on checking for compliance with the law. This step will introduce flexibility into the planning process, allowing attention and resources to be focused on those nuclear licensed sites and plant areas which have a higher safety significance or a poorer record of safety performance.

6. The intention is for each nuclear licensed site to have its own overall site inspection programme which will be drawn up by the site inspector. The programme will include all aspects of regulatory inspection covering reactive and licensing activities etc. (and/but) including a sub-programme of planned inspection against the requirements of licence conditions and other relevant legislation. The overall site inspection programme will be subject to regular review to take account of changing circumstances and of available time.

7. Unlike the current 'basic' inspection programme, the new planned inspection programme will be based on groups of associated licence conditions. These groups will form general inspection topics such as 'control of plant design and status' and 'control of operations'.

8. The planned inspection programme will also differ from the current ‘basic’ inspection programme by covering the various safety-significant processes or plants on the site and taking their relative safety significance into account through the inspection frequency that is attached to each one. Like the overall site inspection programme, these frequencies may be varied through the year according to safety performance considerations and consideration of other, safety-significant work demands being made on the inspector’s time. In accordance with the same considerations, the planned inspection programme itself may also be varied in its extent, although there will be an overriding requirement on site inspectors to have carried out as a minimum checks for compliance, at least once, for each of the licence conditions and all other relevant legislation within a two year period.

9. In summary, inspection planing for civil nuclear installations in the UK is moving towards a flexible, site-specific basis which is driven by considerations of relative safety significance and safety performance. Within this context, planned inspection programmes for licence conditions and other relevant health and safety legislation will be part of an overall site inspection programme for each particular site that will cover all aspects of regulatory work.

PLANT MAINTENANCE

BELGIUM

Maintenance inspections are performed during the periodic inspections on maintenance, but especially at the occasion of the outage period (preparation, follow-up of the outage activities and outage report discussion) or at the occasion of specific activities. The maintenance and corresponding test programme of the utility is examined on a spot-check basis to insure:

- that all the sensitive materials are covered (e. g; steam generator tubes, important valves,...)
- that the re-qualification criteria are adequately applied in conformity with the design
- that the system are unavailable on an acceptable basis (technical specifications and overall reliability of safety functions)

FINLAND

There are two major maintenance inspection areas namely inspections in relation to the annual outage period and maintenance related inspections included in the periodic inspection programme.

The periodic inspection programme contains several maintenance related inspections namely Maintenance Administration, Procurement of Equipment, Procurement of Materials, Spare Parts, Preventive Maintenance Programme, Condition monitoring of Piping and Seawater Systems, Maintenance of Buildings, Steel Structures, Lifting of Heavy Equipment, Concrete and Rock Structures in Waste Repository, Seawater Channels and Tunnels. Annually the extent of inspections is considered. There are inspection guidelines for each inspection.

There are Regulatory YVL Guides to control outage activities namely YVL 1.8 (modifications and large repair works) and YVL 1.13 (outage control) as well as internal YTO Guideline YTO 7.3 to control outage related inspection activities. Several special inspections are carried out during outage period namely Outage Planning and Execution; Refuelling of Reactor; In-service Inspections (ASME); In-service Inspections referred to in the National Pressure Vessel Code; Repairs, Modifications and Preventive Maintenance; Post-Outage Plant Start-up. These inspections are carried out when the power company asks for the inspection because these inspections are required for the continuation of the activities.

The above list of inspections and guidelines actually describes the extent of STUK activities rather well.

FRANCE

PWR PLANT MAINTENANCE IN FRANCE: KEY ISSUES FOR THE SUPERVISION OF OUTAGES BY THE DRIREs

1. INTRODUCTION

In France, the maintenance of the 54 PWRs, operated by EdF is mainly carried out during plant outages at refuelling shutdowns, and their regulatory supervision is implemented by the DRIREs (Regional bodies), on assignment from the DSIN (Safety Directorate for Nuclear Installations).

The DRIREs have gained much experience from such supervision, especially from 1989, when some failures occurred during maintenance operations, mainly due to lack of quality assurance. Since then, things have improved a lot in that respect, and the DRIREs now focus part of their effort on key issues of certain components, some of them in relation with ageing problems.

The DSIN constantly reviews and updates specific requirements regarding safety-related maintenance of such components, to be enforced by EdF site management's, such enforcement being supervised by the DRIREs.

2. ORGANISATION OF REGULATORY SUPERVISION WITH RESPECT TO MAINTENANCE PROGRAMMES AND IN-SERVICE INSPECTION

2.1 On the EdF side

Several years ago, EdF had drawn up a whole set of maintenance programmes of equipment or components, some of them being important to safety or related to safeguards systems, and/or to pressure vessel regulations.

Most of these programmes deal with preventive maintenance, consisting of in-service periodic inspections during outages, with associated procedures implemented under Q/C and risk analysis principles, one of them being to avoid the common mode risk.

Some of them deal more specifically with in-service inspection of primary components like vessel, main piping, bi-metallic joints, etc.: in that case, the programmes and procedures have to comply with the "in-service inspection rules for mechanical components of PWR nuclear islands", as well as various ministerial orders.

Other programmes deal with the secondary circuit or safeguards systems.

More recently, EdF has, in some cases, optimised these programmes by taking into account experience feedback (giving rise to "predictive" maintenance in relation with reliability), for example by adjusting the frequency of in-service inspections.

The inspection procedures themselves (like non-destructive testing of S/G tubes) must be qualified by EdF. Besides, the repair procedures (like plugging of S/G tubes, or complex ones like replacement of S/Gs, or pressure vessels) need also to be thoroughly qualified by EdF or main subcontractors.

Finally, it should be reminded that any maintenance field work is to be validated after subcontractors, and EdF is to make sure that their level of safety culture is adequate through qualification ratings, conduct of Q/C tests, etc.

2.2 On the regulatory authority side

Generally speaking, EdF is responsible for the safety of the PWRs and therefore is responsible also for the maintenance programmes with respect to safety. The regulatory authority checks that their implementation is done in accordance with the different regulations. Therefore in France the regulators do not perform any testing: even for pressure vessel regulation, the hydraulic pressure testing is done by the operator or supplier but certified by the regulators, like the DSIN (BCCN) for spare parts of the primary circuit (AM 1974) or the DRIREs for parts of the secondary or gas circuits (for other ministerial orders).

As mentioned above, EdF has the prime responsibility for conceiving adequate maintenance programmes but for some of them like the one dedicated to in-service inspection of inconel 600 steam generator tubes, an approval from the DSIN is required for each yearly revision, based on IPSN technical advice.

EdF must present the standardised qualification packages dealing with in-service inspection and associated repair work to DSIN, which gives formal approval in the second case (including process and welding qualifications).

In addition, the DSIN makes many written safety related requirements to EdF at corporate level, for specific checkings, inspections or testing whenever necessary (for example checking of non return valves on injection pipes, in connection with the so-called FARLEY TIHANGE problems), mostly following recommendations of the Standing Advisory Group for reactors or recent experience feedbacks.

When implementing such programmes and procedures or regulatory requirements during outages, the EdF plant management’s must report all non-conformance’s dealing with safety (or ministerial orders) to the DRIRE which gives approval (or not) at the end of the outage.

Besides, the DRIREs inspectors conduct appropriate on-site inspections (in general two of them for each outage, including one on Q/C of worksites), which are based on the principle of sampling (of topics or worksites), the main objective being again the verification that EdF applies safety regulations in an appropriate manner.

Finally, the criticality hold point after any outage, even for unplanned outages of at least 15 days, is always subject to DSIN official approval based on the DRIRE recommendation and IPSN technical advice.

3. EXAMPLES

3.1 Stress-induced corrosion of Inconel 600 alloy

This phenomenon appeared at the beginning of the eighties in France (corrosion of steam/generator tubes at FESSENHEIM). It can be reminded that it is based on the alloy composition together with the operating high temperatures (250 to 300°C) and geometrical singularities (giving rise to stress concentrations).

3.1.1 *Cracking of the steam generator tubes*. This is one of the main concerns of both EdF and the regulators since it is very related to the design basis accident “Rupture of a steam generator tube”. Therefore, most steam generators undergo a 100% in-service inspection with eddy current probes for each outage which lead to plugging of a certain number of tubes, according to agreed upon criteria (between EdF and regulators); the list of tubes to be plugged at the end of the outage is always very carefully reviewed by the DRIREs with the help of its technical support (IPSN) and this issue is one of the most important ones for the release of criticality hold point by the DSIN.

Besides, the plugging criteria are related to the primary/secondary leak rate criteria (through the steam generator tubes during reactor operation), the leaks being mostly monitored by the nitrogen 16 leak detection system. At TRICASTIN 1 unit, in 1994, the leak rate had increased mostly during transients. Since then, the DRIREs asked the plant management to carry out more plugging, and, moreover, to impose more stringent conditions on the leak rates during power transients as well as steady state power conditions. A nation-wide operating rule was issued at EdF corporate level shortly afterwards, which depends on the plant type (900 MWe series or 1300 MWe). As a result, some units occasionally cannot “follow the load” on the power network (i.e. cannot undergo power transients, which is now the case for TRICASTIN 2).

Naturally, all these measures are being enforced as compensatory measures before the replacement of the steam generators (five reactors have had their steam generator replaced up to now).

Also, other types of degradations have been observed more recently on the tubes and components of the steam generators, the most recent one being defects observed on the 8th tube support plate of a few S/G (two types concerned); such defects were recently observed either because eddy current methods, as well as televisual inspection methods are getting more and more sophisticated and extensive, or because of other fortuitous reasons (like unadapted washing of secondary circuit).

3.1.2. *Cracking of the welds of some control rod drive inconel 600 penetrations on the vessel upper head*. This had been discovered during the ten-year pressure testing of the main primary system on BUGEY 3 unit; such pressure testing is part of the pressure vessel regulation so called “Arrêté Ministériel de 1974”. Following this discovery, EdF has decided, in relation with DSIN, to complete a comprehensive in-service inspection programme of all penetrations of the French plants which resulted in changing 12 vessel upper heads, equipped with new inconel 690 penetrations (7 more in 1996).

3.1.3. *Bottom vessel penetration tubes*. In relation with the crack problem on the pressure vessel head, the DSIN/BCCN has required EdF to carry out an extensive inspection programme.

3.2 Cracking of nozzle welds

Small cracks have been found to be initiated, at nozzle weld locations, where the weld had induced “cold” cracking at the root of the weld.

More and more sophisticated in-service inspection controls (like gamma radiography, ultrasonic measurements, etc.) have shown such crack initiation:

on main steam pipes of 900 MWe reactors, which can induce fatigue embrittlement, due to high temperatures: a comprehensive repair work (excavation mainly) had to be carried out;

on a number of pipes belonging to safeguards systems, in relation with vibration: there also, excavation repair work was conducted, together with installation of anti-vibration collars.

In all cases, there were discussions not only at the reactor site level, but at corporate level between EdF and DSIN; and DSIN has required EdF to find these adequate repair solutions, in relation with design rules and experience feedback.

4. MISCELLANEOUS

Other components or equipment undergo extensive maintenance (like valves or pumps) but the encountered problems vary a lot, according to the different kinds of valves. There also, experience feedback is mandatory for a good maintenance.

5. CONCLUSIONS

In France, it can be said that the regulatory authority does focus an important part of its inspection resources on maintenance and associated problems (mainly steam generator tubes) and risks.

But an other important issue is reactor operation which is always more difficult at the beginning and end of outage with possible human errors and the DRIREs emphasise associated incident follow-up by the EdF site management's.

Plant modifications is an other important issue for the regulator, since many 900 MWe reactors are now concerned.

GERMANY

According to the Safety Criteria for Nuclear Power Plants, the maintainability of systems and components and access for testing of all safety relevant equipment must be given with due respect to the radiation exposure of the personnel, a comprehensive Quality Assurance Programme (testings during fabrication, construction, and commissioning, documentation) and a programme for conduct of testing and inspection in due intervals must be in place.

Both the regulatory authority and the utility set the priority on preventive maintenance. Operation as well as inspection experiences are basically the sources for defining the maintenance programme.

Corrective maintenance on safety systems due to events often implies maximum time allowances.

The technical specification relevant for maintenance and subject to inspection are:

- the maintenance manual (procedures, intervals),
- the operation manual (isolation procedures, safety requirements),
- the quality assurance manual,
- the testing manual (test procedures, intervals),
- other instructions (shift instructions, commissioning tests),
- documentation

Most of the maintenance activities are carried out during outages. The licensee is required to provide plans for the outage period in advance. According to these plans, a detailed inspection programme will be set-up to cover repairs, preventive maintenance, and the implementation of planned modifications taking into account the operational conditions (availability) of the safety systems, as laid down in the Technical Specifications (Operation Manual), reactor core refuelling, and recurrent testings of systems, components, valves, etc. The calculation of the reactor core composition is to be validated by independent experts (e.g., TÜV). Individual parts of the working plan expected to contribute more than 50 mSv to the collective dose are to be described in detail and are checked for ALARA provisions.

The plant start-up usually requires approval by the regulatory authority after the formal notification, that all required testings have been completed successfully.

ITALY

A safe and reliable plant operation requires that the licensee sets up a plant maintenance programme.

The Regulatory Authority checks to ensure that:

- maintenance activities are carried out by appropriately qualified personnel.
- written procedures, established for initiating request for maintenance and for performing functional testing following maintenance work, have been established and applied.
- procedures and responsibility for returning systems and components to service have been established and applied; an appropriate report of each maintenance activity is filled out which includes details of the verification and tests carried out, appropriate findings, possible corrective actions required and follow-up recommendations.

Maintenance activities during shutdown for refuelling are of particular importance. At these times more thorough and complete inspections and more extensive checks are possible; for example, checks on the integrity of the primary circuit performed on the basis of multi-year programmes and in accordance with the latest applicable Italian and International regulations.

The inspection reports on maintenance activities are regularly analysed within the regulatory organisation in order to keep up-to-date the plant safety review, establish any necessary regulatory actions, reframe as may be advisable the subsequent maintenance programme.

JAPAN

Nuclear power plants in Japan are maintained in compliance with the Technical Standards for nuclear power facilities while the self-safety management of the licensee is respected.

In plant maintenance, the licensee carries out a plan for the consolidation of the operation management system based on fundamental policies including (1) undertaking extensive efforts to rigorously assure safety, as well as achieve stable operation, (2) obtaining the trust of the residents and society at large in the region, and (3) promoting the plant efficiency. The following measures are taken by the licensees in order to perform these activities in a more effective manner.

(1) Measures to improve safety and reliability

A. Preventive Maintenance

a. Measures to prevent deterioration due to ageing.
- SCC measures for the primary coolant system.
- Measures against reduction in wall thickness of piping such as water heaters and extraction steam pipes.
- Replacement of corrosion resistant material, SG, upper head of RPV.

b. Improvement of facilities based on the experience obtained from problems encountered domestically and overseas.
Monitoring functions emphasising the man-machine interface of the main control panel such as the classification of the importance of CRTs and alarms..
Measures regarding TMI accidents.

c. Study and examination of information concerning domestic and overseas problems and difficulties.
- Promotion of systematisation for the collection, analysis and reflection of such information.

B. Programmed training for operators and maintenance engineers

a. Training of personnel based on long-term training programs
b. Expansion and enhancement of training facilities and the content of training
- More simulators for operators with an expansion of programs
- More installation of training facilities for servicing and maintenance

C. Maintenance management system

The licensee specifies the self-safety management manual regarding the management system, maintenance education, maintenance and inspection, as well as operation based on the Electric Utilities Industry Law

D. Quality assurance system

a. Quality assurance planning system for enhancing awareness of quality assurance including contractors
b. Review of documents and procedures concerned with quality assurance in order to promote systematisation of document control

E. Improvement of periodical inspections

a. Employment of metallic heat insulation material
- Improvement of CRD automatic exchange machines
- Automation of inspection equipment
- Development and servicing of ultrasonic decontamination equipment of the cavity

b. Smoothing modification work through mock-up training

F. Improvement of maintenance work management

a. Improvement of the environment through decontamination
b. Utilisation of maintenance training centres
c. Introduction of automatic maintenance equipment

G. Emergency measures

a. Servicing of communication networks by regulatory bodies, the local government, the power station, etc.
b. Upgrading of monitoring facilities

(2) Measures to reduce exposure

A. Reduction of radiation sources (use of less Co material)
B. Improvement of the work environment
C. Training on radiation control
D. Automation of inspection equipment

(3) Increase of plant efficiency

A. Use of high burn-up fuel
B. Reduction in number of times control rod patterns are changed
C. Examination of maintenance methods during operation
D. Shortening of periodical inspections

These activities are mainly performed by the licensee, but the regulatory body also instructs licensees through the following activities so that licensees may perform their activities in a suitable and efficient manner.

(1) Obligation of reporting on Self Safety Management Manual and review of overall safety management

The licensee reports their Self Safety Management Manual to the regulatory body in compliance with the Electric Utilities Industry Law. A project team of regulatory body is dispatched to the plant once every few years in order to review the implementation of the manuals and the maintenance management system.

(2) Qualification for Senior Engineer

The qualifications for each type of position, such as the Senior Engineer of electricity or Senior Engineer of boilers and turbines are stipulated in the Electric Utilities Industry Law and the Law on Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors. The licensees are required to assign persons with appropriate qualifications.

(3) The Resident Senior Specialist for NPP operation

The Resident Senior Specialist confirms the observance of the self safety management manuals through the confirmation of the daily operation and management as well as through patrols of the power station.

(4) Periodical Safety Review (PSR)

The PSR is a system in which attention is paid to the self-safety management activities of the licensee from the viewpoint of integrated preventative maintenance. The Agency evaluates the results of the activities taking into consideration how long the plants have been in operation.

(5) Implementation of Research and Development

Various R&D regarding the extending of plant life evaluation of deterioration due to ageing, inspections during operation, as well as other areas of concern have been implemented.

(6) Examination of maintenance standards

Maintenance standards are examined based on the ASME Sec; XI, and other relevant statutes, codes, etc.

SPAIN

Future Trends in Maintenance Regulations in Spanish NPPs

On 10 July 1991, the US NRC issued a final Maintenance Rule promulgating a revised 10CFR50.49. Later the NRC developed Regulatory Guide 1.160 which endorsed NUMARC 93-01 as an acceptable method to implement the Maintenance Rule.

Spanish Rules follow basically the American Standards, country of origin of NSSS suppliers. Until now, Spanish NPPs have had no specific regulations related to maintenance except regulations and commitments, as reliability targets in response to SBO Rule 10CFR50, surveillance test and inspections performed in accordance to Section XI of the ASME code, containment leakage test performed in accordance to Appendix J of 10CFR50, component surveillance or testing required by plant technical specifications, fire protection test and maintenance requirements set in Appendix R of 10CFR, etc. Additionally, resident inspectors cover operational safety areas including maintenance.

There are other programmed inspections, approximately one/power plant/year involving operational areas of maintenance including environmental qualification. It is the intention of CSN to require the implementation of 10CFR50.49. Spanish utilities have formed a working group in order to answer the initial CSN request and to develop activities leading to implement the maintenance regulation.

Two main steps compose the initial activities: Proposal and approval by the regulatory authority of a detailed methodology to implement the maintenance Rule, which is going to be very similar to NUMARC 93-01, and the development of a Verification and Validation Plan which will be a test in 2 Spanish NPPs (GE BWR and Westinghouse PWR) of the new maintenance requirements. The Maintenance Rule will take effect in 1997.

Implementation of the new maintenance requirements implies the use and development of new concepts. Included are:

Setting up performance criteria or goals when needed, utilities must review their fulfilment and as a consequence the performance of system structures and components under the scope of the Maintenance Rule.

Additionally, the scope of review for safety-related equipment must take into account system structures and components that are non safety-related but are relied upon to mitigate accidents or transients or are used in plant EOPs, and whose failure could prevent safety-related SSCs from fulfilling their safety-related function as well as those whose failure could cause reactor scram or actuation of safety-related systems.

Use of PSA. IPEs allow a prioritisation of structures, systems and components in relation to their risk importance and an increased attention and focalisation /prioritisation of the licensees resources.

Use of maintenance preventable functional failure, cause determination-root cause, corrective action concepts, will allow an increased knowledge of systems performance and weaknesses in maintenance processes.

Use of skills such as Reliability Centred Maintenance techniques, will allow an adequate balance between reliability and availability of SSC, even though it is not required as a specific method for optimisation.

Finally, the Maintenance Rule requires performance of a periodic assessment each refuelling outage cycle not exceeding 24 months, taking into account industry-wide operating experience making adjustments where necessary to ensure that the objective of preventing failures of SSC's through maintenance is appropriately balanced against the objective of minimising unavailability of SSC's due to monitoring or preventive maintenance. In performing monitoring and preventive maintenance activities, an assessment of the total plant equipment that is out of service should be taken into account to determine the overall effect on performance of safety functions.

SWEDEN

Over the last few years the Swedish Nuclear Power Inspectorate (SKI) together with Battelle Seattle Research Centre have developed a process to systematically assess maintenance programmes at Swedish nuclear power plants. An inspection tool (e.g., Inspection guidebook and a companion reference book) was produced to be used as support and a reminder in preparing for inspections, collection of information and safety assessment in the area of maintenance.

Organisational perspective

SKI has chosen to look at maintenance from an organisational point of view. In this perspective maintenance programmes and how they maintain a high quality and strive for improvement are in focus.

Maintenance programmes are designed to support maintenance personnel to perform their tasks with high quality and in a safe way. They have to be supported with programmes handling; training, qualification and staffing, information (performance information, procedures, design specifications) tools and services, material procurement and storage, organisation, administration, planning, scheduling, work control and co-ordination with operation personnel and others involved, etc.

An important aspect of effective maintenance programmes is the setting of goals and development of plans to achieve these goals. These goals should be achievable, well defined, and communicated to all involved parties. The effectiveness of the maintenance programme is defined by comparing the current performance with the stated goals. The plans for achieving the stated goals are also a source of information on the effectiveness and ability of the programme to improve.

In the inspection guidebook all these essential activities or elements have been arbitrarily grouped into 5 so called Resource Functions; People Resource Function, Material Resource Function, Tool Resource Function, Information Resource Function and Co-ordination Resource Function. This was done to make it easy for the inspector to remember all aspects or elements that he has to consider in a systematic way when preparing for an inspection.

The inspector is supposed to use the inspection guidebook both during so called normal inspections, focused inspections or team inspections. What he or the inspection team has to assess from the collected information about the plant is if the maintenance programmes have all the necessary elements of the Resource Functions and if they are improving in a satisfactory way compared to identified weaknesses shown (for instance) in incident reports and/or from inspection findings.

System Review of Maintenance Programmes

Important to realise is that an effective and safe maintenance programme is a complex system with inter-related elements and linkages. For example, a plant modification where new equipments are installed may require modifications or development of procedures, design specifications, as well as training and changes in the planning an scheduling process. Thus, there has to be formal as well as informal linkages that reassure that all necessary information about changes in one so called Resource Function will be recognised in time in the other Resource Functions.

Maintenance Programme Acceptance Criteria

On a very general level the inspector could use the following criteria for the evaluation of the effectiveness and safety of the maintenance programme:

- maintenance programmes must have all essential elements (activities) - although how they are organised at the plant may differ from one plant to another.
- there should be formal and informal linkages in place - improvement decisions should be considered in relation to their impact on other programme activities (the ‘systems view’ should be an integral part of the decision process).
- there should be clear and documented improvement goals and plans to achieve the stated goals.

Another acceptance criteria concerns *the ability of the organisation to be pro-active* and deal with problems at an early stage. In other words, does the organisation have the ability (and process) to identify problems, analyse and characterise the nature of the problem, develop and implement solutions with appropriate support and resources, and monitor the effects and make necessary adjustments?

Benefits of the Systematic Assessment Process and its Tool

The developed assessment method and the tool provide:

- a bases to determine where the maintenance programme is being improved.
- a foundation for SKI and the plant management to make decisions on where resources should be focused.

- a common understanding of the elements and activities of what make up an effective and safe maintenance programme.

SWITZERLAND

Periodic Inspections are dedicated to the main areas important to safety and hence dedicated to the monitporing of the operators performance in the areas related to safety such as organisation and progress of work on authority injuncted actions (asresult of periodic and special safety assessment actions), quality management organisation, personnel training, radiation protection relevant indicators, fuel management, waste management. These periodic inspections are:

UKRAINE

THE PROCEDURE OF ISSUING PERMISSIONS FOR OPERATION OF NUCLEAR POWER UNITS OF UKRAINE AFTER PREVENTIVE MAINTENANCE

To permit the Unit start-up after preventive maintenance, the Nuclear Regulatory Administration of the Ministry for Environmental Protection and Nuclear Safety of Ukraine (hereinafter referred to as "the Ministry") has established technical requirements stipulated by the corresponding documents.

1-3 months ahead of time before the Unit is not under preventive maintenance, the NPP management should provide the Main State Inspectorate with the documents required by the "List of documents to be submitted on safety significant systems".

The list contains the following documents:

- A list of equipment which is planned to undergo:
  - overhaul and medium-level maintenance
  - modernisation and reconstruction
  - changes to the design
- A list and content of tests and testing programmes for equipment and systems which underwent maintenance or reconstruction (upgrading, updating)
- A programme for in-operation metal and welded joints non-destructive examination
- A list of measures taken according to the investigation of violations occurred during the NPP operation
- A list of equipment with the service life expired (the list should not include records related to the scheduled equipment replacement or the service life extension)

- Safety improvement measures to be taken within the permission validity period

- The maintenance quality assurance programme

- The information on the compliance with orders put in by the Ministry and on the orders which deadline for compliance has expired, etc.

To obtain the primary permit, according to the present "Procedure", requires the full-scope submission of all the programmes, including the standard set of post maintenance tests. To obtain the subsequent permits will require submission of those programmes which were not included in the mentioned list and which were not considered.

The documents are to be reviewed by the Main State Inspectorate and the comments presented to the NPP management in writing.

The comments received are mandatory to be taken into account by the operating organisation (NPP) when effecting preventive maintenance procedures (e.g. procedures necessary to be implemented in compliance with the letters of information, etc.)

To obtain a start-up permit after the completion of preventive maintenance, the NPP management shall, 10 days ahead of time before the completion of preventive maintenance works, provide the Main State Inspectorate with materials required by the list of documentation mandatory to be submitted before the NPP Unit is granted a permission for power start-up after preventive maintenance.

The list contains the following documents:

- Documents describing the scope of maintenance, including the maintenance completion report

- Documents describing the scope of work exempted from the maintenance schedule

- Time-frame schedule(s) for equipment and pipelines validation and the schedule implementation report

- Report on measures taken to eliminate violations occurred in the process of NPP operation;

- Metal non-destructive examination executive report with due consideration of a possibility of equipment and pipelines continued operation;

- Report on compliance with enactments and letters of information issued by the Ministry

- Report on implementation of technical solutions involving the issues of NPP safety

- Report on compliance with orders of work issued by the Main State Inspectorate or by the Ministry on-site inspection, and which are to be implemented within the period from the latest preventive maintenance to a power start-up

- Information note by the Ministry on-site inspection with comments on verification of the listed above documentation and on the maintenance works performed at the Unit.

Based on the findings of reviewing the report submitted by the operating organisation, the Main State Inspectorate shall, in written manner, provide the operating organisation with the corresponding comments on the drawbacks detected and which have to be eliminated.

Having the drawbacks eliminated, the operating organisation provides the Main State Inspectorate with the necessary documentation (e.g. the selected reports on examination findings, follow-up technical solutions, etc.) confirming that the drawbacks discussed in the comments have been eliminated.

Based on the results of the report submitted, the Main State Inspectorate shall issue a permission for the Unit to be brought to a minimum control power level to conduct physical tests and measurements at decreased power levels.

After minimum control power level and decreased power level tests confirming design parameters have been completed, the operating organisation shall apply to the Nuclear Regulatory Administration (NRA) of the Ministry for an operation permit.

The application is supported by the enclosure containing:

- the information related to the availability status of safety significant systems to perform their functions after maintenance and testing activities are completed;

- the information related to safety impact of exemptions from the regulatory documents and the corresponding compensatory measures;

- the information pertinent to operational records reflecting the changes made to the safety significant systems in the course of preventive maintenance or according to the results derived from the tests;

- the data on staffing and availability of adequately trained personnel;

- the list of safety improvement measures which are intended to be taken by the operating organisation within the temporary permit’s effective period.

Based on the application review and safety analysis results, the Nuclear Regulatory Administration of the Ministry takes a decision as to granting a permit for the Unit operation which shall contain the permitting conditions.

The permit for operation is officially issued by the Nuclear Facilities Licensing Department of NRA and signed by the Head of NRA of the Ministry.

In case the safety related violations are detected, the NRA issues the corresponding amendments or appendices to the permit granted.

References

1) The Law of Ukraine "On Nuclear Power Utilisation and Radiation Safety"

2) "Safety Assurance at Nuclear Power Plants. General Provisions"

3) "Design Requirements to and Rules of Safe Operation of Power Reactor Equipment and Pipelines"

4) "Welding and Surfacing. Basic Provisions"

5) "Welded Joints and Surfacing. Examination (NDE) Rules"

6) "Arrangements for NPP Equipment Service and Maintenance"

7) "The Unified Instructions for Periodic Examination of Base Metal, Welded Joints and Surfacing Areas of WWER-1000 Equipment and Pipelines"

UNITED KINGDOM

LEGISLATION

UK nuclear safety is regulated under the Health and Safety at Work Act and the Nuclear Installations Act. The latter act provides for licensing and licence conditions, inspection, liability, etc. Offenses under the acts can lead to prosecution or enforcement notices. Regulatory powers include being able to require:

- a utility to shut down, test or inspect its plant,
- that a utility should not start-up plant without the regulator's consent,
- that a plant's Maintenance Schedule (MS) be approved, and
- that extensions to intervals specified in the MS be agreed.

LICENCE REQUIREMENTS FOR MAINTENANCE

Licence requirements relating to maintenance include:

- the need for arrangements for inspection, maintenance and testing,
- preparation of a Maintenance Schedule (MS) for plant which may affect safety,
- the MS must relate to the safety case
- the MS will be a sub-set of the site maintenance plan
- the MS must provide the start of an auditable trail
- the facility for approval of the arrangements and the Maintenance Schedule,

- the needs for competence, instructions, compliance with the MS and supervision,
- the facility for agreement to extensions to intervals specified in the MS,
- that defects are reported and investigated, and
- that reports on maintenance are kept.

MAINTENANCE ACTIVITIES

Maintenance activities include:

- inspection, e.g. of the reactor core and pressure circuit for channel straightness, oxidation, cracks,
- testing and examination, e.g. of cooling water systems, safety relief valves, safety circuits and alarms,
- testing and maintenance, e.g. of control rods and actuators, gas circulator motors and lubrication systems, boiler feedwater systems, essential electrical supply systems, and
- calibration, e.g. of radiation monitors, safety circuit sensors.

(Note that "maintenance" is a lot more than replacement, refurbishment and lubrication.)

REGULATOR / UTILITY INTERACTION

The utility:

- prepares the MS,
- undertakes the specified maintenance,
- monitors compliance with the MS,
- applies for agreement to extensions if necessary,
- reports abnormal findings, and
- revises safety cases if necessary.

The regulator

- assesses and approves the MS (but in the UK we are moving towards approval of procedures for control of the MS rather than approval of the complete MS),
- monitors compliance with the MS,
- agrees to extensions if satisfied with the case made by the utility, and

– undertakes specialist assessment of and agrees to revised safety cases.

REGULATORY INSPECTION OF MAINTENANCE

Regulatory inspection of maintenance activities includes checks on:

- compliance with the MS,
- quality assurance arrangements,
- control and supervision of activities,
- compliance with access and isolation arrangements,
- control of contractors,
- training, recording and investigation of findings, and
- records.

TRENDS IN MAINTENANCE

The following trends relating to maintenance have already been noted or are anticipated:

reducing the administrative burden (for the utility and the regulator), by approving procedures rather than the full MS,

- reducing the amount of maintenance, by more focused maintenance and less routine maintenance,
- reducing loss of output due to maintenance, by working rapidly, avoiding delays and overcoming unexpected problems,
- maintenance optimisation by use of reliability centred maintenance (RCM) etc.
- reductions in utilities’ staffing, and
- greater use of contractors.

SUMMARY

A major part of the regulation of nuclear safety in the UK is based on monitoring of compliance with licence conditions.

The licence conditions require that the utility has adequate arrangements, including arrangements for self-monitoring (self-regulation).

The regulator inspects the utility’s arrangements.

The regulator must be able to react to developments in maintenance such as RCM.

UNITED STATES

PERFORMANCE BASED REGULATION - THE MAINTENANCE RULE

The US Nuclear Regulatory Commission has begun a transition from "process-oriented" to "results-oriented" regulations. The maintenance rule is a results-oriented rule that mandates consideration of risk and plant performance. The Maintenance Rule allows licensees to devise the most effective and efficient means of achieving the results described in the rule including the use of Probabilistic Risk (or Safety) Assessments. The NRC staff conducted a series of site visits to evaluate implementation of the Rule. Conclusions from the site visits indicated that the results-oriented Maintenance Rule can be successfully implemented and enforced.

ASSESSMENT OF SAFETY

BELGIUM

The periodic inspection programme, the approval by the Licensed inspection organisation (LIO) of most safety related modifications as well as the strong presence of the LIO in the plant allow for a broad and good perception of the overall plant safety.

Besides the LIO monitors and makes independent assessments of the incidents and problems occurring at the plant. Their global but informal evaluation allows to act timely when the situation seems to become degraded.

FINLAND

The periodic inspection programme is planned to cover all essential safety related activities in the power plant. As a result the STUK has a broad view how power company handles safety related activities during normal operation.

Assessment of safety is performed also through monitoring and analysis of operational events, following international operating experience as well as performing re-assessment of issues reviewed for an operating license (safety research, advancement of technology, changes in safety requirements etc.). There is an annual research programme e.g. for these purposes and a research budget as well .

The OECD/NEA CNRA/WGIP document for Evaluation of the Safety Performance of Licensees provides more detailed background information on the STUK activities in this field.

FRANCE

In France, there are 54 powers reactors (all are PWRs). These reactors have two specific characteristics: there is only one operator (EdF), but must importantly all these reactors are standardised.

1. INSPECTION AND ASSESSMENT OF SAFETY

The DSIN supervision of these installations consists on the one hand of safety analysis of equipment and organisational arrangements, and on the other hand of inspections.

Safety analysis is carried out by DSIN and its technical support organisations as the Safety Assessment Department (DES) of the Institute for Nuclear Safety and Protection (IPSN).

Inspections use sampling methods to check that the plants and their operation are in conformity with safety requirements (regulatory texts, safety reports, DSIN requests ...). These inspections allow DSIN to assess the adequacy of safety and the controls in place to assure safety. Around 300 inspections per year are carried out on the PWRs.

As all French PWRs are standardised, these inspections:

– may either contribute to an assessment of the safety of each reactor (horizontal slice),

– or, using the inspections performed on the same aspect of all nuclear power plants, may assess the adequacy of safety in technical areas such as: fire protection, quality of maintenance, containment... (vertical slice).

2. ASSESSMENT BY USING SYNTHESES OF INSPECTIONS

In France, the safety authority is thinking about installing a system of safety assessment of each nuclear power plant.

But, until today, only assessments of the different technical areas are carried out. These assessments are based on the accomplishment of syntheses of the inspections concerning the same topic.

Hence, the annual inspection program, the purpose of which is to ensure a uniform surveillance level for all nuclear plants, also focuses on the technical aspects where syntheses appear necessary.

Around 5 syntheses are carried out each year. Thus, syntheses were achieved on topics such as: fire protection, criticality safety, quality of maintenance, environment protection. Each synthesis may consist of 5 to 40 inspections.

Topics of syntheses are chosen according to DSIN knowledge of installation’s safety. This knowledge results from observations carried out during inspections and from the operator’s experience feedback.

The syntheses therefore give us generic information about the conditions of the installations, about the operator’s compliance with safety procedures (technical specifications, periodical tests ...), as well as the adaptability of these procedures to the fixed objectives.

A synthesis lead us to 3 types of actions:

1. The definition of new inspection topics. These topics will include precise points in the areas which were the subject of the synthesis, or they will concern related area.
2. The writing-up of an inspection guide, giving guidelines used for further inspections in this same area.
3. Demand to the operator (EdF) for generic corrective actions about issues or non conformances with requirements which were identified.

3. EXAMPLES OF SYNTHESES

With the presentation of two examples, we will show why a synthesis is carried out, and how its conclusions are used to uphold the level of safety of the installations.

3.1 Integrity of the safety related circuits (except the primary and secondary circuits)

3.1.1 Why a synthesis about this topic?

On the primary and on secondary circuits, many defects (resulting from workmanship or appearing in operation) were detected. For example: cracking of inconel 600, corrosion of dissimilar metal weld or underclad cracking.

But for other safety related circuits, the operator (EdF) has given not much information about their soundness defects.

This inadequacy of information and the importance of these circuits to safety have been the motives of DSIN for carrying out a synthesis about this topic. This synthesis was accomplished in 1995, and it consists of 8 inspections carried out during this year.

3.1.2 Conclusions of the synthesis

- The defence line "prevention" is inadequate: - defects resulting from workmanship remain on the safety related circuits, - many leaks at the safety related circuits occur in operation.

- In most cases, the operator doesn't analyse the discovered anomalies. In fact, he only repairs identically, without assessment nor particular surveillance, contrary to the rule about quality.

- There is not experience feedback. Thus, several leaks, which have occurred on the auxiliary feedwater supply circuit (ASG), could have been avoided if the operating occurrence notices had been exploited.

3.1.3 Consequences of the synthesis

In letters sent to the operator in 199S, DSIN required a strengthening of the defence line "prevention":

- the number of non-destructive examinations have to be increased,

- ability of detecting leaks in operation has to be increased,

- experience feedback has to be exploited better.

3.1.4 Prospects of this issue

- Position of the plants operator: EdF has admitted that DSIN findings are relevant. Hence, in the short term, it will strengthen the preventive maintenance, particularly on nozzles where leaks have occurred. In the long term, EdF will focus preventive maintenance on the circuits on which failure has the largest consequences for risk of core melt. The choice of these circuits will be made by using a Probabilistic Safety Assessment.

- Position of DSIN: DSIN has informed EdF of reservations on its proposals:

  - risk of core melt is not the only risk to take into account. For example, there are also radioactive releases,

  - there are uncertainties in the results of Probabilistic Safety Assessments.

Therefore, DSIN maintains its requirement for strengthening preventive maintenance of the safety related circuits.

3.2 Criticality and divergence

3.2.1 Why a synthesis about this topic?

Watching the reactivity of a PWR is important to provide against a criticality accident. Among the operation stages (start-up, power operation and shutdown), start-up is the trickiest stage since in this stage the power will pass from a very low level to a very high level.

Difficulties in the reactivity monitoring were put to the fore (particularly with operating occurrences). In order to prevent such occurrences, EdF set up a doubling time alarm.

Therefore, in l992, DSIN decided to plan inspections providing an examination of reactivity monitoring. Ten inspections were performed from 1992 to 1994, and their synthesis was carried out in 1994.

The inspections have particularly provides an examination about:

- reactivity monitoring (country rate) during refuelling,
- divergence stage after refuelling,
- divergence stage after a scheduled shutdown (without refuelling)
- reactivity monitoring in operation.

3.2.2 Conclusions of the synthesis

- It is useful to carry out others inspections about this topic. These inspections will verify the operation compliance with:
  - operating technical specifications,
  - procedures for fuel handing and reactor divergence,
  - final storage and operational records procedures (fuel handing, reactor divergence)
- Assessment of different technical points, related to the operating technical specifications, has to be carried out by the Safety Authority and his technical support organisation (DES/IPSN).

3.2.3 Consequences of the synthesis

- Inspections about this topic were carried out in 1995 and others are planned in 1996.
- By letters, sent in 1994 and 1995, DSIN required that EdF indicates its previous corrective actions. These actions have to comply with the conclusions of the synthesis, the assessment of technical points and the findings of the inspections carried out subsequently to the synthesis.

3.2.4 Prospects of this issue

- Position of the plants operator: EdF previous actions are:

  - improvements to documents defining the operator’s doctrine and to prescriptions documents,
  - an increase in workers’ professionalism.
- Position of DSIN: DSIN considers that EdF proposals are incomplete and, recently, asked it to complete its previous actions.

GERMANY

For safety assessment and for inspection of managing of safety the regulatory inspection authorities use the following programmes:

- control of operation of the plant according top the legal requirements regarding nuclear safety and to corresponding rules and guidelines,
- Analysis of the operational experience including event analyses applicable to the particular plant or plant type,
- results of nuclear safety research programmes,
- special safety reviews,
- Periodic Safety Reviews (PSR) including PSA as recommended by the Reactor Safety Commission and carried out at 10-year intervals by the licensee on a voluntary basis.

As the legal framework for licensing and supervision is based on deterministic rules, the regulatory authority gives priority to deterministic criteria to prove the plant’s safety. Nevertheless, the reliability proof is getting increased importance for safety assessments, particularly to check the suitability and the safety significance of the safety systems, their performance, maintenance and proposed backfitting measures.

ITALY

The safe operation of a nuclear installation in Italy rests with the licensee. The Regulatory Authority has the task to verify that:

- the licensee supplies the necessary equipment and necessary personnel.
- the licensee operates within observance to the ‘Organisation Manual’, which specifies all the duties and responsibilities of plant personnel entrusted with functions relevant to nuclear safety and health protection, both during normal operation and during the course of an accident.
- the licensee carries out a set of planned and systematic actions necessary for providing adequate assurance that the installation gives the required performance under its various

scheduled operating conditions; in particular, the action includes organisational arrangements, planning of activities, staff training, checks on the planning basis, quality control, preparation and management of documentation , corrective actions and assessment of systems efficiency.

The Regulatory Authority surveillance programme must include at least verification that:

the technical specifications are respected:

- the operation log-books are up-to-date.
- personnel on shift are present at the working place.
- modifications by the plant safety advisory council have been approved by the Regulatory Authority.
- the licensee and his organisation are trained to cope with emergency conditions.

SPAIN

1. Requirements and Responsibilities for the Management of Safety.

The Spanish Regulations place responsibility for the safety of a licensed nuclear plant on the licensee. These regulations require licensees to have adequate staff, specifying the qualifications of licensed operators and the obligations of other plant staff. They also require that the licensee issue an official document the ‘Management Manual’, which has to obtain formal approval from CSN, establishing the organisation and functions of personnel, their qualifications and training, the operating standards for normal and emergency operations and the requirements for records and reports.

Plant operators are licensed by CSN.

In addition, the specific licensee for a plant requires in connection to management of safety, the following:

- Two safety committees, one at plant level and the other at Corporate level.
- To review and implement derived modifications of new safety requirements in the country of origin of the project.
- To review their own and foreign operating experience.
- To report to CSN about plant events.
- To perform a safety analysis before safety-related plant modifications are approved.

2. Evaluation Methods Utilised by CSN in Assessing Safety Performance.

The CSN uses or is developing the following evaluation methods:

- performance indicators.
- accident sequence precursors (in development).
- panel for review of incidents.
- incident investigations.
- systematic evaluation of NPP performance (similar to NRC SALP) - in pilot phase.

3. Systems used by Licensees in Assessing Safety Performance

At the site level the system includes; self-checking, work verification and work reporting. Also at the site level the system includes; internal quality management audits, plant tours by supervisors, station performance indicators and event feedback systems. At the corporate level the system includes; inspection of sites from company headquarters and company performance indicators.

Some plants have received OSART and ASSET missions from IAEA. The companies have set specific strategic plans for 10 years that includes the aim to enhance the safety culture. Its implementation will likely be controlled by the Corporate Safety Level Committee.

UNITED KINGDOM

Introduction

Assessing safety performance covers many features. In this note we concentrate on one technique developed by the United Kingdom's Health and Safety Executive for assessing the management of safety. Management is the key since without management, there can be no assurance that safe practices will be achieved or maintained. The approach of HSE to the management of safety is set down in a publication "Successful Health and Safety Management" (1) which describes a model showing the principle features of managing health and safety. The model is based on considerable research and practical use in assessing the adequacy of a wide range of industries. Systems have been developed to assess the adequacy of health and safety management using this model. This note outlines the key particular elements which would be expected to be seen on any nuclear installation (2) and goes on to outline the use of the model laid down in "Successful Health and Safety Management" on one UK nuclear establishment.

Features of a successful Safety Management System

Policy

A policy for safety should be established that sets out the Senior Management commitment to meeting its responsibilities, and signals to those who work in the licensee's organisation the fundamental values and beliefs on which management of the activity is based. A designated Senior Manager should have responsibility for providing health and safety advice and ensuring that the policy is put into effect.

Organising

The main purpose of this step is to ensure that the licensee's organisation can readily plan and implement the aims and objectives identified in the policy.

Structure

The licensee's organisation should be defined and its key functions explained as part of meeting the business quality objectives. It is important that organisational changes are managed and carried out in a structured way which involves the peer review of proposed changes to an extent dependent upon their safety significance.

Responsibility

Effective management systems should have clear definitions of responsibilities and limits of delegated authority, together with an adequate degree of supervision. The line of responsibility should run unbroken from the top of the organisation to the bottom and spans of control should be realistic.

Managerial Control

Effective managerial control is achieved by: the setting up of managerial systems, positive leadership by all levels of management; and the securing of the commitment of employees to clear health and safety objectives. Responsibility for nuclear safety normally rests with line management but every employee should understand the safety significance of their duties. When licensees select contractors they should check that the contractor has an acceptable management of safety system and that an appropriate level of supervision is provided.

Communication

In addition to formal systems for communicating the licensee's policy and standards, managers ought to lead by example. They can do this by actively involving themselves in workshop talks, area tours, team meetings and briefings. It is important that the system in place for management communication with employees ensures the transmission of information up as well as down the line (and across organisational boundaries as required). Relevant documents and procedures are best owned, prepared and maintained by the staff to whom they apply. It is appropriate for the licensee to establish routine liaison arrangements with representatives of the public as open behaviour in safety matters demonstrates that the licensee has nothing to hide from those who could be affected by operations on the site.

Co-operation

A united approach to safety requires co-operation of all parties through a combination of participation, commitment and involvement. Co-operation can be aided by a participative forum for employee involvement, including joint health and safety committees.

Competence

All persons who carry out safety related tasks should be suitably qualified, experienced and trained. This requires a systematic approach which is likely to include careful recruitment and selection procedures, identification and delivery of initial, continuing and refresher training needs, systems for the assessment of trainees, and training effectiveness and, in appropriate circumstances, a system for prior authorisation for individuals to undertake roles important to safety.

Independent Advice

In the nuclear industry it is particularly important that management actively seeks and is provided with authoritative and independent safety advice on current and proposed operations. Such advice can include: peer review of safety cases, assessment and monitoring by a licensee's Health and Safety Resource (see below). Further advice on safety proposals that could have significant consequences should be obtained from a Nuclear Safety Committee consisting of a group of senior experts, some of whom are independent from the licensee's organisation. Appropriate specialist advice ought to be available to all staff from, or through, a Health and Safety Resource (HSR) which is independent of production pressures and normally reporting to the designated Senior Manager.

Planning And Implementation

Standards

Measurable, achievable and realistic standards need to be identified for activities on a plant through its lifetime i.e. through design, construction, commissioning, operation and decommissioning. Licensees need to set their own standards or targets of safety performance for the protection of their employees and other persons (both on and off the licensed site) arising from activities in connection with the site. The minimum standards are those required to satisfy the legal requirements. Performance standards can also include actions aimed at encouraging a positive health and safety culture in the areas of control, communication, co-operation and competence as well as in the control of risks.

Safety Assessment

In the nuclear industry it is expected that all activities which may affect safety are underpinned by a safety case. Safety cases justify the design, construction, commissioning of new plant, the modification to, and experiments on, existing plant and the decommissioning of redundant plant. In addition, licensees should review the safety of their operations periodically and revalidate their operational safety case.

Work Plans

Work plans should include clear safety objectives and targets for all managerial and supervisory staff whose work has an impact on safety and provide a clear link between the corporate objectives in the top level operating plan and managers' objectives in departmental work plans. Such plans are most effective if they are monitored and reviewed routinely.

Operational Control

The control of plant operations and the handling of nuclear matter and waste involves keeping them within the requirements of the safety case by ensuring that: all safety mechanisms, controls and indicators are working properly, all required maintenance inspection and testing is up-to-date with acceptable results, plant modifications are controlled properly, the plant is operated within the operating constraints in the safety case and in line with appropriate instructions, there is supervisory control and all members of staff are competent to carry out the operations safely.

Emergency Planning

Emergency plans are required to enable the licensee to mitigate the safety effects of any abnormal event, incident or emergency. The appropriate emergency and contingency arrangements need to be rehearsed periodically.

Measuring Performance

Self Monitoring

In a management system, performance should be monitored to show that the plans (corporate, divisional, individual) in place are achieving the objectives set. Monitoring and reporting of standards of meeting them needs to be done through the operational line management chain (self monitoring) up to Senior Management level.

Reactive Monitoring

Licensees should also have arrangements for monitoring what has gone wrong. These arrangements should include an operational feedback system.

Independent Monitoring

The Health and Safety Resource also has a role in monitoring the system independently of line management so that advice can be given if needed. Independent audits of systems are a recognised method of monitoring performance and to enable the arrangements to be questioned.

Reviewing Performance

A fundamental principle of management systems is their need to be reviewed on a systematic and periodic basis to ensure they work effectively and to see if changes would improve performance. Review operates at all levels of the management system. The Senior Management Board should consider reports on safety and review the Corporate Policy at regular intervals.

Use Of The Model

The model was applied in an extensive review of the UK’s Atomic Weapons Establishments. Because of the existence of a substantial safety management system, the model was used to follow 8 “trails”; namely:

- Hazard identification and Risk Assessment,
- Operations,
- Maintenance,
- Research and experimentation,
- New facilities and modifications,
- Waste and decommissioning,

– Emergency preparedness, and

– Health and safety specialist functions.

The report on the review (5) provides details of how the model was modified to enable a more detailed review of the installations and provide information on the overall system for managing safety.

References

1) "Successful Health and Safety Management", Health and Safety Executive, HS(G)65, 1991, ISBN 0-7176-0425 X.

2) "Managing for Safety at Nuclear Installations", Health and Safety Executive HM Nuclear Installations Inspectorate, 1996, in publication.

3) "The Management of Health and Safety at Atomic Weapons Establishment Premises: A Review of the Health and Safety Executive" Parts 1 and 2, Health and Safety Executive, 1994, ISBN 0-7176-0864-6.

UNITED STATES

OVERVIEW OF NRC ASSESSMENT OF LICENSEE PERFORMANCE

PPR Purpose

– Early Identification of Licensee Performance trends through Integrated Assessment of Objective Information

– Adjust, Document and Communicate Inspection Plans to address Performance trends.

PPR Overview

– Frequency - Semi-annually

– Information - Licensee Event Reports (LERs), Inspection Reports, Investigations

– Participants - Regional Managers, Resident Inspectors

– Documentation - Input, Assessment, Output

– Communication - Letter with plans to Licensee

– Meeting - Optional

– Oversight - Regional Administrator

PPR Process

– Previous PPR and SALP (Systematic Assessment of Licensee Performance) results reviewed fro background

- Utilised reference material must be docketed
- Focus on performance changes since last review and inspection programme status
- Discussions highlight Licensee corrective action effectiveness
- Neither a mini-SALP nor SALP substitute
- Performance conclusions limited to areas with adequate new information
- Inspection initiatives scheduled with due regard to forecasted Licensee activities
- Letter to Licensee limited to observed trends and rationale for inspection initiatives
- Subsequent inspection plan changes will be Promptly communicated
- Resulting PPR Package used as INPUT to SALP and Senior Management Meeting Process

APPENDIX II- OPENING PLENARY SESSION - PRESENTATIONS

WORKSHOP ON CONDUCT OF INSPECTION

GENERAL INFORMATION

by

J.J. Van Binnebeek (AVN)

Chairman W.G.I.P.

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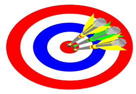
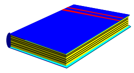
INFORMATION TO PARTICIPANTS

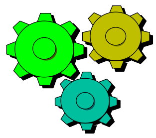
- **PROGRAM**
- **OBJECTIVES OF THIS CONFERENCE**
  - OVERALL AND BREAKOUT OBJECTIVES
  - OBJECTIVE PER SUBJECT



- **PRODUCT OF THIS CONFERENCE**
  - SYNTHESIS OF WORKS
  - REPORT TO CNRA

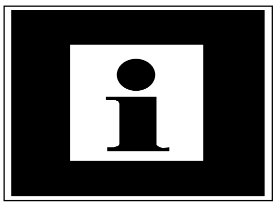


- **HOW THIS CONFERENCE WILL BE RUN**
  - ROLE OF FACILITATORS/RECORDERS/PARTICIPANTS
  - DISCUSSION GROUPS ASSIGNMENT
  - REPORTING



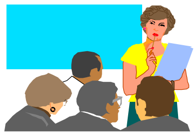
WORKSHOP PROGRAM

- **INTRODUCTORY SESSION**
- **GROUP DISCUSSION WITH FACILITATOR / RECORDER**
- **FINAL REPORTING SESSION**
- **PREPARATION OF THE FINAL REPORT**

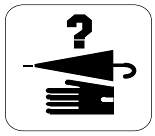


WORKSHOP OBJECTIVES EXCHANGES

- MEET WITH PEOPLE FROM OTHER ORGANIZATIONS



- EXCHANGE INFORMATION REGARDING REGULATORY INSPECTIONS ON THE WORKSHOP TOPICS
- DISCUSS CURRENT ISSUES, INCLUDING QUESTIONS SUBMITTED IN THE REGISTRATION DOCUMENTS



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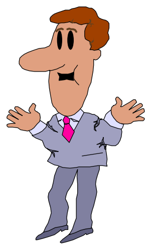
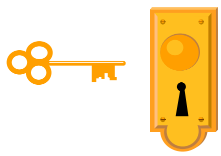
WORKSHOP OBJECTIVES USAGE



- DEVELOP CONCLUSIONS REGARDING CURRENT ISSUES
  (Note that the use of the word **"recommendation"** was specifically rejected. In fact, **"conclusions"** was also suspect. This led to the next bullet.)
- KEEP PEOPLE FREE TO DECIDEi FOR THEMSELVES
- INDIVIDUALS IDENTIFY METHODS TO HELP IMPROVE "BACK HOME"



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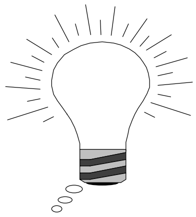
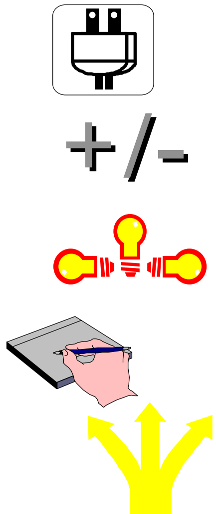
WORKSHOP OBJECTIVES
REPORTING



- **PRODUCE REPORT FOR PARTICIPANTS AND OTHERS**
- **"OTHERS" consists of:**
  – participants' management and organizations
  – non-participants
- **PRODUCE REPORT TO THE CNRA:**
  – Lessons learned from the workshop
  – Conclusions
  – Evaluation
  – Future workshop topics

BREAKOUT OBJECTIVES
GENERAL

- UNDERSTANDING OF DIFFERENT APPROACHES
- ADVANTAGES AND DISADVANTAGES OF THOSE APPROACHES
- UNDERSTAND OR HIGHLIGHT NEEDS IN THE SPECIFIC AREAS
- PREPARE REPORTS
  (For use at the plenary session and for use in the meeting report)
- NOT TO DEFINE ONLY ONE WAY TO DO SOMETHING



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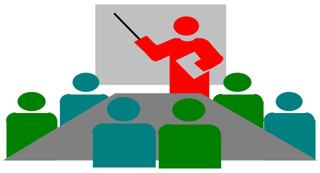
REPORTING SESSION
OBJECTIVES

- ALLOW REPORT FROM EVERY PAIR OF FACILITATORS
- ALLOW QUESTIONS FROM THE FLOOR
- ALLOW FACILITATORS AND OTHERS TO BE CROSS INFORMED
  (From the sessions they did not attend)
- GET SENSE OF PRIORITY
- CHECK FOR AGREEMENT



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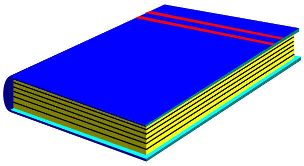
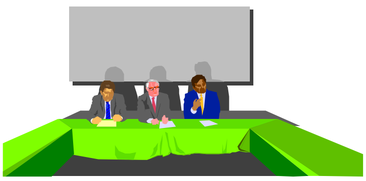
PRODUCT OF THE CONFERENCE

- VALUABLE MATERIAL BROUGHT HOME BY PARTICIPANTS
- REPORT TO CNRA
  - EXECUTIVE SUMMARY
  - USEFUL PRACTICES
- TO BE USED BY OTHERS



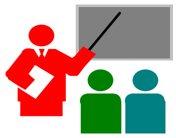
REPORT SESSION PRODUCT

- LIST OF QUESTIONS FROM THE FLOOR
- LIST OF ANSWERS FROM THE FLOOR
- "BULLET" REPORT FROM THE FACILITATORS
- LIST OF PRIORITIES



ROLE OF FACILITATORS-RECORDERS-PARTICIPANTS (F/R/P)

- ROLES IMPORTANT TO **EFFECTIVENESS** OF WORKSHOP
- SPECIFIC ROLE AND IMPORTANCE OF F/R/P
- NECESSITY TO REACH **CONCLUSION**
- IMPORTANCE OF **TIME SCHEDULES**



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EFFECTIVE MEETINGS

- DESIRED OUTCOMES DEFINED
- AGENDA - DEFINED & "OWNED"
- ROLES ARE CLEAR
- PREPARATION
- **UNBIASED** LEADERSHIP
- TOTAL INVOLVEMENT
- "HETEROGENEITY" - DIFFERING VIEWS BROUGHT OUT & **RESPECTED**
- **SHARED** RESPONSIBILITY
- ATTENTION - TASK & PROCESS

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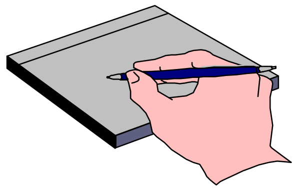
WHAT ARE THE CHARACTERISTICS OF A GOOD **FACILITATOR** ?

- Is a *NEUTRAL* Servant of the Group
- Does *NOT* Evaluate or Contribute Ideas
- If You Know the Answer - Call on Someone Else
- Focuses Energy of the Group on a Common Task
- Protects Individuals and Their Ideas from Attack
- Encourage Everyone to Participate
- Help Group Find ***win/win*** Solutions

WHAT ARE THE CHARACTERISTICS OF A GOOD **RECORDER** ?

- WRITE DOWN EVERYTHING
- DON'T EDITORIALIZE
- ASK FOR CLARIFICATION
- WRITE LEGIBLY
- DON'T WORRY ABOUT SPELLING
- CAPTURE THOUGHT
- OUTLINE/BULLET
- COLOR
- GET THOUGHT - KEY POINTS
- STAY IN ROLE
- DON'T FACILITATE



WHAT ARE THE CHARACTERISTICS OF A GOOD **PARTICIPANT** ?

- EXPRESS YOUR HONEST OPINION
- RESPECT & LISTEN TO OTHERS
- KEEP AN OPEN MIND
- STAY FOCUSED ON TOPIC
- COURTESY
- PARTICIPATE
- SHARE YOUR EXPERIENCES
- DO NOT "*SELL*" IDEAS

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DISCUSSION GROUPS ASSIGNMENT

- **ASSIGNMENT IN GROUPS FOR THE SESSIONS**
  (Main field of interest; facilitator-recorder)
- **GROUP ASSIGNMENT INSURES MIXING AND VARIETY**

WORKSHOP ON CONDUCT OF INSPECTION

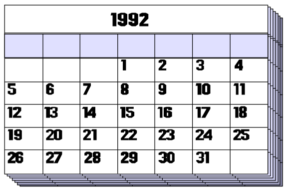
SPECIFIC INFORMATION

by

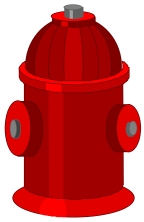
J.J. Van Binnebeek (AVN)

Chairman W.G.I.P.

WORKSHOP TOPICS

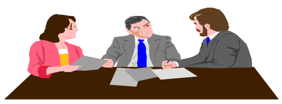


- INSPECTION PLANNING
- PLANT MAINTENANCE
- ASSESSMENT OF SAFETY



DISCUSSION GROUPS ASSIGNMENT

- ASSIGNMENT IN GROUPS FOR THE DISCUSSION SESSIONS
  (Main field of interest; same facilitator-recorder):
  - Inspection Planning
  - Plant Maintenance
  - Assessment of safety



- GROUP ASSIGNMENT INSURES MIXING AND VARIETY
- INFORMAL SESSIONS

OBJECTIVES
INSPECTION PLANNING

- Management assessment & licensee performances
- Planned vs reactive inspections
- Core inspections
- Area of technical concern
- Recent plant events & PI
- Notification of inspection plan
- Resident vs regional office inspections
- Documentation of inspection findings
- Areas of inspection
- Inspection feedback

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OBJECTIVES
PLANT MAINTENANCE

- **MAINTENANCE + ASSOCIATED TESTING**
  - VERY COMPLEX ISSUE
  - SKILLED PEOPLE
  - MULTI-DISCIPLINARY
  - EXPERIENCE FEEDBACK & QA
- **DURING TIME DEGRADATION, BUT LIMITED RESOURCES**
- **WHAT IS ESSENTIAL & MUST BE INSPECTED?**

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OBJECTIVES
PLANT MAINTENANCE (Cont'd)

- **OTHER ASPECTS**
  - REGULATORY REQUIREMENTS FOR MAINTENANCE PROGRAMME
  - REGULATORY MEASURE OF STANDARDS & QUALITY OF MAINTENANCE
  - PREVENTIVE & CORRECTIVE MAINTENANCE vs PREDICTIVE MAINTENANCE

OBJECTIVES
ASSESSMENT OF SAFETY

- **PRIME RESPONSIBILITY FOR SAFETY WITH LICENSEE ==> ORGANISATION**
- **FOCUS ON PROCESSES WITHIN ORGANISATION**
- **ORGANISATION ABILITY:**
  - RECOGNISE PROBLEM
  - CHARACTERISE PROBLEM's NATURE
  - DEVELOP SOLUTION
  - IMPLEMENT SOLUTION WITH APPROPRIATE RESOURCES
  - MONITOR THE EFFECTS 1 ADJUST

OBJECTIVES
ASSESSMENT OF SAFETY (Cont'd)

- **ROLE OF THE INSPECTOR IN ASSESSING THE MANAGEMENT OF SAFETY OF THE LICENSEE**
- **VARIOUS TYPES OF MEASUREMENTS**
- **COMPARISON OF PRACTICES**
- **ISSUES**
  - Requirements & responsibility
  - Evaluation methods
  - Safety target
  - monitoring
  - criteria
  - Understanding of one's responsibilities

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THE ROLE OF PERCEPTIONS AND ATTITUDES IN THE ASSESSMENT OF SAFETY CULTURE

by

Terence R. Lee
Environmental Psychology & Policy Research Unit
School of Psychology
University of St Andrews

'Inspection Planning, Plant Maintenance & Assessment of Safety'
- An International Workshop -
OECD Nuclear Energy Agency, Committee on Nuclear Regulatory Activities (CNRA);
Working Group on Inspection Practices (WGIP)

May 19-24 1996

THE ROLE OF PERCEPTIONS AND ATTITUDES IN THE ASSESSMENT OF SAFETY CULTURE

Terence Lee

Environmental Psychology & Policy Research Unit,
School, of Psychology, University of St Andrews

INTRODUCTION

The purpose of this paper is to present the argument that the most conveniently *measurable* and *valid* elements of a safety culture are the employee's perceptions of and attitudes towards safety. These are oriented towards the whole range of hazards and corresponding safety practices and procedures within the organisation.

The concept of safety culture is discussed and this is followed by a short review of research evidence on the main characteristics of low accident plants.

There follow brief reviews of research in industry on the perception of risks and attitudes towards safety and finally, a detailed account of a large scale survey of safety attitudes in a nuclear reprocessing plant.

The aim is to identify those elements of safety culture that can establish priorities and provide order and structure for those site regulators whose task is to assess their health.

ACCIDENTS

What is particularly remarkable about the exhaustive inquiries into the highly publicised accidents of recent years in the UK, i.e. Flixborough; Bhopal; King's Cross; Herald of Free Enterprise, Clapham Junction and Piper Alpha is that they all came up with much the same verdict.

Despite the adoption of the full range of engineering and technical safeguards, complex systems broke down disastrously because the people running them failed to do what they were supposed to do.

These were not simple, individual errors, but malpractices that corrupted large parts of the *social system* that makes an industrial or service organisation function. It is not enough to describe these diffuse breakdowns as 'human error' and to hope that the 'human factors people' will come up with some cures for such random frailties while others get on with the real business of improving the engineering safeguards or rewriting the regulations. Of course, the efforts over the past 150 years to make the technical side of the system as safe as possible have been highly successful and must continue - but many large organisations are currently finding that their efforts to engineer faults out of the system have worked so well that accident rates have reached a low but undoubted plateau and the only way to continue to improve is to address the *hearts and minds* of the management and workers.

The concept that best summarises the human sciences approach and which has been confirmed and strengthened by the major accident inquiries is that of *safety culture*.

SAFETY CULTURE

Management has come to realise that the general likelihood of an accident occurring in their plant depends not just on the careless or vindictive foibles of a small number of operatives but, to use the terminology of an important CBI report on safety culture, on "*the way we do things around here*" (CBI, 1990). The concept of safety culture is a fairly recent attempt to advance this area of understanding. It does not supplement the many safety ideas and practices that have preceded it, but supersedes or rather encompasses them.

The term 'safety culture' was introduced by IAEA (the International Atomic Energy Agency) as part of their first report on the Chernobyl Accident, published in 1986. The concept itself was not entirely new. It had earlier existed for some years as 'safety climate', but this term fails to capture some of the critical features (see below).

There have been a number of valuable reports and definitions since that time but the latest and most comprehensive is due to ACSNI (The Advisory Committee on the Safety of Nuclear Installations) (ACSNI, 1993).

They define safety culture as follows:

> "The safety culture of an organisation is the product of individual and group values, attitudes, perceptions, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organisation's health and safety management.
>
> Organisations with a positive safety culture are characterised by communications founded on mutual trust, by shared perceptions of the importance of safety and by confidence in the efficacy of preventive measures."

This very generality could, of course, be a weakness. Many such ideas have foundered because they become all things to all men and no-one can actually get a handle on them. This is why it is essential to tie the concept into procedures for measurement.

What is implied by a good safety culture is that the perceptions and attitudes (and hence the behaviour) of all employees towards safety and all its contributory practices is dominant. The concept of culture, as used by anthropologists, covers everything learned or otherwise acquired by a society, social group or organisation that is preserved and passed on to future members. It takes time to cultivate but once achieved it transcends the individual members - it belongs to the organisation. It is more than the sum of its parts - it is a *collective* commitment to safety.

THE CHARACTERISTICS OF SAFE ORGANISATIONS

There is a substantial body of research available that can help in understanding safety culture. It shows the particular organisational characteristics that distinguish low-accident from high-accident plants. We make the assumption here that low accident plants have a healthy safety culture.

Most of the research does not enable us to argue strongly about *causes* - least of all about *independent* causes. The processes are highly interactive, but all of the factors to which I shall refer show up strongly and consistently from the research evidence. Hence, the list should at least help in establishing *priorities* for attention by regulators/assessors who cannot make more detailed measurement.

First, though, a note on the methodology by which these factors have been identified. One approach is to compute correlations between accident rates and, for example, *leadership style*, within a sizeable sample of departments or companies. Another is to select a number of *pairs* of departments or companies, each having one with a high and one with a low accident record, but being similar on other factors such as type of work, age of workers, payment system etc. It is then possible to look for consistent differences (e.g. *good communications*) that might account for the differential accident rates.

Finally, probably the most dependable method is by *intervention*, i.e. the introduction of a new safety practice with a comparison of before/after accident rates. Ideally, the new measure should then be removed for a period to ensure it was really the *cause* of any change that had occurred.

The characteristics of low accident plants (presumably having a good safety culture) are shown in Table 1. The evidence is documented in ACSNI (1993).

Table 1 - Characteristics of low accident plants

- A high level of communication between and within levels of the organisation. Exchanges are less formal as well as more frequent. Safety matters are discussed. Managers do more walkabouts.
- Good organisational learning, where organisations are tuned to identify and respond to structured change.
- A strong focus on safety by the organisation and its members.
- A senior management that is committed to safety, giving it high priority, devoting resources to it and actively promoting it personally.
- A management leadership style that is co-operative, participative and humanistic, as distinct from autocratic and adversarial.
- More and better quality training, not only specifically on safety, but also with safety aspects emphasised in skills training.
- Clean and comfortable (relative to the task) working conditions; good housekeeping.
- High job satisfaction, with favourable perceptions of the fairness of promotion, layoff and employee benefits as well as task satisfaction.
- A workforce composition that often includes employees who are recruited or retained because they work safely and have lower turnover and absenteeism, as distinct from higher productivity.

THE ROLE OF ATTITUDES AND PERCEPTIONS

It will be noted that most of these critical characteristics of safe organisations are both cause and effect of collective attitudes. The measurement of attitudes is a well developed technology and one that can provide a comprehensive overview of the success of any attempts to improve safety culture. For example, an *audit* is useful in telling an organisation whether it is doing all the proper and necessary things and *self-*

assessment helps people to stop and think before acting, but only an attitude survey can tell whether administrative actions are actually achieving what they are supposed to achieve.

Cox and Cox (1991) argue, cogently, that "constructive attitudes among the workforce, because they result from all other contributory features, are probably the most important single index of the effectiveness of a safety culture". Among current attitudes relevant to safety, some of the most important are *attitudes towards risks*. These are subordinate to values and superordinate to risk perceptions.

A good safety culture will also include a reasonable consensus on the perceived severity of the risks involved in the work. This means in turn that effort to avoid accidents will be allocated efficiently - not wasted on improbable hazards or neglected on serious ones. It also means that the various sub groups will not be continually exasperated because others are apparently making an undue 'fuss' about some hazards while ignoring others and vice versa.

WHAT ARE ATTITUDES AND PERCEPTIONS?

An attitude is a relatively enduring tendency to behave in particular ways towards some aspect of the environment - a *stable predisposition*. People's reactions to things and the ways they behave become fairly predictable because they have attitudes. Without this degree of consistency, social interaction would be impossible.

The measurement of attitudes is necessarily indirect. But so is that of electricity or radioactivity. We are obliged to create verbal or pictorial sample situations and to see how people react to these and then to generalise the results to their 'real' attitudes and behaviour. Finally, we should check that this generalisation can be trusted, i.e. that the measurements we have made are valid.

The most ubiquitous and reliable method of measurement, providing people have no interest in deceiving (in which case other methods are appropriate and are available) is the humble but ubiquitous questionnaire. The best way of ensuring that the respondents will not deceive is to make cast iron arrangements for confidentiality. In these circumstances, their willingness, indeed enthusiasm, to say what they think can generally be relied on.

As mentioned earlier, perceptions are subordinate to attitudes, but only in the sense that they are less enduring. It is our constant stream of perceptions that go towards the construction of our attitudes - but once an attitude has been established it acts as an active filter, selecting what is attended to and *interpreting* the stimuli in the course of perception.

Most of what we know about the perception of hazards has been learned from studies of the wider public. These show that there are strong influences from two sources. The first is *cultural*, i.e. people's background, identity, interests and past experiences. The second relates to the *type of hazard*. Is it engaged in voluntarily? Is it 'dreaded'? Is it familiar or unfamiliar? Does it involve a 'risk to self' or a 'risk to society'? And, perhaps most important, who benefits?

RISK PERCEPTIONS IN WORK SETTINGS

An early study was carried out by Ostberg (1980) in the Swedish forestry industry. There are many hazards to which people are exposed during tree-felling operations and Ostberg presented his subjects with a number of these, described and illustrated in a booklet. The managers and workers were asked to assess their comparative severity. There was good agreement on the perceived relative riskiness of the operations but substantial differences in the absolute levels of perceived risk between six levels or trades. These were: fellers, trainers, safety officers, forestry school trainees, safety engineers and supervisors.

By comparison with the norm, trainers overestimated the risks but supervisors, who are at the sharp end of the conflict between productivity and safety, markedly underestimated the risks.

Unfortunately, Ostberg did not have available any reliable accident or injury statistics from which the ‘objective’ risk could be deduced. However, it is sufficient to say that the difference between the two extremes, i.e. trainers and supervisors, was a factor of 4.5, and we have to conclude from this that many of the workers were either seriously over-estimating or under-estimating the risks involved.

Singleton, Hicks and Kirsh (1981) were able to provide a comparison with reliable accident statistics. In their case, they were looking at the familiar task of driving a tractor and comparing the perceived risks of an accident in ten different situations. For two of ten assessments, there were substantial discrepancies between the ‘real’ risk and the ‘perceived’ risk. The risk of being hit by another vehicle on a public road was placed tenth in order, whereas in ‘real’ terms it should have been ranked fifth. The other situation involving a large discrepancy was in the possibility of a tractor rearing over backwards while travelling up a steep slope. This was over-estimated in severity from tenth place to sixth. Research has shown that dramatic, ‘memorable’ accidents tend to be perceived as more likely, an effect that is amplified by the media attention it attracts.

Rushworth et al (1986) studied the perceptions of workers involved in the maintenance and cleaning of very large bunkers that are used for storage purposes in coalmines. The seriousness of the situation can be represented by the fact that ten accidental deaths had occurred over an eleven year period!

Eighteen unsafe behaviours or situations were selected and descriptive scenarios provided for each one. The subjects were given a scale ‘anchored’ to an everyday risk of known probability, i.e. ‘being run over on the road’. Trainees perceived the risk as most serious but trainers had a reasonably accurate knowledge of the risks. The colliery bunker specialists, who were most accustomed to working in the situation, had low awareness of the risks involved and area teams, carrying out the same work but covering a number of pits, were even more over-confident. The study provided strong support for a recurrent finding, that is that experience or familiarity with a task leads to a lowered estimation of its risk. Also, supervisors, who are probably the ones most subject to production pressures, were again shown to seriously under-estimate the risks involved.

In response to detailed questioning, workers gave a variety of seriously considered explanations for the well-known violations of the safety rules. However, these displayed a *completely unfounded* confidence in their own ability to extract themselves from danger. For example, they were sure they would be able to react in time to snatch a rope if they fell, having failed to fasten a safety harness. In most of these cases, there was sufficient technological knowledge and experience to indicate that these and other ‘expected’ reactions were absurdly over-optimistic.

Other studies where reliable accident statistics are available were carried out by Dunn (1972) on chainsaw operators and by Zimolong (1979) on railway shunters. A variety of work situations and tasks were rated for their perceived risk, but there was little correspondence between these perceptions and the ‘real’ risks.

A much more detailed study was carried out by Zimolong (1985) among groups of construction workers. Using German national accident statistics, six high-risk occupational groups were selected for whom data were available. These were carpenter, tile-layer, scaffolding assembler, construction worker, painter and steel construction worker. There was good agreement *within* each group on the perceived risks, but again, little correlation between the objective risks and subjective assessment. There was severe *under-estimation* by each group of the risks with which they were most familiar. In all cases, the effect was considerable. For example, painters under-estimated *ladder* falls by thirty-three per cent and thirty-six per cent for minor and serious or fatal accidents respectively. Scaffolding assemblers under-estimated scaffold accidents by fifty-six percent and forty-three per cent.

This bias may be explained either by the high familiarity of the task or by the fact that these were the particular tasks from which the subjects received direct benefit.

ATTITUDES TOWARDS RISKS IN WORK SETTINGS

Perceptions of particular hazards are likely to be influenced, in part, by generalised attitudes towards risk and risk-taking.

Zuckerman et al (1980) postulates individual differences in 'sensation seeking' which seem likely to have a physiological basis. However, work experience, social learning and cultural factors (e.g. fatalism) are likely also to contribute to the growth of attitudes which may vary on a dimension from risk to caution. Employees also develop attitudes towards the many aspects of safety management such as 'permits to work', alarms and safety regulations.

There is little doubt that the conflict between risks and *benefits* is acute in industrial settings. Peterson et al (1987) studied forestry workers in a 'natural experiment' when their conditions were switched from piecework to day rates. When the change occurred the attitude towards risk-taking changed fairly abruptly. The operatives were well aware that safety procedures were being compromised and explained that they found them time-consuming and a direct hindrance to their earning capacity. Leather (1988) compared building workers employed by private firms on piece rates with those employed by Local Authorities on day rates. Attitudes towards risk were again quite different. There was a conscious realisation that unsafe behaviour and practices were more common in the private sector because they were more *beneficial*. Interestingly, the building workers said that, other things being equal, they would have preferred to work under the less stressful conditions of Local Authority control.

Job satisfaction is another attitude that is linked to safety through such mechanisms as psychological withdrawal, non-compliance, lack of interest in the work, aggressiveness, or resentment leading to violations.

An early study of Calcutta bus drivers by Bose et al (1969) used a simple attitude scale to successfully predict accident rates.

A study by Levine et al (1976) was carried out on the 'closed community' of a US aircraft carrier. Its unique feature was that a 22 item scale was administered to pilots and air support personnel *before* a deployment. A sub-scale of *adventurousness* was extracted by factor analysis which predicted accident rate in both groups, *including loss of/damage to aircraft in the pilot group*.

Andriessen (1978) identified *carefulness* and *safety initiative* attitudes and reported behaviour that were correlated with pressure from supervisors, 'regular mates' and peers. Kynaszczuk et al (1982) have studied general attitudes towards safety in members of a flying club.

There is very little published human factors research (with the exception of studies of 'human reliability assessment') in the nuclear industry, but Marcus (1988) confirmed in a study of twenty-four US nuclear power plants that those operating at the higher rates of general efficiency also had a good measured safety climate (culture) with *favourable employee attitudes* towards safety. The consequences claimed for this were fewer accidents and one-third of the number of 'human error events' than in stations with a poor climate.

Cox and Cox (op cit) gathered data from employees of a multi-national gas company. Their factor analysis of seventeen attitude items produced five orthogonal factors, i.e. personal scepticism (about safety); individual responsibility; safeness of the work environment; the effectiveness of arrangements for safety; and personal immunity. It was hoped that this mapping of people's 'safety space' would generalise widely and this has recently received partial confirmation from studies in a transport company, a food factory, among office workers (Cheyne and Cox, 1994), and an oil company (Alexander, Cox & Cheyne, 1994).

Rundmo (1992a&b), working with offshore oil platform workers in the Norwegian sector of the North Sea is pursuing a similar goal but using path analysis to model the linkages between satisfaction/dissatisfaction with management; working relationships and safety contingency measures and how they influence *job stress* and *risk perception.* He then modelled the effects of these two factors on the ultimate dependent variable, i.e. accidents and near misses.

Although it is increasingly evident that attitude surveys are an invaluable (if not sufficient) way of measuring safety culture improvement over time, Rundmo is the first to demonstrate this by repeating his 1990 survey four year later (Rundmo, 1995).

THE SELLAFIELD SAFETY SURVEY

A number of industries have begun to turn to attitude surveys to assess the health of their safety cultures and to design therapeutic measures. The one briefly described here was carried out at Sellafield in 1992 and is described in more detail elsewhere (Lee, 1993; Lee, Macdonald & Coote, 1993).

The project was initiated by first bringing together approximately 50 people, comprising a representative cross section of the Sellafield workforce, into five "Focus Groups". The purpose of these groups was to identify those safety aspects of working at Sellafield which were of concern to them and to their colleagues.

The particular advantage of a mixed focus group is that it provokes lively exchanges, with occasionally conflicting points of view, and these bring to the surface a wide range of beliefs, attitudes and feelings that would otherwise be inaccessible. There is no formal agenda - but the task of the 'facilitator' is to ensure that all relevant aspects are covered, everyone is brought in, but not all at once. Silent gaps are not a problem!

The (verbatim) records of these discussions were used to help compile and structure an extensive questionnaire. The initial draft of the questionnaire was later reviewed by all those who had taken part in the groups and modified in the light of their detailed comments.

A *pilot* sample of approximately 200 people, selected systematically to represent the whole site, completed the draft questionnaire.

The questionnaire was next refined and validated internally and an effective administration system developed for application. A total of 5,295 completed questionnaires were returned, about an 85% response rate.

It was considered desirable that exactly the same questions should be addressed to every level in the organisation. To achieve this, the form was standardised throughout. It consists of 172 'attitude statements' and respondents are simply asked to express their agreement or disagreement with each one on a 7 point scale. Completion takes 20-30 minutes.

The questions cover nine general areas relating to safety at the plant and these are shown in Table 2. It should perhaps be re-emphasised that these had emerged, or been revealed, from the analysis of the complete transcripts made at the focus group discussions. It is a common criticism (more from within psychology than from outside) that such studies tend to be imperiously structured by the pre-conceptions of the investigator.

There is, without doubt, practical value in the answers to some of the individual questions. For example, whether people agree that the Safety Officers, Health Physicists or Safety Reps. are easy to contact when needed and doing a good job; again, the response to questions such as "Actions in response to entries in safety, in logs, is usually prompt" and "Rules about protective clothing are always strictly enforced". If the level of agreement is unacceptably low, remedies can be considered. A number of these implications are now being addressed, energetically.

The next stage was to reduce the 172 attitude items to more manageable proportions. It is obvious that the meanings and implications of each one tend to overlap with others within its general grouping, to varying degrees. This can be quantified by computing correlations between each item and every other one in its group.

The resulting matrix of inter-correlations is then analysed by Principal Components Analysis to extract the main underlying factors - each composed of a set of items that appeared to contribute to the same, coherent attitude. The degree to which each constituent item contributes to the factor of which it forms a part is indicated by its 'loading'. This, like a correlation co-efficient, varies from 0 to 1.

Table 2 - Principal components analysis

172 STATEMENTS		
9 General areas	**Designation**	**19 Factors/Attitudes**
Safety procedures	Safety	• Confidence in the safety procedures
Safety rules	Rules 1 Rules 2	• Personal understanding of safety rules • Perceived clarity of safety rules
Permit to work system	Permit 1 Permit2 Permit 3	• Confidence in effectiveness of PTW • General support for PTW • Perceived need for PTW
Risks	Risk 1 Risk 2 Risk 3	• Personal caution over risks • Perceived level of risk at work • Perceived control of risks in the plant
Job satisfaction	Jobsat 1 Jobsat 2 Jobsat 3 Jobsat 4	• Personal interest in job • Contentment with job • Satisfaction with work relationships • Satisfaction with rewards for good work

Participation/Ownership	Participation Control 1 Control 2	• Self-participation in safety procedures • Perceived source of safety suggestions • Perceived source of safety actions • Perceived personal control over safety
Design	Design	• Satisfaction with design of plant
Training	Train 1	• Satisfaction with training
Selection	Train 2	• Satisfaction with staff suitability

An additional analytical procedure known as *varimax rotation* enables us to adjust the composition and loading of items to achieve factors from within a given grouping that are independent of each other, that is, they address different aspects of the same general area.

Each factor has to be labelled appropriately and this is done by looking at the main thrust of the items that compose it - particularly those with the highest 'loadings'.

Each person is given a single score for each attitude, which is derived by adding together his/her score on the relevant items, each being first 'weighted' by its factor loading.

The outcome of this process was the identification of a total of 19 factors covering the 9 areas relevant to safety at the plant. Time does not allow for a detailed description here of more than a few of these factors and, given the main topic area of this Workshop, it seems most appropriate to show, for illustrative purposes, the items contributing to the three factors in the Risk Perception grouping (Table 3).

It will be seen that the perception of risks consists of three independent factors.

- **Personal caution over risks**
- **Perceived level of risk at work**
- **Perceived control of risks in the plant**

Validation: The major question that needs to be asked next is the extent to which the responses to such attitude items are frank and honest and whether the factors that emerge are anything more than a theoretical structuring. In short, whether they are *valid* as indicators of safety behaviour at the plant.

Although it was not possible to deduce this from accident records without sacrificing the essential anonymity on which the whole survey hinged, the respondents were asked the following question.

> "Have you had any accidents resulting in time off work for three days or more while working for BNFL? If YES, approximately how many?"

Analysis showed that 17 of the 19 attitudes discriminated between the accident group and others. This is shown in Fig. 1.

Fig. 2 shows the same data for 15 of the most predictive attitudes when the sample is broken down into sub groups who have experienced variable numbers of accidents.

A further extension, which cannot be described in detail here, is the use of a statistical technique known as Discriminant Function. This enables us to determine which of the attitudes is most predictive of the vital accident/no accident criterion.

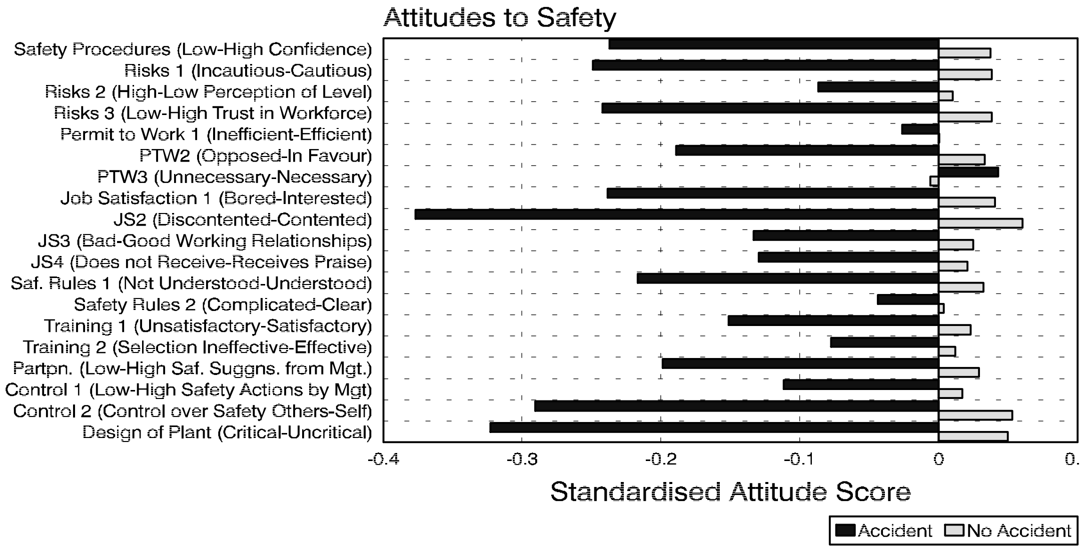
Table 3 - Principal components extraction

Group No. 2 - RISKS
Factor 1 - Personal caution over risks / Factor 2 - Perceived level of risk at work / Factor 3 - Low-high trust in workforce

	Factor 1	**Factor 2**	**Factor 3**
If I didn't take a risk now and again, the job wouldn't get done	-.640		
What I really enjoy is a job with a spice of danger	-.486		
Everyone takes risks in the home and it's difficult to switch over at work	-.491		
I sometimes have to turn a blind eye to the strict safety rules to get the job done on time	-.666		
Most accidents just happen - there's not much you can do about it	-.482		
I know the job so well that I am extremely unlikely to have accident or be involved in one		.475	
There are certainly risks in working at Sellafield			.464
The risks at Sellafield are completely cancelled out by the safety precautions		.589	
I never think about the risks now I am used to the work	-.495	.431	
A certain amount of risk is no problem if you have 'what it takes'	-.548		
The Permit to Work system ensures safe working		.542	.443
The Permit to Work system is just a way of covering people's backs	-.476		
Having the Nuclear Installations Inspectorate makes me feel safe		.463	.509
In my place of work the one who is most careful in applying the safety rules and instructions is myself			.457
So far as safety is concerned, you can trust most people in my place of work		.472	
There is sometimes pressure to put production before safety from myself	-.462		

Fig. 1 - The Relationship Between 19 Attitudes and Accident Group

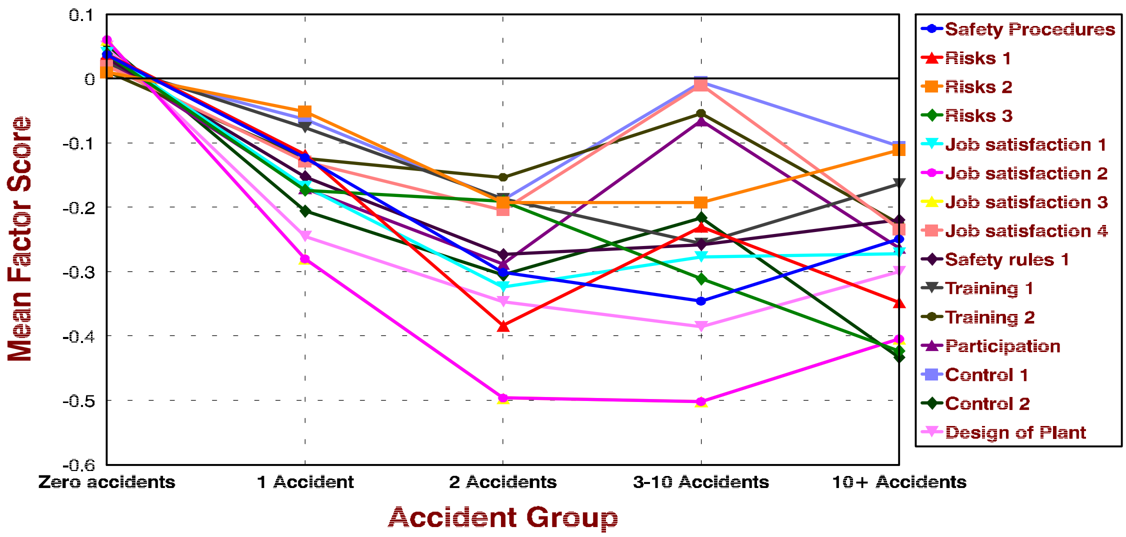
Whole Plant



N = 5198 (Accident = 684; No Accident = 4514) / Plant Mean = 0

Fig. 2 - Relationship between Attitude and Number of Accidents

15 Attitudes towards Safety



Zero accidents = 4,514; 1 accident = 285; 2 accidents = 105; 3-10 accidents = 94; 10+ accidents = 76; Total = 5,074

The practical value of such a survey is, first, that it can be used to assess the current state of the safety culture and, if repeated at say, two yearly intervals, any improvement.

Secondly, suitable analysis has enabled us to identify not only the attitudes that are most in need of improvement but to break this analysis down by the following variables.

> Department, Age, Sex, Length of Service, Broad Type of Job, Detailed Type of Job, Shift or Day-worker and Employed in Active Area.

A survey of attitudes towards safety is an ideal way of monitoring the health of a safety culture, especially if it can be repeated every few years. The main problem for the future is how to synchronise or combine the two invaluable tools of the safety survey and the safety audit.

PRACTICAL IMPLICATIONS

There is an increasing use of attitude scales to monitor safety and the latest version of the ISRS Audit Handbook advocates their use. Regulators may be able to encourage Nuclear Licensees or Utilities to carry out safety surveys. This would provide valuable evidence to mutual advantage. The method is currently being extended to nuclear power stations in the UK and the results of this study should provide more specific evidence within the coming year.

If the results are to be relied upon, the method must be valid and shown to be so. If the results are to be useful, detailed breakdowns and appropriate statistical analyses are needed. Hence, professional expertise is desirable, if not essential.

In situations where it is not feasible to carry out a representative survey, the summary presented here of the features of low accident plants and the profile of safety attitudes identified at Sellafield may prove helpful in devising structured check-lists for use by Site Inspectors or, at the very least, in guiding their subjective observations.

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United States
Nuclear Regulatory Commission

INTERNATIONAL WORKSHOP
REGULATORY INSPECTION ACTIVITIES
THE
PLANT PERFORMANCE REVIEW (PPR)

ROBERT M. GALLO

MAY 20, 1996

United States
Nuclear Regulatory Commission

PPR PURPOSE

- **Early Identification of Licensee Performance Trends through Integrated Assessment of Objective Information**
- **Adjust, Document and Communicate Inspection Plans to Address Performance Trends**

United States
Nuclear Regulatory Commission

PPR OVERVIEW

- **Frequency = Semi-Annually**
- **Information - Licensee Event Reports, Inspection Reports, Investigations**
- **Participants - Regional Managers, Resident Inspectors**
- **Documentation - Input, Assessment, Output**
- **Communication - Letter with Plans to Licensee**
- **Meeting - Optional**
- **Oversight - Regional Administrator**

United States
Nuclear Regulatory Commission

PPR PROCESS

- **Previous PPR and SALP (Systematic Assessment of Licensee Performance) Results Reviewed for Background**
- **Utilised Reference Material Must be Docketed**
- **Focus on Performance Changes Since Last Review and Inspection Programme Status**

United States
Nuclear Regulatory Commission

PPR PROCESS (Cont'd)

- **Discussions Highlight Licnesee Corrective Action Effectiveness**
- **Neither a Mini-SALP nor SALP Substitute**
- **Performance Conclusions Limited to Areas with Adequate New Information**

United States
Nuclear Regulatory Commission

PPR PROCESS (Cont'd)

- **Inspection Initiatives Scheduled with Due Regard to Forcasted Licensee Activities**

- **Letter to Licensee Limited to Observed Trends and Rationale for Inspection Initiatives**

United States
Nuclear Regulatory Commission

PPR PROCESS (Cont'd)

- **Subsequent Inspection Plan Changes will be Promptly Communicated**

- **Resulting PPR Package Used as INPUT to SALP and Senior Management Meeting Process**

OECD
Nuclear Energy Agency

INTERNATIONAL WORKSHOP
REGULATORY INSPECTION ACTIVITIES
19-24 May l996

Plant Maintenance
The Licensee's Viewpoint

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ABSTRACT

Plant maintenance is a very complex process which requires considerable effort from both within the maintenance process and also many support activities. It is important that the plant maintenance policy is translated into a maintenance programme which will define all relevant aspects of the maintenance. An aspect of this maintenance programme will be a maintenance catalogue which will define the maintenance activities to be carried out and at what frequencies. This paper is aimed at discussing the maintenance philosophy and resulting maintenance catalogues currently adopted in Nuclear Electric Ltd, and in particular at Heysham 2 Power Station. It goes on to consider whether these maintenance catalogues contain the optimum maintenance and if not should they be changed. If change is required, the process by which this change will be brought about is also discussed.

1.0 INTRODUCTION

Nuclear Safety in particular and asset management in general is preserved through good design, operation and maintenance. In the past Nuclear Electric has placed considerable emphasis on this approach to safety and this can be borne out by its exemplary safety record.

Plant maintenance is very complex with a wide range of issues. It is essential that any organisations policy with regard to plant maintenance is transparent and with clear objectives. These policies must be translated into a maintenance programme which clearly defines all aspects of the maintenance including the support which will inevitably be required.

When you consider the activities performed at any power station, such as procurement, stores control, inventory management, planning of work and many others, they all have a common factor. This is that they are part of maintenance, affect maintenance, or are affected by maintenance. This leads to the conclusion that control of maintenance spending has a major affect on our ability to control costs. Maintenance is often the major contributor to unavailability. This unavailability may come in the form of outages to refurbish the plant or breakdowns due to damaged or degradation of equipment. With this in mind, it appears that the most effective method of controlling the amount of money spent in the pursuit of the right amount of maintenance is to optimise maintenance. This paper will focus on this aspect of maintenance management and in particular consider:

- the current maintenance philosophy and resulting maintenance catalogue
- can these maintenance catalogues be optimised?
- where optimisation is identified, how can this be achieved; maintaining the high safety standards that currently exist?

1.1 Background to Nuclear Electric Ltd (NE)

Nuclear Electric plc (NEP) was one of the three generating companies to emerge from the split up of the former Central Electricity Generating Board (CEGB). NEP owned and operated the commercial nuclear power stations in England and Wales. It was set up in 1990, following the British Governments decision to retain nuclear power in the public sector on privatisation of the electricity supply industry. It's operational power stations consisted of six Magnox, five advanced gas-cooled reactors (AGR) and one pressurised water reactor (PWR). Two Power stations were in the process of being decommissioned.

The new structure of the UK's nuclear power industry was set out in the Government's White Paper of May 1995. This paper proposed that the older, Magnox nuclear power stations should be retained in the public sector, while the UK's eight most modern nuclear power stations should be transferred to the private sector through the privatisation of British Energy. British Energy comprises British Energy plc and its two operating subsidiaries, Nuclear Electric Ltd (NE) and Scottish Nuclear Ltd (SN). Five AGR stations and the PWR station are owned and operated by NE in England, and two AGR stations are owned and operated by SN in Scotland. For the year ended 31.03.95 NE generated around 14% of the electricity consumed in England and Wales, whilst SN generated around 53% of the electricity consumed in Scotland.

1.2 What Is Maintenance?

When we talk about maintenance, it is important that we understand what is meant. Maintenance can be considered to be *"the way in which we ensure that the physical assets i.e. plant and equipment, continues to fulfil their intended functions".* There is an assumption that the equipment is capable of fulfilling this function to start with. It is important to recognise that maintenance will, at best, only deliver the inherent capability. If the equipment is inherently unreliable, maintenance cannot compensate for this design flaw.

Maintenance is not only the craftsperson undertaking a maintenance task. It includes a complex process involving a predefined maintenance programme designed to provide personnel with the necessary skills, knowledge, resources and support to properly perform their tasks. This involves support and involvement from a number of different groups including: planning, engineering, operations, procurement, stores, training to name a few.

2.0 MAINTENANCE PHILOSOPHY AT HEYSHAM 2 POWER STATION

The current maintenance catalogue at Heysham 2 Power Station was developed with two distinct policies; one which upholds the principles expressed in the Site Licence and the second in relation to the balance of plant. The former is predominately based on inspection and testing, whilst the latter utilise the more traditional method of strip-down maintenance. In both cases the emphasis on reliability is consistent with developments, of the principles of maintenance, over the last couple of decades.

2.1 Compliance With Site Licence

The Nuclear Installations Act is Statutory Law made by Parliament. A breach of Statutory Law constitutes a criminal offence.

The objective of the Nuclear Installations Acts is to control nuclear installations, such as power stations, by means of Licences which contain detailed conditions. These conditions place requirements on the Station Director who is the agent of the licensee, which is the Company. The arrangements for compliance with the conditions are contained within:

- ☞ The Operational Quality Assurance Programme
- ☞ The Department Manuals
- ☞ The Management Control Procedures and their Parts
- ☞ Departmental Instructions

- Section Instructions
- Operating Rules
- Identified Operating Instructions
- Station Operating Instructions
- Plant Item Operating Instructions
- Work Specifications

Heysham 2's Site License is posted on site at various locations for all to see. Management Control Procedure No 1 identifies individuals who are responsible for the specific arrangements for complying with each condition. The Engineering Maintenance Manager has responsibility for Condition 28 which requires that the licensee make adequate arrangements for the regular and systematic examination, inspection, ma}maintenance and testing (maintenance[MIT]) of all plant which may affect nuclear safety.

Heysham 2's designs and operating regimes were substantiated by means of formal probabilistic safety assessments. The levels of maintenance[MIT] specified within these assessments are not simply reliant on good engineering practices but rather that level demanded to meet the targets of probability failures necessary to protect against activity releases under various fault scenarios. It is the Station Safety Report (SSR) which contains both the design and associated maintenance[MIT] which meets the safety case reliability targets and therefore provides adherence to the principle expressed in Site License Condition 28.

The maintenance[MIT] as defined within the SSR, is translated into a schedule which specifies the frequency of, and the arrangements for, the testing, inspection and maintenance of plant and the methods to be employed. This schedule is known as the Maintenance Schedule.

These three elements of maintenance[MIT] have been deployed in a complementary fashion such that:

- Testing is undertaken to ensure that plant is capable of carrying out its safety related function, particularly for plant which is not normally running or not frequently operated
- Inspection is carried out to ensure continuing integrity of plant and operation within prescribed limits assumed in the safety case
- Maintenance is carried out where testing has revealed failures or significant degradation or where a time dependent failure mode is known to exist

The design approach has been to use only plant components of types where experience is available to claim for their application. This approach applies to both essential and non essential plant. Diversity and redundancy of systems and plant are provided to ensure that safety related systems can meet the overall station risk criteria taking account of realistic maintenance requirements. With regard to these maintenance requirements the general strategy is to rely primarily on test and inspection of plant to provide evidence that the design and safety intent is being achieved. There may however be certain occurrences and conditions which will become evident during subsequent operation and maintenance which may require to have maintenance invoked as means of demonstrating continuing integrity of the plant. Alternatively data may be accumulated to justify a relaxation in the needs.

2.2 Balance of Plant Maintenance Policy

The maintenance policy that has been adopted on the non-nuclear safety related plant has been a combination of Corrective and Preventative maintenance. The maintenance programmes for these areas of plant are broadly based on manufacturers' recommendations with some modifications over the years to take account of individual engineers' perceptions of best practices. This approach has led to a vast number of routine maintenance tasks associated with each system.

2.3 Existing Maintenance Catalogue

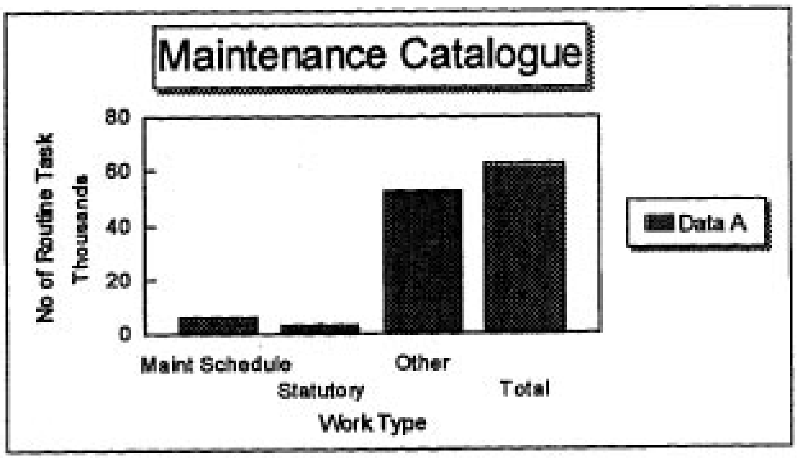

Figure 1 Maintenance Catalogue

The existing maintenance catalogue consists of 62,228 routine tasks of which 6,749 are Maintenance Schedule, 3,166 Statutory and 52,313 Other. The maintenance schedule routines relate to maintenance[MIT] activities on nuclear safety related plant. Statutory routines relate to activities in relation to other legislation i.e. Pressurised Systems Regulations, Lifting Equipment etc. Work type Other relates to all rerunning routine activities, and these being mainly associated with the balance of plant i.e. non-nuclear safety related plant.

2.4 Maintenance Organisations

The engineering and maintenance responsibilities were undertaken by two separate departments; Engineering and Production. The Production Department had the responsibility for operating the plant and also planning and carrying out the maintenance, whilst the Engineering Department had the responsibility for the engineering well-being of the whole station. The newly formed Engineering Maintenance Department combined the planning and maintenance responsibilities from the Production Department with the engineering functions of the old Engineering Department. The organisational structure is shown in Figure 1.

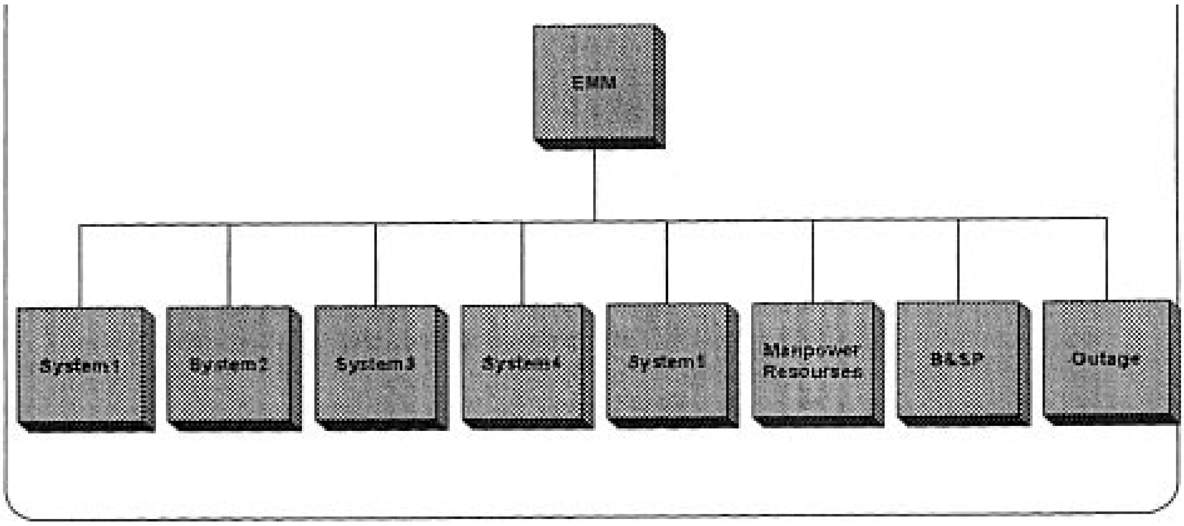

Figure 2 Heysham 2 Engineering Maintenance Department

Five of the department groups have adopted the system engineering concept and are totally accountable for the well-being of their particular systems. Their role is to support the plant systems with regard to safety, legislation, reliability, maintenance and efficiency. The system engineers within these groups have full responsibility] for all aspects of their plant systems.

The Manpower Resources Group contains, medium and short term planning, Diagnostics, the majority of the stations craft personnel with a small number of support engineers. This group has recently carried out an organisational review with the ultimate aim to release the untapped potential that currently exists within this group, and taking advantage of best practices. This has been carried out with consultation with customers and also building on current strengths and addressing acknowledged weaknesses. The proposed restructure engenders multi-discipline team working, reducing barriers between individual disciplines and promoting flexibility within the groups.

The Outage Group is responsible for the overall project management of the statutory outage ensuring that it is delivered to the required quality, cost and within the agreed duration. It is also responsible for managing the long term planning and liaising with all other department/groups in preparation for future outages. It has recently taken on the additional responsibility of coordinating all outages whether planned or otherwise.

Business and Special Projects provides support to the other groups within the department in all business aspects of the Engineering Maintenance Department. Its aim is to raise the business acumen in both individuals and the systems that are currently operated. The group also manage any significant project which involve common issues across more than one group.

The reorganisation was aimed at providing all staff with a greater focus on their responsibilities for ensuring the Stations safety commitments and for striving towards the most cost affective maintenance regimes. The principles behind this reorganisation include:

- ☞ greater personal accountability and responsibility
- ☞ ownership of work environment and decisions taken
- ☞ shorter dines of communications, particularly between the specifiers and the doers

☞ reinforcement of the customer/supplier principles.

3.0 OPTIMUM MAINTENANCE

Heysham 2 has compiled a considerable maintenance catalogue as indicated in the previous section. It is important to identify the true maintenance requirement for the plant and remove any unnecessary activities which either serve no value and/or degrade plant reliability. Identifying the right amount of maintenance is only apart of the equation, ensuring that the maintenance teams are being utilised effectively is equally important.

3.1 Why Change What We Already Have?

A national survey commissioned by the Department of Trade and Industry (DTI) in 1988[Ref1] discovered that British industry could save £1.3 billion a year through better maintenance management and practices. This survey involved mainly the manufacturing sector. However, it is reasonable to assume that saving of similar orders would be available in the electric utility industry.

As competition within the electric utility industry heats up, cost considerations are becoming paramount. There is certain cost which the generator has negligible control. However, operation and maintenance (O&M) costs are exceptions. The relative importance of O&M expenditure has been rising for more than a decade. A recent EPRI Journal [Ref2] indicated that, at nuclear power stations the O&M portion of power station production cost grew by more than 120% between 1981 and 1991.

The existing maintenance catalogues within NE were produced during the days of the CEGB. The requirements on those personnel involved in drawing up these catalogues were very different from those that exist today. The main focus for the company then was to meet production demand with very little consideration to what this cost. In fact the pay and productivity schemes of that period were designed at keeping large quantities of personnel occupied rather than minimising the work. In most cases the catalogues were heavily biased to preventive maintenance, using mainly intrusive techniques. It is also important to recognise that each station developed its own catalogue without particular reference to other stations. This can borne out by the significant variations between maintenance regimes on similar plant. The vast operation experience gained throughout the company, has not always been used by all. Once in place, these catalogues have remained substantially unchanged.

It is now generally accepted within the engineering community that intrusive maintenance i.e. routine strip-down maintenance, does not lead to highest reliability. In some circumstances an increase in the frequency of routine strip-down or preventative maintenance may increase the probability of failure as a consequence of "burn-in" or '"infant mortality"'. lnformation from a study of maintenance in the aircraft industry [Ref3] has shown that for complex equipment, similar to that found in some nuclear power station systems, only 5% of failures result from equipment wearing out whereas 68% of failures stemmed from overhaul or replacement of equipment.

3.2 Dispelling Maintenance Fallacies

There are a number of fallacies in relation to maintenance and these include:

☞ **More Maintenance Means Greater Reliability-** the design and components from which equipment is made result in an inherent reliability. There will be an optimum maintenance regime for which this reliability can be maintained. Additional maintenance over and above this regime will not add any value.

- **Reducing Maintenance Costs Increases Risk -** arbitrarily reducing maintenance in an attempt to reduce costs may lead to an adverse effect on nuclear safety. It can also lead to an increase in breakdowns which rather than reduce may result in an increase in costs. However, critically reviewing maintenance catalogues with the overall aim being to establish the optimum maintenance, will result in reduced costs and reducing the occurrence of spurious reactor trips. Reducing the dependence on preventive maintenance could lead to higher availability] of safety related plant.

- **Maintenance Should Be As Prescribed by The Manufacturer; They Know Best -** maintenance catalogues for existing plant have been significantly influenced by manufacturers recommendations. In some quarters there is a belief that manufacturers know best. However, in many instances manufacturers are not aware of how their equipment performs once installed and commissioned. Many utilities deal with plant problems in-house without either consultation or even feedback to the original manufacturer. In such cases it is not surprising that the manufacturer continues to turn out the same maintenance recommendations without due regard of operational experience.

- **Frequent Overhauls Result in Greater Reliability -** question *"consider when your car is most likely to breakdown "?* Answer *"as you are driving the car away from its last service".* Maintenance induced defects are a consequence of intrusive maintenance. Frequent overhauls requiring restoration and/or discard routines may and often does result in an increase in infant mortality failures. In certain circumstances leaving well alone i.e. if it's not broken don't fix it, is the best policy.

3.3 Maintenance and Risk

Carrying out maintenance has the consequence of risk to both personnel and plant. These risks include:

- hotworking i.e. use of welding equipment etc.
- live working i.e. electric/fluids still present
- isolation of plant for preventative maintenance
- plant reinstatement errors - valve, electrical reconfiguration
- erecting temporary assess platforms and the use of same
- rigging and transportation of equipment
- maintenance induced failures

Minor accidents and major disasters in the workplace are often linked to maintenance. With regard to the Piper Alpha accident Lord Cullen stated *"I conclude that the leak resulting from steps taken by night-shift personnel with a view to restarting the other pump which had been shut down for **maintenance.** Unknown to them a pressure safety valve had been removed from the relief line of that pump. A blank flange* *assembly which had been fitted at the site of the valve was not leak-tight. The lack of awareness of the removal of the valve resulted from failures in the* ***communication*** *of information at shift handover earlier in the evening and failure in the operation of the permit to work system in connection with "the work which had entailed its removal ".*

As indicated in the above sections, it would appear that the existing maintenance catalogues will provide considerable potential for optimisation. The overriding principle which will need to be adopted is that the maintenance should be targeted at meeting specifically identified safety and commercial requirements and that the activities that are carried out should be that most cost effective ones capable of achieving these requirements. It is important that **we define what *should* be done and not what *can* be** done.

Heysham 2 have recognised the importance of getting the balance right between safety, quality end profitability. Too great an emphasis on any one of these may adversely affect **the other** two. Focusing on profitability may lead to degradation of both quality and safety. It would be very short sighted to neglect safety and quality with, in the extreme case, the potential effect of receiving Prohibition Notice from the NII and consequential lost of generation. Conversely incurring unnecessary costs in providing excessive quality will lead to unprofitability. We believe that the maintenance function carried out safely and to an appropriate quality standard will provide the highest probability of achieving a profitable maintenance process.

4.0 ACHIEVING OPTIMUM MAINTENANCE

Whether organisational or specific maintenance catalogue changes, it is important that the goals and objectives for such changes are formulated. These changes must be managed with constant reference to the identified goals ensuring that the desired objectives are met. This continuous review will ensure that any deleterious effects are identified and rectified at an early stage.

4.1 What Is Maintenance Optimisation?

What does Maintenance Optimisation mean? Briefly, Maintenance Optimisation means doing the right thing at the right time. It is another way of saying "establishing the best maintenance at the lowest cost". In order to do the right thing at the right time, we must consider the aspects of maintenance which can affect reliability of the equipment and components that make up the system. These areas are then targeted to identify the most appropriate maintenance regime ensuring unnecessary work is eliminated. This will result in the workforce focusing on doing the right maintenance at the right time. An important feature of Maintenance Optimisation is that it is a self-improving, 'living" maintenance programme being continually updated by feedback of information from subsequent maintenance experience.

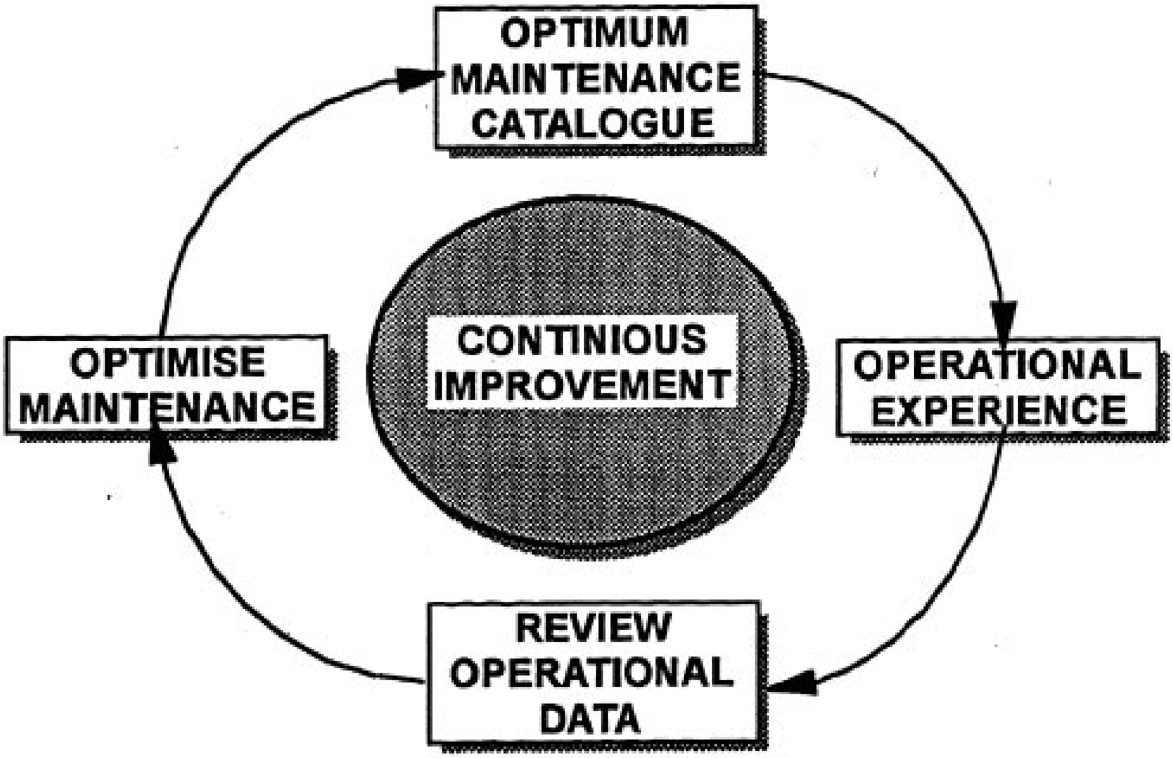

Figure 3 Living Maintenance Programme

4.2 Achieving Maintenance Optimisation

An important feature of managing change is that the process by which change is to be achieved is clearly defined and when used provides an auditable trail to all decisions made. Until very recently maintenance optimisation within NE was achieved on an ad hoc basis without any overall co-ordination. It became evident that if NE was to be successful in optimising its maintenance, it would need to develop a maintenance optimisation process. The process which was developed consists of six sub-processes, as shown in Figure 4' and they, are:

Establish - this element reviews the plant register and defines all items which are included in each plant system. It also collects all data which will be used throughout the process, this will include routine/defect tasks and associated costing information. This is the point in the process where the indicators are identified by which the system will be monitored during the continuous review stage.

System Selection - in the situation where potentially the complete maintenance catalogue is to be optimised, this element prioritises the systems. This prioritisation is broadly based on the significance of the system to both safety and generation, and the potential for optimisation i.e. current high cost of maintenance. The approach will be to focus on high potential gain/easy implementation systems first

Decide Review Method - this identifies which of the approved Maintenance Optimisation Tools to use. This will depend on the significance of the system fin relation to safety/generation and the current maintenance spend on that system. There is a range of tools which may be used for actually reviewing the existing maintenance catalogue on any system. These tools include Reliability Centred Maintenance (RCM), Streamlined RCM, Safety Case Development, Engineering Appraisal, Engineering Judgement etc.

Analyse System - using the above tool and all information which has been gathered about the system, a new maintenance catalogue will be produced. This will be achieved by consensus view from a multi-discipline review team who have intimate knowledge of that system. The review team may include plant area specialist and, where appropriate, the manufacturer of the equipment under review. It is perceived that condition monitoring will be a major consideration when reviewing alternative maintenance tasks. Obviously such tasks will need to meet specified criteria.

Implement - throughout the maintenance optimisation, a file will be kept which will collate and record details of work undertaken. On completion of the analyse element a further entry into this file will be a report which will recommend changes to the existing maintenance catalogue. These recommendations will range from simple changes to entries within the Work Management System to modifications to the existing plant. With regard to nuclear safety related systems, recommendations may require presenting to the Regulator for their approval along with all the necessary justification. The existing modifications procedure will be used in such cases.

Review - this element will objectively evaluate the changes in the maintenance catalogue to ensure that there has not been any deleterious effect to either safety and/or generation capability. This element will also consider whether the gains forecast are actually delivered.

NE in general and Heysham 2 in particular have mainly relied on corrective and preventive maintenance policies to determine their maintenance catalogues. Predictive maintenance has been mainly overlooked, albeit some station have tinkered with the concept. Predictive maintenance, more commonly known as *'Condition Monitoring'* takes the view that, rather than looking at a calendar and assessing what attention plant equipment needs, we should utilise the variety of existing and proven diagnostic systems, which provide unprecedented ability to monitor equipment condition in real time and to spot trends that indicate incipient failure. The advantage of this approach is that it enables the plant equipment to send out a call for help, making timely maintenance possible while avoiding unnecessary maintenance and overhauls. Heysham 2 are currently appointing a full time condition monitoring co-ordinator, who's role will be to establish an overall condition monitoring strategy and provide the necessary infrastructure for its implementation. We believe that such an approach will best complement the overall maintenance optimisation programme. Condition Monitoring should not be considered a separate exercise to optimising maintenance rather an integral part of the overall process. It is essential that constructive dialogue is established with both NE's internal regulators i.e. HSED as well as the Regulating Authority i.e. NIl, in relation to this matter.

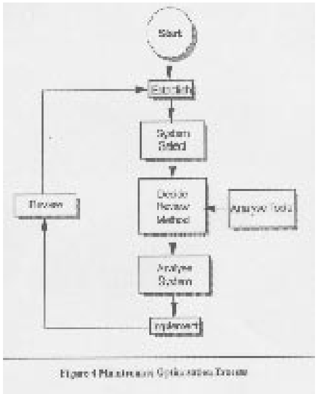

Figure 4 Maintenance Optimisation Process

4.3 Through-Life Maintenance Optimisation

The Station Safety Report, as referred earlier, indicated with regard to nuclear safety related plant that in certain circumstances it may be necessary to review the existing maintenance[MIT] to take account of operating and/or maintenance experience. To fulfil this obligation, regular reviews of results from both real and test operations are carried out to demonstrate that the safety claims are being met. These reviews are identified within the Maintenance Schedule and are referred to as Safety System Reviews. Further investigatory work is undertaken, in compliance with an Identified Operating Instruction, to validate the reliability claims of the Probabilistic Safety Assessment. This work results in the compiling of regular Reliability Reports.

To complement this work, with the potential of increasing the investigations to plant other than nuclear safety related, NE is currently implementing an electronic Reliability Data Analysis System, called REGCARD. Current practices are centred on interrogation and statistical analysis of NE's maintenance record databases. These records are maintained at each NE power station using the Work Management System called PASSPORT. REGCARD extracts specific maintenance history from PASSPORT. This data is interrogated on PC's where Pareto, trend and Weibull analysis can be carried out. This system in conjunction with the reviews referred to above will support the maintenance optimisation activities. It should also be capable of detecting early indications of ageing affects on the plant equipment and components.

4.4 The Journey to Excellence - Achieving Zero Defects

Defects may be considered in terms of Sporadic and Chronic Losses as illustrated in Figure 5. Sporadic are those that arise from time to time and have the consequence of diverting attention away from underlying maintenance problems. They tend to have straight-forward causes, and solutions are generally found quite quickly, allowing restoration tasks to be implemented. Chronic losses are the much longer term issues which can lay around for many years, generating defects without ever resolving the root cause. They generally do not get the attention they require due to resource being drawn to deal with sporadic defects. They tend to have complex causes and very often require innovative approaches to resolve, as indicated in Figure 6. However, it is dealing with and resolving chronic defects that will enable us to achieve 'zero defects'.

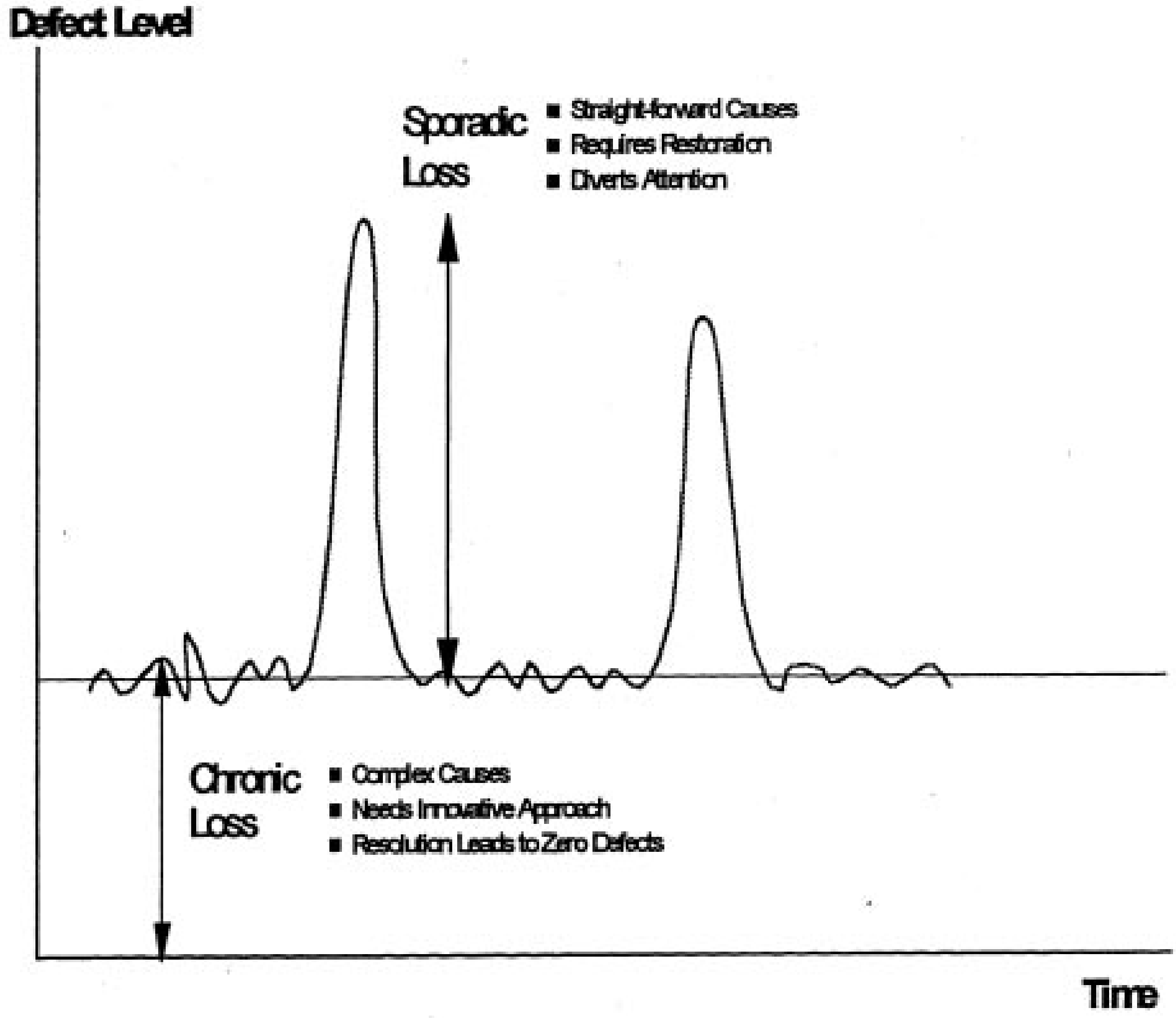

Figure 5 Exposing Hidden Defects - Sporadic and Chronic Losses

It is not unusual for maintenance staff, in the electrical utility industry, to spend in the order of 40% of their time attending to defects i.e. corrective tasks. These utilities are in the vicious circle of 'Stopgap Repairs' i.e. firefighting. Due to the extensive maintenance programme that generally exists and in particular associated with the nuclear safety related plant, very little opportunity is available to deal with this situation. Fortunately maintenance optimisation should address this problem. Not only does the maintenance optimisation process developed by NE consider the existing routine preventive tasks, it also reviews defects that have occurred on the plant equipment. It applies a logical and systematic approach to analysing each defect and identifies the root cause.

Albeit, Heysham 2's aim is to achieve a maintenance catalogue which has the right maintenance carried out at the right time, this may include breakdown maintenance as an integral part of this overall policy. This appears to clash with the aim of achieving a zero defect regime. We believe that both aim can be brought together and be complementary in achieving the overall goal of a maintenance catalogue that up holds safety and utilises the most cost effective maintenance regimes.

5.0 ROLE OF THE REGULATOR

The powers available to the NII under the Nuclear Installations Act (1995) as amended are quite clear. They range from giving consent for some activities or approval for some set of arrangements to issuing a direction to shut down some operation. As their formal consent is required following periodic maintenance carried out under an obligation imposed directly by one of the licence conditions, failure to satisfy the NII over the maintenance carried out would have the effect of their preventing return to power at a time when the licensee may consider work complete. In addition, the Health and Safety at Work etc. Act (1974) gives NII Inspectors powers to issue prohibition or improvement notices, which may also constrain activities on the site. Albeit, that in practice prosecutions are rare, the NII appear to wish to maintain public confidence in their role as 'protector of the public'. With this in mind, we must consider what is the best approach in satisfying this role.

NE have recognised the importance of engendering a 'no blame culture'. It is evident that for each significant incident there may be hundreds of warnings in the form of near misses. It is a clear hope that taking appropriate action, when a near miss occurs, will result in avoidance of the significant event - though if it succeeds, it cannot easily tee proven (because it has not happened). If it fails, the argument falls, and the effort was wasted! Nevertheless, it is important that this no-blame culture is allowed to flourish, and this will be facilitated by continued development of an effective working relationship between the NII and the Licensee.

The current UK legislation makes the operator i.e. Licensee, responsible for safety. This responsibility placed on the operator is right and proper, however does the approach currently adopted within the UK encompass best practices currently being applied internationally? Unlike the approach adopted in other countries, the UK Regulator does not provide safety standards or guidance. The onus is on the Licensee to continually demonstrate that as far as is reasonably practicable that they have taken account of experience and developments in technology in the interest of safety. This approach can lead to situations where the arrangements put in place are far more onerous then that necessary to satisfy the Licensees responsibility in terms of nuclear safety.

The NII has a vast experience of licensing in the UK They can further draw on the experience of an international network of regulators. Appropriate channelling of this experience may enable nuclear utilities to eliminate aspects of their arrangements which experience may have shown do not add value. This will enable the operator to focus on those areas that really do contribute to maintaining the current high standards of nuclear safety.

6.0 REFERENCES

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2. EPRI Journal May/June 1995 - Maintenance Optimisation

3. J M Moubray - Reliability Centred Maintenance. Butterworth-Heineman, Oxford, August 1991

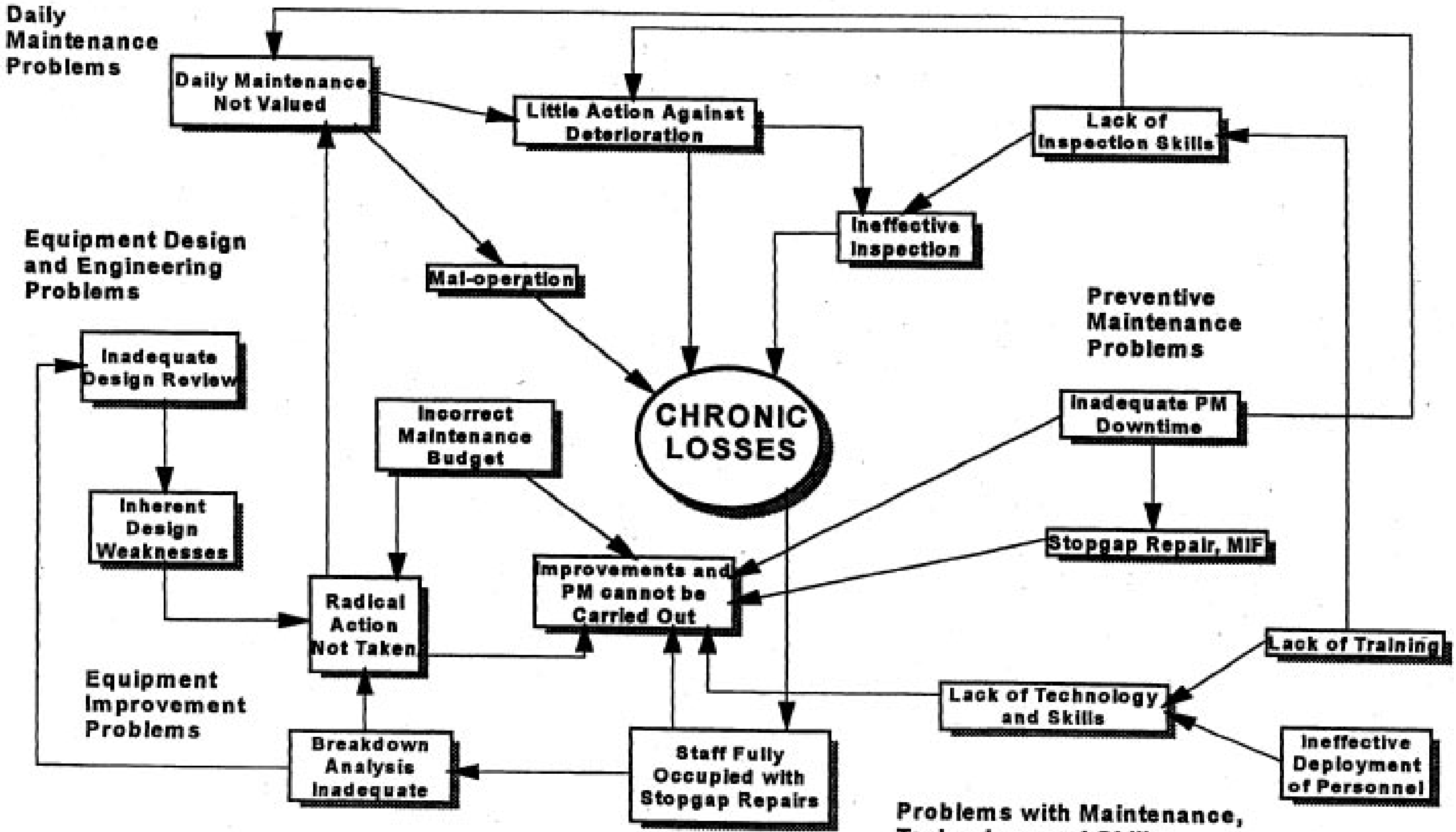

Figure 6 Complex Origins of Chronic Losses

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PERFORMANCE BASED REGULATION - THE MAINTENANCE RULE

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ABSTRACT

The U.S. Nuclear Regulatory Commission has begun a transition from "process-oriented" to "results-oriented" regulations. The maintenance rule is a results-oriented rule that mandates consideration of risk and plant performance. The Maintenance Rule allows licensees to devise the most effective and efficient means of achieving the results described in the rule including the use of Probabilistic Risk (or Safety) Assessments. The NRC staff conducted a series of site visits to evaluate implementation of the Rule. Conclusions from the site visits indicated that the results-oriented Maintenance Rule can be successfully implemented and enforced.

I. INTRODUCTION

The U.S. Nuclear Regulatory Commission has begun a transition from the "prescriptive" regulations of the past to a more "risk and performance based" approach which takes into consideration risk and plant performance. 10 CFR 50.65, "Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants" (the Maintenance Rule), which takes effect on July 10, 1996, is an example of a performance based rule that mandates consideration of risk and plant performance. This type of regulation gives each licensee the flexibility to determine the most efficient and effective way to meet the requirements.

This paper provides a discussion of performance based versus prescriptive regulations, and the use of a risk and performance based approach to the implementation of the Maintenance Rule. The NRC has established an Implementation Plan for Probabilistic Risk Assessment to achieve improved regulatory decision-making and more efficient use of licensee and NRC resources. The NRC recognises that the increased use of PRA in regulatory matters is dependent upon the state-of-the-art in PRA methods and the data available to support PRAs. A goal of the PRA Implementation Plan is to establish decision criteria on the use of PRA and its interdependence with deterministic engineering principles.

II. PRESCRIPTIVE VERSUS PERFORMANCE BASED RULEMAKING AND REGULATION

Although they do not appear to have formal definitions, the terms "prescriptive" and "performance based" are increasingly being used to describe various rulemaking and regulatory activities. A prescriptive rule, the traditional approach for most rules, is one that provides detailed processes, requirements or instructions. 10 CFR 50, Appendix J, "Primary Containment Leakage Testing for Water Cooled Power Reactors" and Appendix R, "Fire Protection Program for Nuclear Power Facilities...." are examples of regulations that are considered prescriptive. They both contain detailed requirements such as test frequency, test pressures, training program and record keeping requirements. The advantage of a prescriptive rule is that the requirements are generally clearer and more detailed, and thus are easier to implement and regulate. The disadvantage to such rules is that they tend to be inflexible and thus may prevent licensees from using the most efficient and effective means of achieving the desired intent of the rule. Another disadvantage is the lack of a direct link to risk and safety in the implementation of the rule.

A performance based rule is one that describes, in general terms, the process to be followed and the results expected. Such a rule has the advantage of allowing the licensees to devise their own means of implementing the process to achieve the results described in the rule. The disadvantage to such a rule is that it can be more difficult for the licensee to develop the detailed procedures and processes for implementing the program and be assured they have satisfied the rule. In effect, each licensee's program will be customised to meet its individual needs. Also, it may be difficult to monitor compliance with a performance based rule because the requirements are less clearly defined and there may be little uniformity of implementation between different licensees.

One example of the disadvantages of a performance based rule, (e.g., less specific details) became apparent during the development of regulatory and industry guidance for the maintenance rule. Because the guidance had to be general in nature to be consistent with the intended flexibility in the rule, industry representatives asked that the inspection procedure (which is normally developed after the regulatory guidance has been issued) be prepared early and provided to them for their use during the development of the industry guidance document. They wanted to use the inspection procedure to provide some of the details that were not in the rule itself. The industry-developed guidance, which provided much more detail than the rule, was endorsed by the NRC as one acceptable method of implementing the rule.

III. THE MAINTENANCE RULE

A. Requirements

Being performance based, the Maintenance Rule allows licensees considerable flexibility in developing and adjusting their implementation activities based on plant and equipment performance and risk (or safety) significance. However, no rule is entirely performance based or entirely prescriptive; most rules contain elements of both. The Maintenance Rule contains elements that could be considered to be prescriptive, for example, the requirement that a periodic evaluation be performed each refuelling cycle. Some specific requirements of the Maintenance Rule follow.

1. Monitoring. The performance or condition of structures, systems, or components (SSCs) must be monitored against licensee-established goals, to provide reasonable assurance that these SSCs are capable of fulfilling their intended functions. These goals should be commensurate with safety, and take into account industry-wide operating experience. The fact that these goals are to be set by the licensee rather than the NRC is an indication that the rule is not prescriptive. The fact that the goals should be commensurate with safety (risk) and take into account industry-wide operating experience are additional risk and performance based aspects of the rule.

2. Defined Goals. When the performance of an SSC does not meet established goals, appropriate corrective action must be taken. This corrective action could include modification of the goal if plant experience has shown that the original goal was too restrictive. This flexibility of being able to modify the goals based on plant or equipment performance is another performance based aspect of the rule.

3. Preventive Maintenance. The rule permits licensees to eliminate goal setting and monitoring where it has been demonstrated that the performance of SSCs is effectively controlled through preventive maintenance. This flexibility to utilise effective preventive maintenance instead of goal setting and monitoring is another performance based aspect of the rule.

4. Periodic Evaluation. The requirement that each licensee perform a periodic evaluation of all activities related to implementation of the maintenance rule program is a prescriptive requirement. However, the requirements to include consideration of industry-wide operating experience and to make adjustments to the program where necessary to balance improved reliability against the objective of minimising unavailability of SSCs, are risk and performance based aspects of the periodic evaluation.

5. Safety Assessments. The rule also requires an assessment be made of the total plant equipment that is out of service before removing equipment from service for monitoring or maintenance. Prior to the Maintenance Rule, regulatory requirements for specifying which plant equipment could be taken out of service for any reason, including maintenance, were generally contained in each licensee's technical specifications. Technical specification out of service times were assumed to cover surveillances and corrective maintenance, but not extensive on-line preventive maintenance. In addition, some licensees established self-imposed administrative limits on equipment that could be taken out of service for maintenance. The technical specification requirements specify allowed out-of-service times and compensatory testing that must be performed for specific systems. These technical specification requirements will remain in effect after implementation of the maintenance rule but the need for self-imposed administrative limits may be obviated by implementation of the maintenance rule. The maintenance rule is non-prescriptive in that it does not specify allowed out-of-service times or required testing. It only requires that a risk or safety assessment be performed before removing equipment from service. The process for evaluating risk is left up' to the licensee to determine, however, the NRC will inspect the licensee's process.

6. Scope of Maintenance Rule. The scope of systems, structures and components (SSC) in the rule includes all safety related SSCs and those non-safety related balance of plant (BOP) SSCs that are (1) relied upon to mitigate accidents or transients or are used in emergency operating procedures; (2) whose failure could prevent safety-related structures, systems, and components from fulfilling their safety-related function; or (3) whose failure could cause a reactor scram or actuation of a safety-related system. The scope of the Maintenance Rule is spelled out in some detail and would therefore probably be considered a prescriptive aspect of the rule.

B. Implementation of the Rule

The NRC has endorsed via a Regulatory Guide, the Nuclear Energy Institute (NEI) guidance for implementing the rule. This guidance describes a process for establishing risk significance, performance criteria, and goals for SSCs covered by the rule. A multidisciplinary expert panel, using input from the PRA/PSA, as well as other plant information, is responsible for determining more-risk significant versus less-risk significant SSCs. The process of determining more risk significance is very important if the staff is to continue implementing risk-based regulation. The process described in the NEI guidance document has been used by most, if not all, licensees. However, the staff has seen some variations in the implementation of the process. The determination of risk significance is based on a combination of PRA insights and expert panel deterministic considerations. Three risk importance measures are considered, which theoretically should result in a listing of systems ranked by relative importance to safety. The results of all three determinations are provided to an expert panel, which is composed of representatives from operations and maintenance, in addition to a representative who is knowledgeable of the PRA, and its strengths and weaknesses. This expert panel then considers the PRA insights, and determines which plant SSCs are more-risk or less-risk significant. The NRC may determine that additional guidance regarding the use of PRA insights is necessary. This subject is discussed in more detail later in this paper. Those SSCs that are more risk significant or are stand-by systems would be monitored against system specific performance criteria (e.g., reliability and availability), and those that are less risk significant would be monitored against plant level performance criteria (e.g., plant scrams or safety-system actuations). In a few instances, with appropriate supporting analysis, an SSC could be permitted to run to failure. However, after a repetitive failure or a failure to meet performance criteria, the establishment of goals would be required.

C. Site Visits to Verify Implementation of the Rule

The NRC staff performed a series of nine site visits to determine the validity of the draft inspection procedure that will be used to evaluate licensees' implementation of the rule, as well as to provide feedback to the industry on the strengths and weaknesses of the various programs. In June 1995, the staff issued a formal evaluation document, NUREG 1526 and held a public workshop to present the results of these visits and to describe any revisions to the inspection procedure. The NRC also provided comments to NEI for their consideration when revising the guidance document. This will give licensees approximately one year to study the results of the site visits and make any changes to their maintenance program before the effective date of the Maintenance Rule, July 10, 1996.

D. Results

Results of the pilot site visits indicated that the risk and performance based Maintenance Rule can be successfully implemented and enforced. The NRC will continue its evaluation of the implementation of the Maintenance Rule to assure consistent results by all licensees.

E. Inspections

Beginning on July 10, 1996, NRC inspectors will verify licensees compliance with the maintenance rule. On a routine basis, NRC site resident inspectors will use a new inspection procedure IP 62707 to evaluate licensees' day to day maintenance activities. The approach to inspections after the rule goes into effect will be somewhat different than those currently conducted. Currently, inspectors focus was on the actual maintenance activity being performed on selected equipment, if licensees followed procedures while performing maintenance tasks and on the results achieved by maintenance as reflected in equipment operability. Inspectors also verify that licensees' maintenance activities are conducted in accordance with plant technical specifications including verification that allowed outage times for equipment taken out of service for maintenance are not exceeded. The new focus of routine maintenance inspections after the rule goes into effect will be on how licensees monitor the results of their maintenance activities as reflected in the performance or condition of plant equipment under the scope of the maintenance rule as well as the controls they have in place to perform maintenance. Inspectors will also review licensees processes for evaluating equipment performance or condition including trending, cause determinations for poor performance and failures and corrective actions. Also, inspectors will verify that licensees execute overall plant safety assessments prior to removing equipment from service to perform maintenance activities in addition to verifying plant technical specifications are met.

After the effective date of the rule, the NRC will begin a two year program of baseline inspections that will be conducted at every site. These baseline inspections will include a comprehensive review of licensees' processes to implement the rule following the guidance contained in IP 62706. A team of 4 to 5 inspectors will spend one week preparing for each on site inspection including reviewing plant performance information such as LERs, inspection reports, and SALPs. The team will also develop a list of SSCs which they believe are under the scope of the maintenance rule for that particular site. This list will be derived from FSARs, EOPs and PRA/IPE results. The onsite evaluation will last one week and will consist of the following activities:

- overview of the licensee's maintenance rule program and status;
- comparison of inspectors' SSC scoping list to the licensee's list;
- evaluation of SSC risk determination processes, including interviews with the expert panel members;
- detailed review of selected SSCs in the (a)(2) and (a)(l) categories including performance criteria or goals, performance and condition monitoring activities and results, cause determinations and corrective actions, use of industry wide operating experience and interviews with system engineers;
- review of licensees' safety assessments performed prior to taking equipment out of service for maintenance;
- review of licensees' periodic evaluations (or plans) and reliability and availability balancing processes and results.

Consistency in inspection and enforcement of the maintenance rule is crucial to the success of the baseline effort as well as all inspections dealing with the maintenance rule. To help assure the necessary consistency, there will be only one inspection in July, two in August and September and four per month thereafter. The first inspection is scheduled for the Palo Verde Station and the team will be comprised of a headquarters team leader and inspectors from each of the four! regional offices. These regional inspectors will lead baseline teams after the Palo Verde inspection. This team composition should ensure that all regional and headquarters inspectors perform the inspections in a consistent manner. Furthermore, headquarters maintenance rule inspectors will assist the regional inspectors on each inspection. To foster consistency in the enforcement of the rule requirements across all regions, all potential maintenance rule enforcement actions will be evaluated and approved by a joint headquarters and region panel.

The challenges with inspecting this first performance based rule will be significant. Both the industry and NRC will closely monitor rule implementation, inspections and enforcement results to assure consistency and fairness.

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