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Safety Aspects of Long-term Operation of Nuclear Power Plants

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ABSTRACT

In the last years many Member States started a programme to assess the possibility for a Long Term Operation of their older nuclear power plants. These programs follow different approaches, being intrinsically dependent on the national regulatory framework and technical tradition. Typical safety assessment processes such as the Periodic Safety Review can be used as a framework for the preparation of long-term operation. Also the Licence Renewal based on the review of ageing management programs in context with other regulatory tools as the regular updating of the Safety Analysis Report could be used to ensure a safe long-term operation. The analysis of the practice in countries operating NPPs suggested that despite the differences related to the regulatory process, the main components of the programs and their basic technical tasks are shared among most of the countries. This paper aims at identifying the technical aspects more directly affecting the decision for a long-term safe operation of a nuclear facility, independently from their licensing framework. The paper includes an analysis of the safety implications of a program for preparation of long-term operation of NPPs, with reference to the available IAEA documents and experience in the review of national programs. The program running at Paks NPP Hungary represents one of the most recent experiences in the field. It is presented in the paper as an example of application of general safety principles to a real case, with proposals of solutions for practical problems common to many similar plants.

KEY WORDS: life extension, life cycle management, license renewal, periodic safety review, aging, evaluation of existing facilities, design basis reconstruction, equipment qualification, safety analysis report

INTRODUCTION

Extension of the operational lifetime of NPPs proves to be an economically attractive strategy. Such programs have heavy safety implications that require both a proper regulatory framework and a utility programme.

The Regulatory frameworks for long-term operation (LTO) differ from country to country in accordance with the licensing system. In countries where the operational licence is granted for a well-defined operational lifetime, a formal licence renewal is practised. In some countries the utilities have a license renewal for 20 years [1]. Some other Member States have just started the development of regulations for licence renewal and project planning. In the countries where the operational lifetime is not limited by licence, the Periodic Safety Review (PSR) is frequently chosen as the regulatory tool for an LTO. This is also the approach recommended by the IAEA Safety Guide [2].

The content of the national programmes for LTO also depends on the regulatory approach in force in the country to guarantee the compliance with the current licensing basis (CLB). It is clear that some parts of the regulatory control processes may be relevant also to the LTO, but a guarantee for an LTO should concentrate only on the specific aspects, which have a direct influence on the long-term operability. Concerning the content of the programs of LTO all over the world, it is noted that there is a potential for confusion between those technical issues that are technical conditions for a long-term safe operation of the plant, and other issues which are more related to the current safe operation of the plant. The availability of an updated design basis, for example, is definitely a precondition for a long-term operation of a plant, but it is not strictly related to the preparation of the plant long-term operation itself. Therefore in this paper, all the issues relevant to the compliance with the CLB are discussed in the category of the “pre-conditions” of the LTO.

Despite of the differences that affect the regulatory strategy in the countries and the consequent differences in the application/approval process for LTO, the main technical components of the LTO programs and their basic technical tasks are shared among most of the countries. This paper intends to highlight these safety relevant aspects of the generic LTO program, with emphasis on the safety relevant issues and in line with the IAEA recommendations. The Hungarian case study carried out for Paks NPP, one of the most recent experiences, may represent a useful opportunity for the validation and improvement of what is proposed in this paper.

This paper is an outcome of the IAEA experiences in the support to some countries, validated by the opinion of many international experts, but it does not present an official IAEA position shared by all the Member States. The IAEA has not yet developed any specific document on the detailed procedure to be followed for the extension of the operational lifetime, as the approach in the countries is very differentiated and in many cases not yet mature. However, a large number of IAEA documents are available on basic safety concepts that could be relevant to life extension programmes. A Safety Guide [2] on “Periodic Safety Review” (under review) presents the basis for the IAEA policy; a different approach is allowed, but the alternatives represent matter for discussion, as reflected in this paper. Other technical documents present technical aspects of ageing management (see e.g. [3] and [4]) and equipment qualification.

This paper intends to be restricted to the safety aspects of the LTO program. Therefore other key areas typically considered part of the LTO are not discussed here either because they are not safety related or are too dependent on the country specific regulations, e.g. the environmental impact evaluation. It has to be noted that this paper is not supposed to deal with either the economic aspects of the LTO nor the details of the safety assessment process or the ageing evaluation; all these topics are discussed in other existing IAEA documents, some of them are mentioned in the References.

MODELS FOR REGULATION OF LONG TERM OPERATION

The concept of the periodic safety review

In many countries the safety performance of the nuclear plants is periodically controlled via the PSR system. The regulatory review and acceptance of the PSR give the right for the licensee to operate the plant for the next PSR cycle (usually 10 years). The Regulatory system is not limiting the number of PSR cycles even if the new cycle is going beyond the original design lifetime of the plant. The only condition is to demonstrate the safety of the plant operation for the next PSR cycle with some margins. The PSR is therefore a regulatory tool for the identification and resolution of the safety issues. In this framework the LTO is achieved by applying the PSR, by identification and resolution of the safety issues as a condition of operation for the new PSR cycle. It is clear that the PSR is not a proper tool to control changes and tendencies with an evolution time shorter than 10 years. It is also not a suitable system in case the licensee needs a technological guarantee for a long-term operation longer than 10 years; in many cases economical considerations suggest an extension of 20 years or more of the design life.

However, it should be noted that the concept of PSR was developed to be part of the normal regulatory or safety monitoring process and not specifically to justify long-term operation of a plant. The PSR was originally used primarily to assess the safety status of the plants designed to early standards. In these cases the PSR gives an overall review of all aspects of plant operation that may be relevant to safety. This review includes subjects as emergency arrangements, organization and administration, procedures, research findings and feedback of experience. All of them are mainly relevant to current operation and not directly related to the justification of the long-term operation.

According to recent practice, the PSR has to focus on the cumulative effects of plant ageing, assessment of plant status and modifications, operating experience, modifications of national safety standards science and technology developments, and site hazard modifications [2]. If the PSR process is to be used for the justification of continued operation of the plant, then special emphasis should be given to the assessment of aged status and ageing management of those safety related structures, systems and components (SSC) that limit the operational time of the plant. It is obvious that these SSCs are those, which cannot be replaced or reconstructed. A PSR implemented beyond the original design life may require a deeper safety review, addressing the following:

1. Evaluation of the plant safety against current standards
2. A new evaluation and/or qualification for items affected by time dependent phenomena
3. The ageing management program which has to be extended over the planned operating life
4. A new safety assessment, to show that the as-designed conservatism (not the safety margin!) might be reduced thanks to a careful plant operation and better understanding of the degradation mechanisms. The overall safety margin should be kept consistent with current safety requirements

In conclusion, a full scope PSR [2] applied for LTO is not different in principle than a PSR applied during the design life, but the emphasis has to be oriented to the ageing of SSCs limiting the plant operational time and on the related safety issues.

The plant life management

In some countries the licensees implement a continuous Life Management Programme (PLIM) to keep the plant in good condition in the long-term, usually with a time target of 50-60 years. This includes careful operation and maintenance, development of a replacement strategy, and mitigation of ageing effects. This kind of PLIM program needs continuous and effective links from the operating experience to the long-term decision-making. The regulatory tool for approving the long-term operability might be the PSR. However, the use of the PLIM to ensure the LTO can be misunderstood: the scope of the PLIM may not cover all ageing relevant issues up to the end of the extended lifetime of the plant. The advantage of a mixed system PLIM + PSR is that the identification and the resolution of the safety issues are not only completed in the frame of the PSR, but it is continuously addressed during the operation.

The concept of License Renewal

The concept of Licence Renewal (LR) is usually followed by the countries where the operational licence is granted for a fixed time span limited either by the design lifetime or other considerations. This concept is based on the correlation between the continuous control of the CLB and the control of those aspects of the plant safety, which are depending on the unavoidable ageing of safety related SSCs. In these regulatory systems the CLBs are maintained and they are documented in the (annually updated, living) Final Safety Analysis Report (FSAR). In addition to this, the efficiency of the maintenance system is controlled with some performance criteria for the active safety related SSCs. The LR process itself is focused on the ageing management of long-lived passive SSCs, on the review of the validity of the time limited ageing analyses and environmental qualification. The licensee should be able to demonstrate that actions have been identified and have been or will be taken to manage the effects of ageing on SSCs within the scope of the LR such that there is reasonable assurance that system, structure, and component intended functions will be maintained in accordance with the current licensing basis during the long term operation. In this regulatory system both type of processes and tendencies are controlled: the processes and tendencies with a short time constant are controlled via regular updating of FSAR and control of efficiency of the maintenance, the long term tendencies are controlled by the LR procedure.

This system allows for the licensee an optimal planning of its activities and expenditures, which gives a guarantee for the payback of the capital investments into plant life management.

In some countries the compliance with CLB and the fulfilment of the LR conditions are controlled also via PSR additionally to the annual update of FSAR and the evaluation of effectiveness of the maintenance. In this case the PSR is focused on the processes with a long time constant: feedback of experience, changes in the regulation, new scientific results, new information on hazards, new safety analysis methods and tools, and last but not least ageing of the plant with emphasis on the comparison with forecasts made in the LR application. The PSR is a self-assessment of the licensee. The Regulators approving the PSR might request measures and actions related to CLB.

PRECONDITIONS FOR LTO

Minimum safety requirement

Prior to giving consideration to long-term operation, it is essential to check that the plant has been maintaining an acceptable safety level of the operation. This safety level, among other considerations, should serve as the basis for the long-term operation. Many NPPs that were built to earlier standards have already undertaken major upgrading programmes to comply with new national requirements that reflect the best international standards and practices. As a major requirement for the implementation of an IAEA review, these upgrading programmes should be completed before any consideration is given to LTO.

The approved safety level of a plant should consistently comply with the national accepted safety requirements applicable to that type of plant. However, the desirable safety level could change as a consequence of new regulations as new regulations and standards are often developed with reference to new plants. The new regulations could accept some temporary or permanent exceptions for the operating plants. These exceptions could be approved on a probabilistic basis. In any cases any deviation from current standards should be identified and justified by, for example, additional control or administrative procedures on specific issues. The acceptance criteria should be based on guidelines of national authority. The national safety standards should be compared with the IAEA safety requirements and recommendations. This will help to provide international acceptance of the long-term operation of an NPP and to prove the state-of-the-art safety of the plant.

Should a plant not have a clearly defined licensing basis, it is imperative that its license basis be re-established before any long-term operation is attempted. Compliance with existing licensing basis, also compliance with widely accepted safety requirements should be a precondition for the plant lifetime extension projects.

The plant safety has to be assessed using state of the art methods and properly documented either in a comprehensive FSAR or in the PSR. From the point of view of long-term safe operation the conservatism of the input data and assumptions, the applied safety margins, the validity limits of the analysis, the validation of the methods and models could be important aspects to be appropriately documented.

Importance of the design basis information

From the technical point of view, the knowledge of the design basis and the operational history are conditions for the assessment and approval of an LTO programme. As the practice of some countries shows, both the PSR and FSAR updating could be an appropriate framework for the systematic documentation of the design basis information. From the point of view of the long term operation, the availability of the following updated information is very important:

- The plant design base and information related to the operational conditions, initiating events, internal and external hazards
- The design loads, load combinations, load cycles, environmental conditions derived from the design basis
- The material selection, the assumptions on the ageing processes made at the design, designer prescriptions for ISI, repair etc.

The FSAR is a key input to a continued operation of an NPP. The CLB documents of the plant (e.g. Technical Specifications, FSAR) should ideally be continuously updated during operation and periodically reviewed as a part of the normal regulatory process. Although updating the FSAR can be carried out on an annual basis, some countries have used a major safety review such as the PSR as a basis for carrying out the update of the FSAR.

In some countries the updated FSAR documents are required to be submitted in connection with the application for continued operation. The use of FSAR in describing the arguments for the long-term operation project by a utility will help to ensure the completeness of the information, and will aid in shortening the time needed for the regulator review process of LTO. It should be noted however that the original FSAR is not developed for an operating life longer than the technological design life of the most critical components. Therefore, unless the FSAR is reviewed as part of the LTO programme, its main purpose is to justify current operation.

Design Basis reconstruction

In case of necessity, a plant specific programme has to be developed for the reconstruction of essential design basis information. In some cases the design documentation may be unavailable, incomplete or may no longer reflect the current plant configuration. In these cases it is necessary, as a pre-requisite of the continued operation review, to re-establish the essential documentation by consolidation of existing records or, in some cases, by additional analyses. Emphasis should be made on the quality and reliability of design information related to the operability of the equipment, which is limited in time (lifetime limitation caused by fatigue, embrittlement, etc.).

Environmental Qualification

The plant equipment important to safety should be qualified with reference to those environmental conditions that are experienced at the plant. A plant specific environmental qualification (EQ) program may be necessary to achieve the required qualification, which may include recovery of supplier EQ documentation, re-qualification or replacement of equipment. Emphasis should be made on the EQ for harsh environmental conditions (qualification of pre-aged equipment for service conditions appropriate for design basis accidents) [5]. The updated environmental qualification of equipment should be maintained during the whole operation of the plant, with reference to the real environmental conditions.

Hazard assessment

The level of knowledge on the external hazards, especially the hazards related to the human activity may change during the operation of the plant. The safety of the plant has to be assessed on the basis of a state of the art, valid hazard assessment. The re-assessment of the external event hazards could be performed either in the framework of a PSR process or in the framework of a FSAR updating.

BASIC INGREDIENTS OF THE LTO PROGRAM

Project organisation

The organisation of the project for LTO depends largely on the system chosen to justify the LTO of the plant. In any case particular attention should be given to:

- Ensuring that the legal and regulatory requirements for long term operation are agreed and understood;
- Ensuring that adequate resources (financial and human) are available;
- Ensuring that the responsibilities of all staff involved in the project are clearly defined (for both the Utility and the Regulator) and that appropriate training is given;
- Ensuring that there is an effective communication mechanism between utility and regulator;
- Defining project timescales and making appropriate plans to ensure that these are adhered to; and
- Ensuring that there are communication routes to the general public where required by national laws or customs.

Scoping of an LTO project

Once the plant's licensing basis is well defined or updated to modern standards, the focus for the long-term operation should be the management of the ageing effects on safety related SSCs. The ageing management programme (AMP) review should be conducted before a decision on the long-term operation is made. Generally, the scope of this review would focus on those systems, structures, and components that have an intended safety function or the failure of which could have an adverse effect on the plant safety during the long-term operation. The scope of this AMP review can therefore be grouped into the following two categories:

1. All safety-related systems, structures, and components relied upon to ensure the following functions:
   - The integrity of the reactor coolant pressure boundary;
   - The capability to shut down the reactor and maintain it in a safe shutdown condition; and
   - The capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposure.
2. All non-safety-related systems, structures and components whose failure could prevent satisfactory accomplishment of any of the functions identified above

Certain SSCs are dedicated to a specific function that may be essential to the safe operation of the plant, such as fire protection, severe accident management, etc. These SSCs may or may not fall into either of the above two categories, but they should be included in the scope of the assessment of long-term operability.

Consideration should be given to whether all safety related structures and components should be subjected to ageing management. A large part of the safety related SSCs are replaced on a defined time interval or if a functional degradation is detected. A status monitoring of these SSCs may help to optimise the replacement in time and minimize the expenditures. A proper scoping may affect very much the cost of an LTO programme. The assessment of long-term operability has to be focused mainly on the SSCs that will not be refurbished or replaced during the plant life.

A schematic proposal for LTO relevant items is shown in Fig. 1.

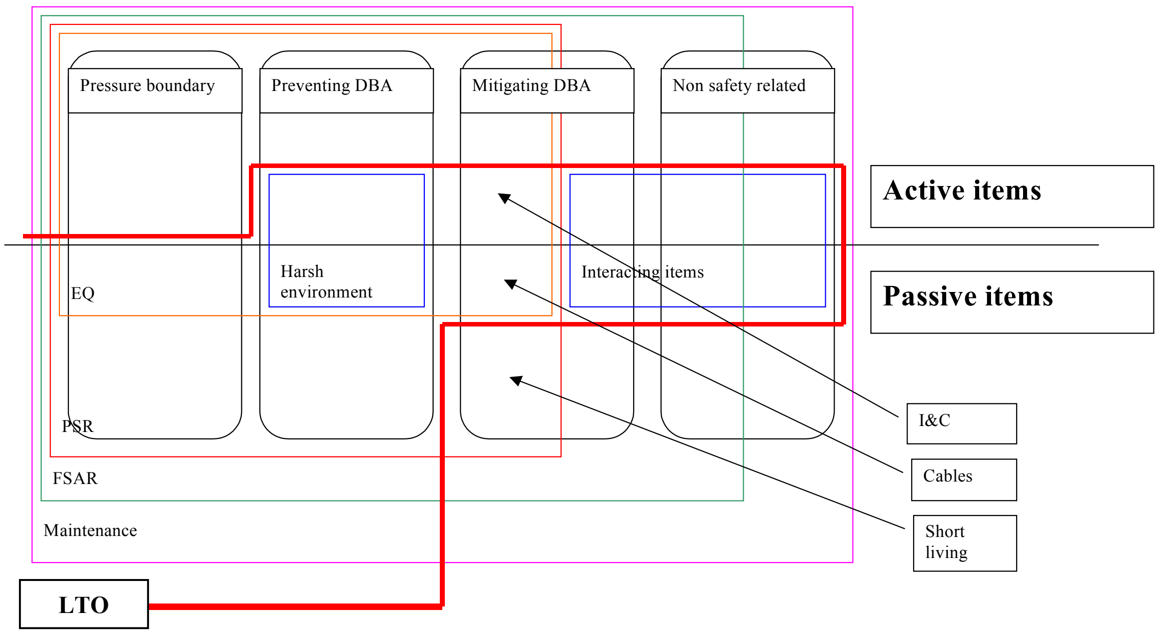

Fig. 1. Definition of the LTO programme scope compared with the scope of other related programs

If the performance of the active system is regularly controlled after plant maintenance, the active SSCs might be excluded from the LTO considerations too.

Ageing evaluation

In general, ageing is addressed in procedures for maintenance, surveillance, in service inspection programme, etc. as one of the physical processes, which could lead to failure. References [6, 7] properly address ageing as part of the surveillance and inspection. The operating experience shows that active and short-lived SSC are in general addressed by existing maintenance programmes. Conversely, the performance and safety margins of the passive long-lived SSC are assumed to be guaranteed by design. However, the analysis of the operating experience showed that unforeseen ageing phenomena may occur either because of shortcomings in design, manufacturing or by operating errors. Therefore the implementation of an AMP is definitely a condition for the operation within the limits of design or licensed lifetime and is a pre-condition for an LTO as well. Moreover, the ageing management is intended to provide a cross-cutting connection among all maintenance and inspection activities carried out on active components also, to provide a unified understanding and treatment of the degradation phenomena. In conclusion, the AMP could be accepted if the following actions are completed:

- Program scope is defined
- Preventive actions are developed
- Parameters to be monitored or inspected are detected
- Detection of ageing effects is ensured
- Monitoring and trending is performed
- Acceptance criteria are defined
- Corrective actions confirmation process are defined
- Administrative control is fixed
- Operating experience of the programme is considered

Some of these attributes are inter-related. Particularly the frequency, the trending and the number of locations to be monitored may reflect the operating experience from past operation.

An important task of the ageing evaluation is the identification of SSC that have a limited lifetime as per design, such as limits defined by fatigue, or metal embrittlement due to temperature and radiation, etc. The ageing analyses defining time limits have to be reviewed.

Documentation and confirmation

In addition to the existing documentation, the LTO review itself generates new processes and procedures. It is essential that these processes are clearly documented and that the updating of the relevant documentation is managed effectively.

One outcome of the LTO review should be a programme (naturally a part of the AMP) to confirm that the LTO assumptions continue to be valid and that any identified necessary corrective actions are taken. Such confirmation will include planned inspection and testing of safety related components and will be supported if necessary by appropriate analyses.

BASIC TECHNICAL AREAS OF AN LTO PROGRAM

The technical issues addressed in an LTO programme

The LTO programme has to address the changes in the plant status due to ageing and obsolescence which are foreseen by design. However, specific attention has to be paid to the unexpected, unforeseen modifications affecting the design basis. These are often plant dependent and addressed through the maintenance (i.e. based on statistic evidences) or ageing management programmes (AMPs). Among the unexpected issues, the following can be listed:

- Discovery of unknown degradation mechanisms as a result of the research programmes, operational experience in other plants;
- Discovery of unexpected degradation mechanisms, e.g. from construction, despite QA, unforeseen environmental conditions, etc.
- Discovery of unplanned technological obsolescence.
- Modifications in standards and practice.
- Other unexpected changes in market conditions, ownerships, etc.

All these technological issues should be addressed in an LTO programme through the review of the current plant status and of the expected evolution.

An essential element of the LTO programme is the assessment of the AMP experience and the extrapolation of the detected degradation on the planned operational lifespan. The licensee should demonstrate that for the extended operational lifetime:

1. The safety and ageing analysis remain valid and could be projected to the end of intended operational lifetime
2. The effects of ageing on the intended function(s) will be adequately managed.

In many cases, the plant existing ageing management programmes can be credited as acceptable programmes for the long-term operation. For the remaining cases, either the plant existing programme can be augmented to satisfy the listed above attributes or new programmes should be initiated.

The results of the AMP trend analysis should be evaluated considering the following:

- The entity of life time extension
- Time required to implement corrective actions
- Probabilistic Safety Assessment (PSA) application
- Expert judgment (risk is often subjective)

One of the following strategies can be implemented in case of non-compliant items:

- Replacing or restoring the component
- Changing the operational conditions and/or improving ISI
- Developing additional analyses (eliminating initial conservatism with more refined methods)
- Performing a re-evaluation test (with improved qualification methodologies)

In fact beyond design life the design safety margin can be maintained through accommodation of the new issues into the design conservatism, sometimes built up with rough design methods, conservative environmental conditions and conservative operation assumptions.

Preservation of long term technical expertise

Competence and professional culture are needed for the long-term safe operation of nuclear power plant. The ability and intellectual potential of the licensees, the regulatory authority and their technical support should be guaranteed in time. Average age of employees of the nuclear power plant and technical support institutions has remarkably shifted towards the fifty years.

For the long-term safe operation, the plants have to develop a human strategy to provide qualified labour for future operation. The experience and knowledge accumulated by operators should be collected and transferred to the new generation of operators.

The human strategy and knowledge management of a utility has to be understood in broad sense, in connection with revitalization of technical capability of the whole industry and related educational system.

REVIEW OF AN LTO PROGRAM

The objective of a safety review of an LTO programme might be the following:

1. The identification of a proper scope for LTO programme, the review of the FSAR with specific attention to the SSCs that affect the time limit of the operation of the SSCs.
2. The evaluation of the ageing management programme. A trending analysis has to show enough safety margins in the foreseen extended lifetime.
3. The review of the preservation of the long-term technical expertise at the plant and at the regulator.

There are "pre-conditions" to such a review, e.g. the availability of an updated FSAR, which includes an updated design basis, a valid hazard assessment for external events, an updated equipment qualification record, a suitable AMP in place, etc. The review of these "preconditions" is part of the review of an LTO programme. The IAEA provides recommendations for the review of these basic "ingredients" of an LTO process (key factors and preconditions), through the Safety Report on EQ and AMP, the safety guides on hazard evaluation, design and QA, and the many TECDOCS on ageing mechanisms (see for example [8]).

The review of the regulatory process connected to LTO cannot follow a generic approach. They are usually very much country dependent and the review should focus on the safety issues rather than on the process in general. For example, in case a country does not follow the PSR approach, "it should be demonstrated that each alternative could meet the PSR generic objectives" defined in [2].

In conclusion, any review should check first that the safety factors identified in [2] are met, even if some of the factors are not formally addressed in a PSR framework. As a second step, the review of the technical safety issues may use a broader group of IAEA documents addressing the specific aspects of interest. At last, the review of the trend analysis and the acceptance criteria for long term operation have to be based on a generic engineering judgement that meets the overall safety objectives.

PAKS NPP EXPERIENCE

The operating license of Paks NPP Unit 1 expires at the end of 2012. There is a licensing condition on a yearly update of the FSAR. The Design Basis has a technological constraint at 30 years, specified in the FSAR, but there is no evidence of any relationship between this assumption and any other design limitation (except the vessel embrittlement). Nevertheless the design lifetime limits the operational licence.

The PSR system is in place: the first PSR full scope PSR was completed in 1997-1999. According to the recent Hungarian Regulation the PSR has a limited scope compared to the [2] because of the annual FSAR updating requirement. The PSR is considered a standard self-assessment tool for the licensee whose results have to be provided to the Regulator for review and approval every ten years. The necessity of the design basis reconstruction and environmental qualification of the equipment has been recognized during the PSR of the units No 1-4 in 1997-1999. The reconstitution of the design basis is still going on: it has to be incorporated into an updated FSAR at the beginning of 2004. The re-qualification and replacement programme for the resolution of EQ issue is going on. An AMP is in place since 1998. The NPP Paks completed a comprehensive four-year safety-upgrading program by the end of 2002. According to the PSA results the safety level of the Paks NPP reached the safety level of plants in the same vintage built in developed countries.

In 2001, NPP Paks launched a project for the preparation of LTO. A detailed study based on the plant status assessment and a business analysis showed the interest for an extension of the operational lifetime by 20 years beyond the design lifetime. The licence renewal process will be a two-step process, because of the peculiar regulatory framework in Hungary. In 2007, the NPP Paks has to get a licence in principle for the extended operation time and in 2012 the operational licence has to be renewed. The basic tasks of the project for the preparation of the LR are the integrated plant assessment and review of time limited ageing focused on the long-lived passive SSCs, as described above. This is possible because the function of the active safety related systems and components would be evaluated and controlled through adequate performance criteria after each maintenance period. The updated FSAR has also an essential role in the definition of the scope and content of the LR process. In this framework the PSR will be focused on the processes with long time constant: feedback of experience, changes in the regulation, new scientific results, new information on hazards, new safety analysis methods and tools, and last but not least ageing of the plant with emphasis on the comparison with the forecasts made in the LR application.

CONCLUSIONS

Basic features of LTO programmes have been defined both from regulatory and technical point of view. The regulatory pre-condition for an LTO programme is represented by the evaluation of the compliance with the current licensing basis. Despite the different regulatory approaches, the LTO programmes have similar technical content in most of the countries with an experience in this field. The pre-conditions of an LTO decision are usually the same: compliance with CLB, well defined and updated design basis information, ageing management, and programme for identification and resolution of safety issues in place. The technical part of the LTO programme should be focused on the assessment of the ageing and operational time limits mainly for long-lived and non-replaceable safety related SSCs.

The technical part of the LTO programme should be coupled with a regulatory review process. The IAEA recommends the use of PSR for such purpose, but other approaches could also be appropriate and acceptable.

Some implementation aspects have been highlighted by the application of the described concepts to a real case. Most of them can be generalised at least to the plants of the same type of Paks NPP. In particular the extensive use of monitoring, preventive maintenance techniques, premature detection, and surveillance programmes may have the same components. The objectives of an LTO programme have been summarised: to increase the level of knowledge of the current plant status and to drive a reliable trend analysis. The preconditions, particularly, are probably shared among many WWER plants: the design basis reconstruction, the updates of the FSAR, the recovery of the equipment qualification status, the ageing oriented collection and processing of environmental data, the early implementation of an AMP, the recovery of operational records and the recovery of the operational experience.

In conclusion, it has to be noted that the proposal for an LTO programme presented in this paper is definitely in line with the IAEA safety programme, but it is not endorsed yet by any IAEA committee for safety standards. However, it is believed that its contribution to the discussion can bring an invaluable support to the management of the current national programmes, in the framework of a safe and feasible approach.

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