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REPORT

PEER REVIEW SERVICE ON SAFE LONG TERM OPERATION (SALTO PEER REVIEW SERVICE)

PEER REVIEW MISSION FOR WOLSONG NUCLEAR POWER PLANT UNIT 1 IN THE REPUBLIC OF KOREA

(FULL SCOPE)

Wolsong, Republic of Korea
29 May – 7 June 2012

DEPARTMENT OF NUCLEAR SAFETY AND SECURITY
Division of Nuclear Installation Safety
SAFE LONG TERM OPERATION REVIEW SERVICES (SALTO)

REPORT

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PEER REVIEW MISSION FOR WOLSONG NUCLEAR POWER PLANT UNIT 1 IN THE REPUBLIC OF KOREA

(FULL SCOPE)

Mission date: 29 May – 7 June 2012

Location: Wolsong, Republic of Korea

Facility: Wolsong 1 Nuclear Power Plant,

Organized by: International Atomic Energy Agency (IAEA)
Wolsong Nuclear Power Plant

IAEA Review Team:

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"*Findings, conclusions and recommendations resulting from the IAEA Programme are intended only to assist national decision makers who have the sole responsibility for the regulation and the safe operation of their nuclear power plants. Moreover, they do not replace a comprehensive safety assessment which needs to be performed in the framework of the national licensing process."*

IAEA-2012
Issue date: 2012-10-01

CONTENTS

EXECUTIVE SUMMARY

Upon the invitation of the Korea Hydro & Nuclear Power Co. (KHNP), a peer review mission on safe long term operation (SALTO) was provided to review programmes / activities of the Wolsong Nuclear Power Plant (NPP) Unit 1.

The administrative address of the Wolsong NPP Unit 1 is 260 Naa-ri, Yangnam-myon, Gyeongju-shi Kyongsangbuk-do. The plant is located at the south-eastern coast of the Korean peninsula. The turn-key contract is on design, construction, and initial start-up operation of Wolsong NPP Unit 1 was awarded to AECL (Canada). Hyundai Engineering & Construction participated in the construction as sub-contractor in the primary system and Dong Ah Construction Industrial in the secondary system. Canatom (Canada) took charge of its architecture engineering. Wolsong NPP Unit 1 is a pressurized heavy water reactor (PHWR) power plant. Its nuclear steam supply system was supplied by AECL (Canada) and is contained in a pre-stressed concrete building. Its reactor output is 2,061 MWth and electrical output of turbine generator is 678MWe. It uses heavy water as moderator and coolant. Nuclear fuel is bundle-shaped natural uranium and can be loaded and withdrawn during operation. Turbine generator was supplied by Parsons (UK).

The commercial operation of Wolsong NPP Unit 1, the first heavy water nuclear power plant in the Republic of Korea attained at initial criticality in November 1982. The unit will be 30 years old in November 2012, reaching its design lifetime. Like many other countries, the licensing period is not granted in the Republic of Korea when the Operating License is issued. However, as the nuclear safety is key concern to the public the operation beyond its design life could not be considered as usual.

The license period of nuclear power plant is not limited under the current legal framework in the Republic of Korea. It is mandatory for the utility to conduct periodic safety review (PSR) for its operating nuclear power plants at the intervals of every ten years and submit PSR reports for regulatory review and approval. The definition of the continued operation (CO) (equivalent to the IAEA term “LTO – long term operation”) is stated in Paragraph 4 of Article 36 of the Enforcement Decree of Atomic Energy Safety Act and, under this legal statement, it allows extension of the plant operation beyond its design lifetime. Wolsong NPP Unit 1 plans to extend its operating life with 10 years until 2022.

Wolsong NPP Unit 1 is required to perform an LTO assessment to demonstrate the safety of the plant for 40 years of operation. This SALTO mission is in support of and has reviewed details related to this LTO assessment. The scope of the SALTO mission was agreed to and defined in Terms of Reference issued in February 2012. Preparatory meetings were held in September 2011 and February 2012. Further details were specified in Preparatory Meeting Minutes. According to these the review team was organized and is constituted of the IAEA team leader and six external experts covering all disciplines involved in Terms of Reference and Preparatory Meeting Minutes.

The mission reviewed planned, in-progress and completed plant activities related to LTO and ageing management of systems, structures and components (SSCs) important to safety.

The IAEA team found that plans are being prepared and extensive engineering work has been done to review ageing degradation mechanisms, and to review/implement ageing management programmes with the goal of justifying safe continued operation beyond November 2012 with

an operational life time horizon of 40 years. In addition, the team noticed good practices and good performance in areas as follows:

Good Practice

- Procedure for electrolytic capacitor replacement ;

Good performance

- Medium voltage cable periodic diagnosis;
- Preventive Maintenance Templates;
- Systematic improvement process of maintenance programmes for CANDU reactors;
- Proactive activities to identify non-safety SSCs failure of which affects safety functions;
- Environmental radiation monitoring vehicle;
- Plant Design Basis Data Management;
- Structure Life Management System (SLMS);
- Well-structured AMP in civil structures and buildings.

Taking into account of the above mentioned points, the team recognized that the plant approach and preparatory work for safe long term operation generally follow international practices.

Nevertheless, the team identified areas for further improvement. Thirteen issues were raised including:

- Definition of lifetime in final safety analysis report (FSAR) for continued operation;
- QA related to documentation and records` keeping for LTO;
- Structure and comprehensiveness of the PSR;
- Scope of the Continued Operation (CO) evaluation;
- Coverage and interfaces of different programmes that manage ageing of SSCs in the scope of the CO evaluation;
- Evaluation of effectiveness of programmes to manage ageing of active subcomponents;
- Operating experience related to vibration fatigue;
- Reactor assembly subcomponents excluded from inspection;
- Insufficient attributes of time limited ageing analysis (TLAA) and environmental qualification (EQ) for motor operated valves (MOV) and cables;
- Seismic fixing of electric/ I&C equipment;
- Preventive actions to minimize and control ageing degradation of reactor building containment;
- Measurement of loss of pre-stress force and corrosion in tendons for reactor building containment;
- Suitability of atmospheric dispersion model for gaseous releases.

A summary of the review was presented to Wolsong NPP management and Korean Institute of Nuclear Safety (KINS) representatives during an exit meeting held on 7 June 2012. Press release was provided to Korean media by the IAEA Team and the press conference was hold after the exit meeting.

This report includes in Appendix III the Team's detailed recommendations arising from this mission.

1. INTRODUCTION

1.1. SUMMARY OF IAEA SALTO PEER REVIEW SERVICE

IAEA Member States give high priority to the safe, continuing operation of NPPs beyond their original anticipated time frame (e.g. 30 or 40 years) as an alternative to decommissioning. In this respect Long Term Operation (LTO) is defined as nuclear power plant operation beyond an established time frame originally set forth by the licensing term, design limits, standards or regulations. LTO is justified by a safety assessment that considers life limiting processes and features for structures, systems and components.

The peer review approach has been proven to be a very effective mechanism to perform safety reviews of complex issues, and to evaluate the safety performance of an entire NPP organization. This is confirmed by on-going good experiences with OSART (Operational Safety Review Team) Reviews.

The Agency has conducted various types of safety review services, including those for design, engineering, operation and external hazards. Several Member States have requested AMAT (Ageing Management Assessment Team) missions. Through these activities, it was recognized that a comprehensive engineering safety review service related to LTO would be very useful for Member States.

The Safe Long Term Operation (SALTO) peer review is a comprehensive engineering safety review service addressing the strategy and the key elements for safe LTO of NPPs. This includes the original AMAT objectives and complements OSART reviews.

1.2. SUMMARY INFORMATION ON WOLSONG 1 NUCLEAR POWER PLANT

KHNP is the largest among the six power generating subsidiaries that separated from Korea Electric Power Corporation (KEPCO) in April 2001, accounting for approximately 25% of electricity producing facilities, hydro and nuclear combined.

KHNP operates nuclear power plants in Kori, Yonggwang, Ulchin and Wolsong, and several hydroelectric power generation facilities along the Han River, providing approximately 40% of the national power supply.

The Wolsong NPP Unit 1 has the following characteristics:

Reactor type: PHWR
Thermal power: 2061.4 MW (th)
Electric power output: 678.7 MW (e)
Number of primary loops per unit: 2 Loops
Volume of the primary circuit: 44 m3
Pressure in the primary circuit: 11.35 MPa (a)
Average temperature of the primary coolant: 310 °C (out), 266 °C (in)
Length/ inner diameter of the pressure tube: 257 inch/ 4.07 inch
Length/ inner diameter of the calandria vessel: 3.98 m/ 7.595 m
Enrichment of the fuel: natural uranium
Number of turbines per unit: HP- 1, LP- 3

Pressure of secondary circuit main steam line: 51kg/cm2

Wolsong NPP Unit 1 was designed, manufactured and constructed following the design guide of AECL of Canada for each field based upon the CSA code, which is the Canadian national standard established by Canadian Standard Association, and CSA-N code, which is the technical standard of nuclear power field. Many of such Canadian technical standards have partly quoted US technical standards or strengthened their requirements. Especially, the technical standards of CSA-N285 series have comprehensively referred to ASME B&PV Code Sec. III.

Design of pressure retaining system and components was conducted in conformity with the stipulations in Canadian CSA national standard CAN3-285.1. For the design of pressure retaining system and components which are classified into classes 1, 2 and 3, the requirements in ASME Sec. III., NB, NC, and ND were applied.

Regulatory framework

The license period of nuclear power plant is not limited under the current legal framework in the Republic of Korea. It is mandatory for the utility to conduct PSR for its operating nuclear power plants at the intervals of every ten years and submit PSR reports for regulatory review and approval. The definition of the continued operation (CO - equivalent to the IAEA term “LTO”) is stated in Paragraph 4 of Article 36 of the Enforcement Decree of Atomic Energy Safety Act and, under this legal statement, it allows extension of the plant operation beyond its design lifetime.

The CO safety evaluation reports that should be documented by license contains three major areas: PSR reports, lifetime evaluation reports for CO, and radiological environmental impact assessment report. The application submittals must describe enough information which is in compliance with the NSSC Notice No. 2012-25 published by Nuclear Safety and Security Commission (NSSC).

The CO safety report should be submitted to the Nuclear Safety and Security Commission (NSSC) no less than two to five years before the end of original license period. NSSC Notice No. 2012-25 states the scope of lifetime evaluation for CO and applicable guidance on the technical basis of CO. The scope includes 4 major parts including 1) identifying the systems, structures, and components (SSCs) within the scope of the CO, 2) aging management programs (AMPs), 3) time limited aging analyses (TLAAs), and 4) the use of operating experiences from other plants and research findings. Fig. 1 illustrates regulatory framework for continued operation in the Republic of Korea.

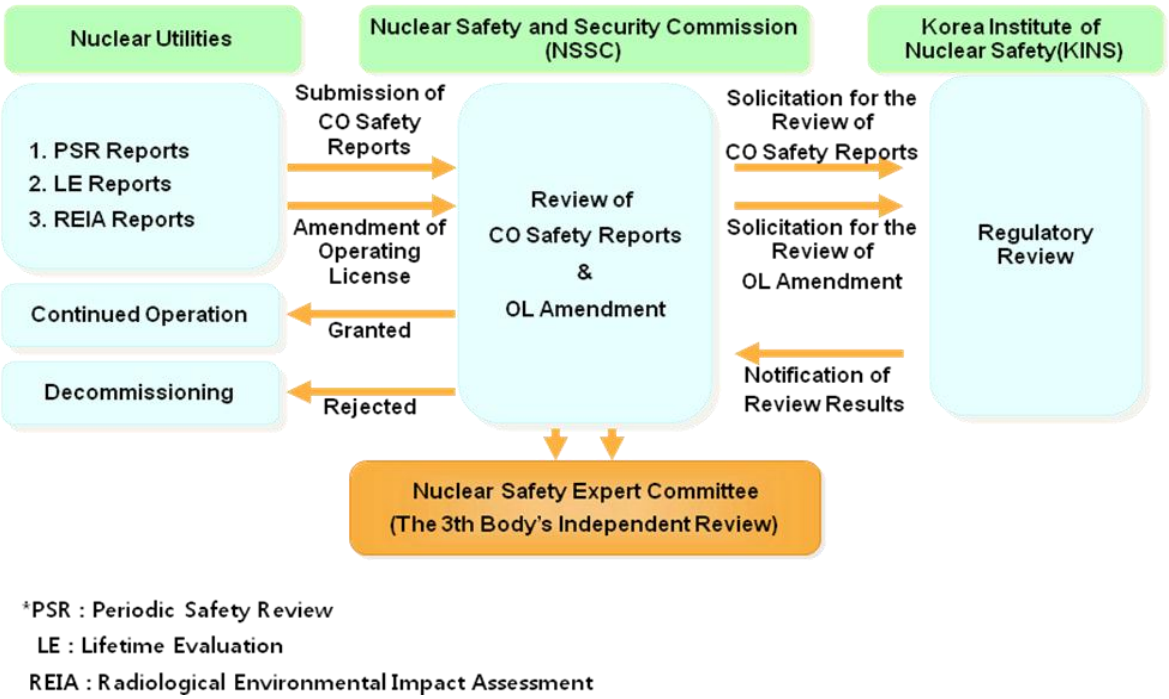

Fig. 1 Regulatory framework for continued operation

Licensing procedure

When a nuclear power plant reaches the end of its design life, the licensee has the option to terminate or continue the operation. Fig. 2 illustrates the overall review process of permanent shutdown or to continued operation.

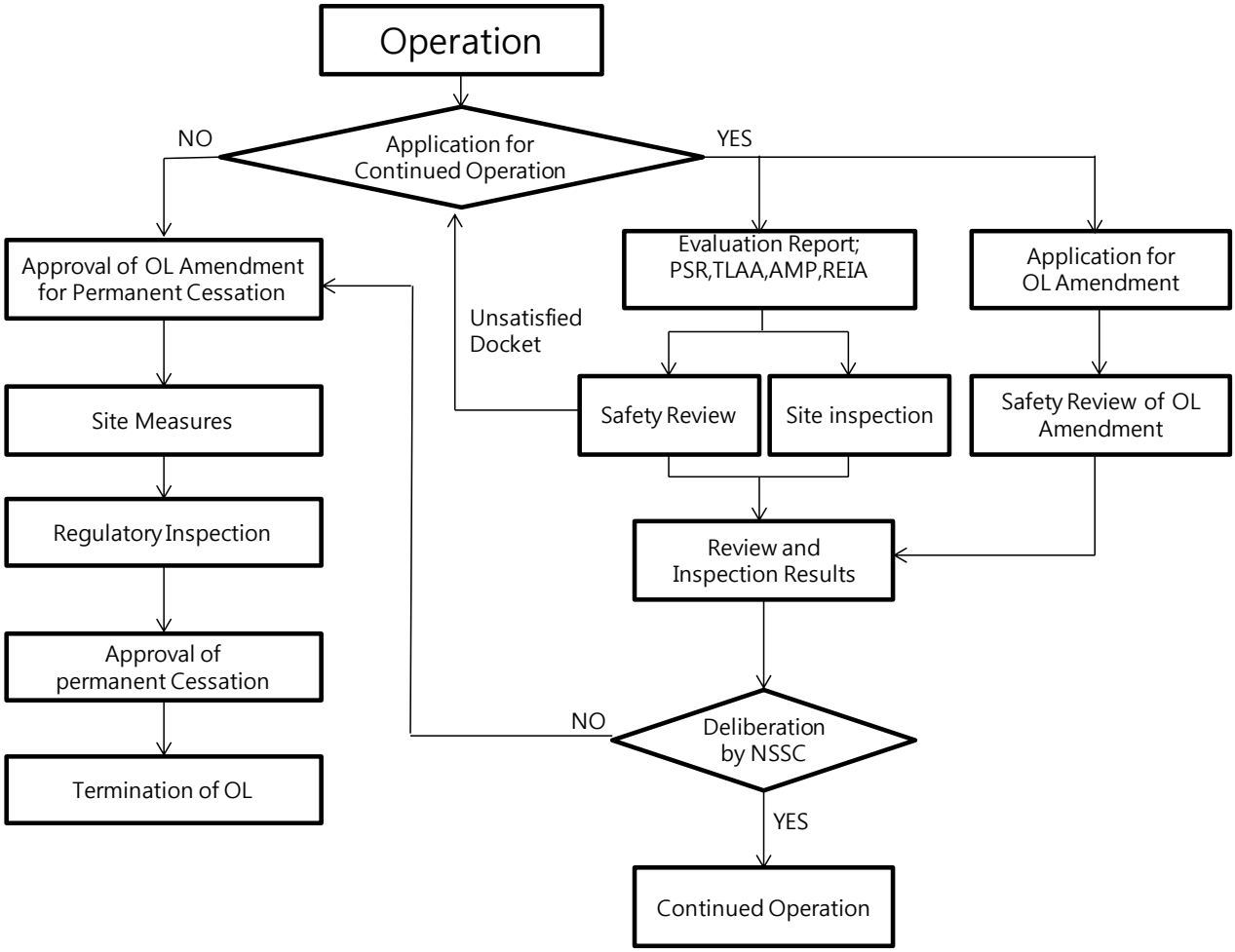

Fig. 2 Flow chart of continued operation process

1.3. OBJECTIVES

The objective of this service is to review the current status of the activities for the safe long term operation programmes performed in Wolsong NPP Unit 1 based on related IAEA Safety Standards and guidance documents, and internationally accepted practices. It was decided during the kick-off meeting held on 20-21 September 2011 in Vienna [12] and the preparatory meeting held on 8-9 February 2012 in Wolsong NPP [13], this peer review will be a full scope SALTO mission "Safe Long Term Operation (SALTO) for Wolsong Nuclear Power Plant Unit 1 in the Republic of Korea".

1.4. SCOPE

As agreed during a preparatory meeting held on 8-9 February 2012 in Wolsong NPP [13] the full scope SALTO peer review service for Wolsong NPP Unit 1 focuses on the following areas:

1) scope of the standard SALTO peer review service, which should include areas according to chapter 3 of IAEA SALTO Guidelines divided as the follows:
    - Organization and Functions, Configuration/Modification management;
    - Safety analysis reports and existing plant programmes relevant for LTO;
    - Review of ageing management programmes and related TLAAs divided to:
        - Mechanical SCs;
        - Electrical, I&C SCs;
        - Civil SCs.
2) Review of Radiological Environmental Impact (based on OSART module “Radiation protection” screened specifically for this mission).

1.5.CONDUCT OF THE MISSION

1.5.1. IAEA Review Team and preparatory work before the mission

Taking into account the objectives and the scope of the mission, as indicated above in Sections 1.3 and 1.4, it was agreed with the counterpart that the IAEA Review Team be constituted by one (1) IAEA staff members and six (6) external experts covering all disciplines involved in the studies. In this regard, review scopes of the reviewers were:

Reviewer A (Mr. Ervin Liszka)

Organization and Functions, Configuration/ Modification Management:

- Related regulatory requirements and guidelines;
- Organizational structure for LTO;
- Plant policy (LTO, scope of SSCs for LTO);
- Plant implementation programme for LTO;
- Configuration/ modification management.

Reviewer B (Mr. Takeyuki Inagaki)

Safety analysis reports and existing plant programmes relevant for LTO:

- Current safety analysis report and other licensing basis documents;
- Existing plant programmes relevant for LTO;
- Maintenance, EQ, ISI, Surveillance and monitoring, Chemical regimes;
- Methodology and criteria for scoping and screening of SSCs for LTO;
- Completeness of SSCs scoping for LTO.

Reviewer C (Mr. Zhaojing Zeng)

Review of ageing management programmes and related TLAAs for mechanical SCs:

- Scoping and screening of SSCs for LTO;
- Review of Ageing management programmes;
- Original TLAAs;
- Design Basis information;
- Revalidation of TLAAs;
- ISI and Surveillance programmes;
- Maintenance procedures;
- Data collection and record keeping.

Reviewer D (Mr. Kurt Thoma)

Review of ageing management programmes and related TLAAs for electrical and I&C components:

- Scoping and screening of SSCs for LTO;
- Review of Ageing management programmes;
- Original TLAAs;
- Design Basis information;
- Revalidation of TLAAs;
- Cable AMP, Equipment Qualification /as one of TLAAs;

- Data collection and record keeping.

Reviewer E (Mr. Arvind Shrivastava)

Review of ageing management programmes for civil structures and related TLAAs:

- Scoping and screening of SSCs for LTO;
- Review of Ageing management programmes;
- Original TLAAs;
- Design Basis information;
- Revalidation of TLAAs;
- Concrete ageing;
- Data collection and record keeping.

Reviewer F (Mr. Tomas Pospichal)

Review of Radiological Environmental Impact (based on OSART module "Radiation protection" screened specifically for this mission):

- Related regulatory requirements, limits and guidelines;
- Plant policies on Radiological Environmental Impact (REI);
- REI project organization and management;
- Monitoring of environment;
- Achieved results.

Team Leader – Mr. Robert Krivanek

In preparation for the peer review, an electronic file of an advanced information package (AIP) was provided by the counterpart about one month before the mission.

1.5.2. Basis for the review and review methodology

The IAEA Safety Guide and Safety Report on the procedure to be followed for ageing management programmes and LTO [1-3, 10] were used as support materials for the peer review. In addition, a large number of IAEA existing documents related to basic safety concepts that could be relevant to life extension programmes were utilized. A Safety Guide on "Periodic Safety Review" [4] addresses some aspects of the preconditions to LTO. Other technical documents present technical aspects of ageing management [5] and equipment qualification [6].

The following documents and information were used as a basis for the review:

- IAEA Safety Guides and relevant application documents;
- IAEA Safety Reports and Review Guidelines;
- Advance Information Package [14];
- State-of-the-art practices in other Member States (MS).

Final programme report of the IAEA Extra Budgetary Programme on Safety Aspects of Long Term Operation of Water Moderated Reactors (EBP) [3] was used as a generic, useful reference to the practice in some countries.

1.5.3. Conduct of the mission

The list of participants in the mission and their functions and contact information is given in Appendix I, while the programme of the mission is presented in Appendix II of this report.

The mission was conducted through meetings and discussions of the IAEA Review Team with counterpart specialists from the plant and technical support organizations. The meetings were held at the plant. Plant walk-downs were also arranged as a part of the mission.

Plenary sessions and parallel discussions were organized as needed. The discussions were conducted in parallel for all the areas assigned to the experts. Each expert had an assigned counterpart from the KHNP responsible for the area of the peer review. Other specialists were invited from plant technical support organization suppliers such as KEPCO E&C, HYUNDAI ENGINEERING and PONU TEC.

2. MAIN CONCLUSIONS AND RECOMMENDATIONS

2.1. GENERAL CONCLUSION

The unit will be 30 years old in November 2012, reaching its design lifetime. Wolsong NPP Unit 1 plans to extend its operating life with 10 years until 2022.

Korean Authority adopted Periodic Safety Review (PSR) in 2001 as an effective measure to ensure the safety of NPPs. The first PSR was completed in May 2003 to evaluate 11 safety factors including ageing in accordance with IAEA Safety Series No.50-SG-012 [15]. Safety factors Plant Design, Deterministic Safety Analysis, Probabilistic Safety Analysis and Hazard Analysis were not assessed in accordance with a valid IAEA Safety Guide No. NS-G-2.10 [4] issued in 2003. All operating NPPs in Korea are required by Korean Authority to conduct PSR every ten years. Current version of the IAEA PSR Safety Guide should be used in a full scope for next PSR.

For a purpose of CO beyond Design Life, the regulatory authority prepared the regulatory framework. The CO regulation was established as an extension of PSR, in that two requirements were added to the PSR - implementation of an AMP including TLAA and assessment of the radiological impacts on the environment. The legislation of the CO was completed in 2005, including supplements of the Atomic Energy Acts, Enforcement Decree, Enforcement Regulation, and safety review guidelines. NSSC Notice No. 2012-25 states the evaluation scope and the applicable guidance on the technical basis of CO.

Application for CO License was submitted to a regulatory authority in December 2009. CO Licensing Documents Preliminary Evaluation was completed by the regulatory authority in December 2010.

The continued operation is based on two key principles:

- Since the current licensing basis (CLB) provides an acceptable level of safety, the CLB should be maintained during the period of continued operation to ensure that the level of safety during continued operation term should be no less than before the expiration of design life time.
- The acceptance standards, taking recent safety research results and operating experiences into account, should be met in order to make sure that a high level of safety is maintained even in the light of international safety standards.

The scope of the standard SALTO peer review service was covered by the team in accordance with IAEA SALTO Guidelines.

Beyond the common scope of full scope SALTO peer review mission and in accordance with the counterpart requirement, the review of Radiological Environment Impact was also performed by the team. The scope of this area was based on OSART module “Radiation protection” screened specifically for this mission.

Assessment of those specific areas is reflected in issue sheets developed by the team. Good practices/performances are described in chapter 2.3 of this report.

The Wolsong NPP Unit 1 CO project is not structured in accordance with IAEA Safety Guide 57 “Safe Long Term Operation of Nuclear Power Plants” [2]. It is a combination of partially performed PSR, US approach to active components (maintenance rule), ageing management review for passive, long-lived components and revalidation of TLAAs. It is basically covering

the whole scope SSCs as in IAEA Safety Guide 57 but it is difficult for NPP to demonstrate that all degradation mechanisms/ageing effects of SSCs are properly managed. Improvement in areas of evaluation of effectiveness of programmes to manage ageing of active subcomponents and coverage and interfaces of different programmes that manage ageing is recommended.

AMPs are mostly properly managing SSCs and their degradation mechanisms/ ageing effects. Nevertheless, some AMPs need improvement, especially their preventive activities. Several issues were raised to improve ageing management of SSCs and their degradation mechanisms/ ageing effects as reactor building containment, tendons for reactor building containment, reactor assembly subcomponents, EQ for MOV and cables and vibration fatigue.

SSCs after numerous walk-downs in NPP were found in very good conditions. Nevertheless, the EPS DG (Emergency Power Supply Diesel Generator) and SCA (secondary control area) need improvement from the point of view of fire protection, radiation protection and habitability to be prepared for solving of emergency situations.

Through the review of available documents, which included the AIP and other plant documents, and presentations and discussions with counterparts as well as with other staff of the NPP, the IAEA team confirmed that plant has done an extensive work in the field of LTO and ageing management. Wolsong NPP Unit 1 plans to complete activities related to LTO, in conjunction with the implementation of IAEA recommendations and suggestions, will, if implemented in a rigorous manner, place the plant in a good position to enter the LTO period in compliance with the IAEA safety standards and international good practices.

During the review the team identified good practices/performances which are described in section 2.3.

Taking into account of the above mentioned points, the team recognized that plant activities and planned actions for safe long term operation are principally following and are in line with international practices as implemented by various countries in accordance with their respective regulatory regimes.

Nevertheless, the team also noticed that some plant activities for LTO need further enhancement. The team encourages plant management to facilitate early implementation of all related activities. Implementation of actual activities on the planned schedule is important. In addition, there are some areas which should be improved or have room for further improvement to reach the international good practice level.

Thirteen issues have been raised. Issue details and corresponding recommendations and suggestions are shown in section 2.2. Individual issue sheets are presented in Appendix III. Additional comments of the team related to the areas observed are contained within the relevant subsections of the report below.

2.1.1. Organization and Functions, Configuration/ Modification Management

The review area covered:

- Related regulatory requirements and guidelines;
- Organizational structure for LTO;
- Plant policy (LTO, scope of SSCs for LTO);
- Plant implementation programme for LTO;
- Configuration/ modification management.

The following topics were presented and discussed:

Periodic Safety Review-Continued operation precondition

Legislation of the Continued Operation (CO) has been completed in 2005 including supplement of Nuclear Safety and Security Act, Enforcement Decree, Enforcement Regulation, and safety review guidelines. Originally Nuclear Safety and Security Act is the basic requirement in respect of PSR where it is stated that plant shall assess safety periodically every 10 years. According to this the first PSR for Wolsong NPP Unit 1 has been started in 2003 and finally approved by regulatory authority in 2005. For the purpose of plant continued operation beyond design life an updated PSR is required to be presented, as requested by the new legislation, valid since 2005. For the period of continued operation it is limitation given by regulatory authority to additional 10 years of operation and such extension is under conditionality of presence new PSR results. The prescribed PSR format and scope is using the first version of IAEA safety guide containing only 11 safety factors to be compared to the latest IAEA Safety Guide NS-G-2.10 recommending 14 safety factors. Therefore, CO regulation is requiring an extension of PSR, in two requirements which were added on the PSR: one is an aging management program including time-limited aging analysis and the other is an assessment of radiological impacts on the environment.

In 2007 Korean Institute of Nuclear Safety (KINS) has prepared and issued guidelines over requirements for continued operation such as basic safety level for extended period, technical standards, an environmental review and procedural standards, etc. (KINS/GC No.11, 2007). Currently, the valid guidance is “Guidelines on Application of Technical Standards for Assessment of Continued Operation of Nuclear Reactor Facilities beyond Design Life”, issued by Notice NSSC, No. 2012-25. They are to be followed in preparation for CO application.

Ageing Management

Ageing management process is done through programme in accordance with Notice of the NSSC, No.2012-25 that is basically identical with the technical references, NUREG-1801. In addition, in case when the AMP needs to reflect the specific characteristic of the reactor design or operation experiences, those items should be included. If some of items of the Notice of the NSSC, No.2012-25 are judged irrelevant in the AMP they may be excluded from assessment with providing the appropriate rationale.

FSAR changes

The PSR itself is a confirmatory process for regulator to verify whether the nuclear power plants are in compliance with current applicable requirements and specifically Current Licensing Bases (CLB). As the technical standards of continued operation are upgraded taking the aging management and operating experiences into account, result of safety review of continued operation application can require some changes or modifications in the already licensed documents, such as FSAR. The licensee shall apply the alteration in the CLB through application for licensing condition changes. The licensee shall submit FSAR and Technical Specification (TS) supplement if there are any changes or modifications identified through safety review of continued operation application. The submission of FSAR and TS supplement could be, therefore, done in parallel with continued operation application.

The FSAR supplement shall contain a summary description that provides the information which parts of FSAR has been affected as a result of continued operation application. The supplement should also provide detailed descriptions that will be revised thereby, about programs and activities for managing the effects of aging and the evaluation of time-limited aging analyses during the continued operation term.

Operation limitations given by design life are arising as argument for necessity to apply for CO even an unlimited license for operation exists. In this respect there is unclear which kind of status plant has after refurbishment performed and replacement of the critical components. The plant is currently mixture of original and new SSCs. What are the limiting factors from point of view of design life in the new plant configuration should be clearly given as safety of the plant operated beyond such time technical limitation is controlled by physical status of aged components. It should be somehow managed in plant ageing/LTO and policy/strategy. Definition of design life in FSAR is still used and in this respect the impact of refurbishment and replacement of components as limiting factor for operation, even that unlimited operating license is effective and valid, needs further clarification.

Plant LTO organizational structure

The plant has organized a separate organizational department for “Plant innovation” directly under plant manager. The duties include responsibilities such as preparation application for CO and activities in area of configuration management. Plant internal document regulating duties and rights of the department is Project document - Plant organization for Continued Operation (2011).

Department for “Plant innovation” has totally about 20 qualified engineering staff. For period of CO for the staff of this department will be reassignment of the duties done and reorganization is in preparation to merge this function with maintenance department as a specific unit for Ageing Management (AM).

The organization is valid for CO preparation and for period of LTO organizational changes are planned to redistribute engineering resources mainly into Maintenance and Engineering Department. The plant is following Kori model and process of preparation for CO, i.e. AM issues and team dealing with comprehensive work in this area is part of Maintenance Department, after finalization of CO activities. The Draft Integrated Guidelines for AMPs is prepared for period after successful finalization of CO process and reorganization of temporary established department of plant innovation.

Plant policy (LTO, scope of SSCs for LTO)

At corporate level of KHNP, an LTO division has been established in 2007. The role of this division is a central policymaker in respect of LTO and AM. Clear policy on a plant level does not exist. The procedure is currently related and mainly focused on existing on-going project for CO. The temporary established department of Plant Innovation will be reorganized and partly included into Maintenance and Engineering Department. Probably the AM and LTO policy for period of CO are under preparation as e.g. Draft Integrated Guidelines for AMPs is mentioned. Integrated Guidelines for Ageing Management Programme are established by KHNP Central Research Institute (CRI) on basis of PSR and contain plant data and evaluation report as well as scoping and screening results.

The overall assurance of proper safety level and assessment of plant safety status are currently solved within the existing organizational chart. Safety Division is in charge of standard safety work. AMPs are managed on the level of system engineers in the Maintenance and Engineering Department. In addition to this, emergency preparedness as one of the important safety aspects of the plant is under responsibility of site vice-president and organizational entity on that level.

Integrated guidelines were mentioned above and are under preparation for management of AMPs in period of CO. However, it is still unclear if an overall strategy of the plant is in place and beyond to take care of the future ageing, obsolescence and wear problems in organized way where a predicting and overall philosophy for LTO of the plant exists.

Plant implementation programme for LTO

List of measures as result of PSR has been presented by the plant. The implementation of the measures is to be finished as a part of CO application by the end of 2012. The list is updated every 6 months, the last one available is dated January 2012 and reflects situation by the end of 2011 (schedule chart printout dated 2012.5.22 has been presented).

For the period of CO there are currently 44 AMPs identified and which have been setups based on existing programmes and potential degradation processes. This is result of CO preparation. For the period of CO, an Integrated Ageing Management Programme is prepared which includes organizational changes in respect of ageing management planned after CO approval. The Integrated AMP should take care of an overall process of management of ageing and includes descriptions of processes as well of periodicity of regular review of AMPs.

Configuration / modification management

There is well documented process of design changes management starting at corporate level with involvement of the central office of KHNP for LTO and decision-making process on technical administrative level steps. Safety assessment as well as the regulatory authority approval is a part of the process which is finalized in documentation and record keeping (KHNP Corporate standard for maintenance, 2002).

Function of the plant as design authority is not explicitly mentioned, but from way of application of procedure and as stated in design changes implementation manual it is obvious that such function is with plant and it has all the necessary attributes of responsibility and information

ownership of the plant design data. Also in the process of design changes review, especially for components of safety class 1 and 2, function called “third part independent review” is in place.

The main responsibility for modification management is in one unit which is a part of system engineering of Maintenance and Engineering Department. Permanent modifications are managed by Engineering Department, but all the temporary changes are under Operation Department because such changes are limited to only up to 6 months.

To follow the current status of units, a Corrective Action Programme (CAP) is controlled on corporate level. A person/ department in charge of a design change is identified. The status of prepared changes is monitored monthly on the level of plant and daily on the level of CAP cases.

Installation of two isolation valves in emergency core cooling system valves (PV 162, 163) has been used as an example of implementation of design modification. Through the example the whole chain of activities and process in accordance with valid procedure has been demonstrated (Design Manual DM 59 – 34320 Rev.1 81-10-16). Original AECL Design Report availability in archive and implementation of the change including emergency reactor protection (ERP) system was reviewed in more detail.

For purpose of preparation to continued operation of the plant it has been established modern and well equipped archive for storage of all available original design documents in form of original Design Reports and all information relevant to original design. The archive is equipped with electronic system for easy access and search the information. The archived hardcopies are updated and all the design data were converted into electronic files. All data are also available via ERP system and thus easily accessible via plant network.

Presentation and interviews about following projects and activities connected with LTO were carried out:

- Quality Assurance Programme – presentation on Monday, 4 June 2012.

Beside the scope the team has the following observations and comments: N/A

After the review the team found that the following areas need enhancements:

- FSAR and use of definition of lifetime limitation for continued operation;
- QA related to documentation and record keeping for LTO.

During the review the team identified the following good practices: N/A

As good performance team recognized activities related to plant function as design authority and mainly very well organized Plant Design Basis Data Management.

Documents and information used during the review were:

- Advance Information Package for IAEA SALTO Peer Review of Continued Operation for Wolsong NPP Unit 1, KHNP, April 2012;
- Draft FSAR for Continued Operation , vol.1 -chap. 1.2;
- Guidelines for Continued Operation of PHWR, KINS/GE – No.11, 2007.12;
- PSR report (2009) , Volume 1, copy 30 from 68, chapter 4.1.Current licensing basis definition;
- Draft Integrated Guidelines for AMPs (2012);
- Project document - Plant organization for Continued Operation (2011);
- Continued operation project- Weekly meeting -Minutes of meeting, 2012.05.23;
- Organizational flow chart of Wolsong NPP Unit 1, 2012.05.22;
- Detailed work division of Wolsong NPP Unit 1 – plant doc. (FGO, 000, 09, 1-18);
- Flow chart – design changes, KHNP Corporate standard for maintenance (2002);
- Design changes implementation – plant procedure -Maintenance -02, rev. 21, 2012.03;
- Flow chart – Design changes implementation, Maintenance -02, rev. 21, 2012.03;
- ECCS (emergency core cooling system), Design Manual DM 59– 34320 Rev.1 81-10-16;
- Procedure for Corrective Actions Programme – Operation-10, rev.2, 2010.

2.1.2. Safety analysis reports and existing plant programmes relevant for LTO

The review area covered:

- Current safety analysis report and other licensing basis documents;
- Existing plant programmes relevant for LTO including Maintenance, EQ, ISI, Chemical regimes;
- Methodology and criteria for scoping and screening of SSCs for LTO;
- Completeness of SSCs scoping for LTO.

The following topics were presented and discussed:

FSAR

Final Safety Analysis Report (FSAR) had been prepared by KHNP and approved by the regulatory body before the plant started operation. It was confirmed that its structure and contents are equivalent with IAEA recommendations.

The current FASR clearly states the design life of the plant is 30 years. After the CO approval, the design life of the plant will be the same but a description "continuous operation of 10 years is approved" will be added.

When the plant conducts a modification of SSCs shown in FSAR, FSAR must be revised beforehand. In case of minor modifications, revision of FSAR is performed along with the design modification procedure and a revised FSAR is to be submitted to the regulatory body 30 days before the modification. In case of major modifications, revision of FSAR is performed according to Technical Specifications and the revised FSAR is submitted long time before the modification for the regulatory body's review. In the case of replacement of the pressure tubes, the revised FSAR was submitted in July 2007 while the modification started in December 2008.

PSR

The first Periodic Safety Review (PSR) report was submitted to KINS in May 2003. After the first PSR, 27 follow-up actions were identified. The most of them were implemented during the extended outage, which was from 1st April 2009 to mid of July 2011.

The second PSR is mainly for the continuous operation. In this regard, the whole report for the second PSR is called the continued operation report and consists of the two reports, i.e. the PSR report and the life time evaluation report. It was issued in December 2009 and is being reviewed by KINS. After the review, it is supposed that 44 AMPs will be established and implemented during the continued operation.

It is noted that the current PSR report has 11 safety factors while the latest IAEA Safety Guide on PSR recommended 14 safety factors be evaluated. This difference is basically due to the Korean regulatory requirements which refer to the previous IAEA Safety Guide. The IAEA Integrated Regulatory Review Service (IRRS) team for the Korean Regulatory Body suggested revise the requirements to make them along with the latest IAEA Safety Guide. The plant performed a comparison study of the current PSR contents against the 14 safety factors prescribed in the latest Safety Guide. The result of the study was that plant had performed

necessary analyses, such as the hazard analysis and PSA, and acquired necessary information to meet the 14 factors. They are currently either shown in the different sections of the current PSR report or preserved in documents such as a PSA report that are independent from the PSR.

It was also noted that evaluation of the Fukushima accident and setting up necessary actions are currently performed separately from the PSR due to the time constraint, although these activities are important elements of the PSR.

Existing plant programmes relevant for LTO

The plant is performing various programmes such as maintenance programmes and ISIs to manage ageing of passive and/or active components (functions).

KHNP has established effective maintenance performance monitoring programme and equipment reliability programme for Wolsong NPP Unit 1-4 to systematically review and improve maintenance programmes. Although these activities are based on the USA practices, they are the first case among CANDUs in the world. Also from practical point of view, the process is working well. Conservative conditions are used taking component failure rate of other CANDU reactors into account to set up necessary performance criteria. Precise "Failure Mode Evaluation and Criticality Analyses (FMECAs)" are performed taking into account all potential ageing degradation effects. The management plan of the active components was evaluated in accordance with Article 8 (Use of operating experience from other plants and research findings) of Ministry of Education, Science and Technology - MEST Notice No. 2009-37 (Reactor.035). It is noted, however, that comparison between the effective maintenance performance programme and evaluation based on the attributes necessary for AMPs has not been performed yet.

Environmental qualification is performed as a part of TLAAs for certain electrical components and cables located in harsh plant environments using methods specified in the MEST Notice and NUREG-1800.

The seismic qualification was conducted for SSCs necessary for safe shut down in accordance with Article 8 of MEST Notice No. 2009-37 (Reactor. 035). It was based on the USA NRC USI (Unsolved Safety Issue) A-46 and SQUG (Seismic Qualification Utility Group) GIP (General Implementation Procedure for Seismic Verification of Nuclear Plant Equipment).

The in-service inspection (ISI) program for safety class components of Wolsong NPP Unit 1 includes the requirements for ISI, repair, and replacement in accordance with CSA code. The ISI program also includes the items required in MEST Notice No. 2009-37 (Reactor.035) and the administrative actions, approved reports, and procedures and implemented measures concerning the regulatory body in relation with the program. The ISI for coolant pressure boundary includes the requirements for inspection, inspection results evaluation, repair, replacement, and changes of vessels, piping, pumps, valves, attachments, and supports of reactor facilities, which are specified in CSA-N285.4-05. The ISI for reactor building boundary includes the requirements for inspection, inspection results evaluation, repair, replacement, and changes of leakage prevention of related system piping, structural integrity, and operability, which are specified in CSA-N285.5-M90.

Wolsong NPP Unit 1 periodically monitors and controls chemicals which can cause degradation of materials or cracking in accordance with primary and secondary system water chemistry related procedures, which were established based upon the guidelines for CANDU 6 PHWR

water chemistry control (AECL Chemistry Control Design Manual DM-XX-03081/01200 Rev.4) and the water quality control guidelines of EPRI (PWR Secondary Water Chemistry Guideline Rev.5).

Scope of evaluation for the continued operation

The scope of the ageing management review in PSR and life time evaluation includes safety related structures and components (SCs) that have at least one of the following safety functions:
Integrity of reactor coolant pressure boundary,

Capability to shut down the reactor and maintain it in a safe shutdown condition,

Capability to prevent or mitigate the consequence of accidents that could result in potential off-site exposure

SCs to prevent or mitigate fire (Fire Protection Facilities, Fire Water Systems, Masonry Wall) are also within the scope and AMPs have been established for them.

A hazard analysis was performed based on the latest IAEA Safety Guide on PSR. The result shows that the maximum sea water level including tsunami is 4.7m lower than the ground level. The above hazard analysis also shows that the buildings and facilities in the plant can withstand against predicted typhoon. Predicted maximum precipitation evaluation results shows that the highest water level is lower than the first floor. Therefore external floods and extreme weather conditions are not taken into account in the scoping process.

Although the PSA result shows impact on CDF due to internal flooding is very low, internal flood due to a failure of non-safety component which can affect safety functions is taken into account. Non-safety SSCs that have possibility to cause internal flooding and affect any of safety functions are included into the scope of the CO evaluation. The sump pump systems are also included in the scope.

The safety related SSCs belong to high seismic safety class and therefore are included in the scope. The earthquake detector, which will be used also for automatic shutdown in the near future, is also included in the scope and subjected to AMP.

Pressurized thermal shock is not an issue for PHWR and according to the regulatory requirements, ATWS is excluded for PHWR.

Station black out is also excluded for CANDU reactors in the Republic of Korea according to the regulatory requirements. The basis of this exclusion is that the CANDU reactors have further redundant Diesel Generator Systems. It is noted, however, that although this redundant system can lower the possibility of the SBO, it is impossible to completely eliminate it. After observing the emergency power supply diesel generator (EPS DG), their building and the secondary control area (SCA) under the EPS DGs, team encourages NPP to evaluate the impact of tsunami.

All non-safety-related SSCs whose failure could impede satisfactory accomplishment of any of the above mentioned safety functions are included in the scope. To judge whether an equipment falls within this category, it was examined whether the damage of non-safety related equipment could affect nearby safety-related equipment, referring to the standards suggested in NEI 95-10 Rev.6, App. F. Wolsong NPP quickly incorporated recommendations for Kori 1 regarding to

expand the scope of non-safety SSCs failure of which can affect safety functions. The plant staff made a great effort to identify the SSCs in this scope.

Screening of SCs within the scope

After identification of SCs within the scope, the identified SCs went through the screening process. Through this screening process, passive and long-lived components/subcomponents and structures were identified and ageing management reviews (AMRs) were conducted for them as a part of the PSR report. Based on the result of AMRs, 44 AMPs have been established and they will be implemented during the continued operation.

Ageing effects of active components/subcomponents are managed by maintenance programmes. Consequently ageing of subcomponents of SSCs in the scope of the CO evaluation is managed by various programmes, e.g.:

- AMPs for passive long-lived subcomponents and structures;
- TLAAs including EQ programmes;
- Preventive maintenance programmes, in-service inspection programmes, in-service testing programmes for active subcomponents.

LTO assessment

Effectiveness of these AMPs during the continued operation was evaluated against 10 ageing management attributes in the life time evaluation report. As mentioned before, effectiveness of the maintenance programmes is evaluated by the effective maintenance performance programme which is equivalent to the maintenance rule in the USA.

It was noted that it is difficult to have a clear picture on whether ageing of all SSCs are fully and adequately managed and how multiple programmes are effectively managing ageing of those SSCs within the scope. Also for passive long lived SCs, it is difficult to understand how multiple AMPs work together to cover the all necessary attributes.

Presentation and interviews about following projects and activities connected with LTO were carried out:

- The whole structure of the CO evaluation ;
- Scoping/ screening processes;
- AMPs;
- Effective maintenance performance programme;
- Maintenance programmes (staff training, procedures, relation with AMPs).

Beside the scope the team has the following observations and comments:

- The plant has commenced evaluation study of the Fukushima Dai-ichi NPP accident immediately after the accident occurred. Actions in various areas, such as strengthening structural safety against earthquake/tsunami, upgrading of power and cooling system capability and improvement of emergency response to severe accident have been set up and being implemented. It is important to review and further improve these actions taking account latest findings and research results regarding the accident.
- According to the discussion with one of senior managers in the maintenance department, the new combined system to manage ageing of SSCs, a combination of AMPs and maintenance programmes, is well understood by the maintenance staff members. They are well trained to implement maintenance activities as well as ageing management programmes set up for the continued operation. Newly established procedures for AMPs are playing an important role.

After the review the team found that the following areas need enhancements:

- Structure and comprehensiveness of the PSR;
- The scope of CO evaluation;
- Overall picture about coverage and interfaces of different programmes that manage ageing of SSCs in the scope of the CO evaluation;
- Justification regarding the evaluation of effectiveness of programmes to manage ageing of active subcomponents.

As good performance team recognized the following activities:

- Systematic improvement process of maintenance programmes for CANDU reactors;
- Proactive activities to identify non-safety SSCs failure of which affects safety functions.

Documents and information used during the review were:

- Advanced Information Package;
- The Notice of the Nuclear Safety and Security Commission (NSSC) No. 2012-25;
- The first PSR report (May 2003);
- The report on continued operation (Dec 2009);
- The second PSR report (Dec 2009); final version submitted to KINS and its draft version;
- The Report on “How to apply the new IAEA PSR Safety Guide to Korean NPPs” (August 2011), 1227207050 7002-1 5.1;
- The draft interim report on comparison the PSR to the latest IAEA Safety Guide (May 2012).

2.1.3. Review of ageing management programmes and related TLAAs for mechanical SCs

The review area covered:

- Scoping and screening of SSCs for LTO;
- Review of Ageing management programmes;
- Original TLAAs;
- Design Basis information;
- Revalidation of TLAAs;
- ISI and Surveillance programmes;
- Maintenance procedures;
- Data collection and record keeping.

The following topics were presented and discussed:

Screening of SSCs for LTO

Impact from failure of the non-safety related SSCs on safety functions was discussed. It was ascertained by the plant that flooding which could widely threaten intended functions of safety-related equipment has been considered during scoping and screening process.

Assessment of aging effects is discussed. Assessing degradation effects is based on the procedure "Operating Guideline for Wolsong-1 Aging Management Program" (Gyeong1-10-100). The procedure is in accordance with the methodologies defined in NSSC Notice No. 2012-25 which refers to NRC NUREG-1800 and 1801.

Adequacy of AMPs for LTO

It was presented by the plant that the process of modification of the existing programme or development of a new programme is in place. It was noted that adequacy of ageing management for pumps needs to be justified due to pumps involving several AMPs and several maintenance programs. The plant provided a document titled "Periodic Review of Wolsong NPP Unit 1" (Volume 2, Subsection 4.2.3.3 in Section 4.5 PHT Pump). The document shows that adequacy of aging management for PHT pump has been evaluated, and concludes that aging effect is managed through relevant programs and procedures.

TLAAs and design basis information

It was ascertained by the plant that the original safety analyses involving time limited ageing assumptions, such as the number of operation transients, has been re-evaluated based on degradation mechanisms and operating records. ASME B&P Code Sections III and XI have been followed for time limited ageing analysis for mechanical components. Six TLAAs are developed which describes the scope, acceptance criteria, methods, and results of TLAAs necessary for the review for continued operation.

Environmental effect on fatigue was discussed during interview. Regarding environmental effect on fatigue, current fatigue analysis is based on fatigue tests results conducted in the air

atmosphere, while the actual service environment in primary side is heavy water. It was ascertained by the plant that based on USNRC's generic safety issue GSI 78 and GSI 166, environmental fatigue does not need to be considered during 40 years of operating period. Wolsong NPP Unit 1 will consider environmental fatigue when continued operation is pursued following the operating period of 40 years.

Acceptance criteria and transient account method for fatigue evaluation were discussed during interview. It was ascertained by the plant that the actual pressure and temperature transients were properly collected and accounted, and compared with the transients specified in design specifications.

Revalidation of TLAAs

It was ascertained by the plant that a total of 34 plant-specific TLAAs specified in NUREG-1800 and industry guidelines for continued operation were reviewed to identify whether plant-specific TLAAs applicable to Wolsong NPP Unit 1 in consideration of its design and operational characteristics. As the results, a "Component/Piping Subsurface Indication Analysis" is developed to evaluate the growth of subsurface indication identified during in-service inspection in accordance with the requirements of ASME Code Sec. XI, which is compared against critical flaw length in order to confirm integrity.

In- service inspection surveillance programmes

A Long-Term In-service Inspection Plan (59-03550-LTP-004) is in place with detailed inspection categories, inspection points, inspection methods, inspection schedules, and drawings.

Wolsong NPP Unit 1 has developed an AMP specifically for Safety Class Supports In-service Inspection. Degradation mechanisms for supports are different from degradation mechanisms for the pressure retaining components. Therefore, having a separate AMP specifically for supports of pressure retaining components is to be useful to manage aging issue of supports.

There is specific AMP for Flow Accelerated Corrosion (FAC) in AIP. To demonstrate how to implement the AMP the plant showed a FAC SMART-P program. This program is capable to retrieve piping segment information (total 1552 segments), drawings, inspection areas, U/T data and inspection status.

Maintenance procedure

Maintenance activities to be performed are well defined by "Preventive Maintenance Templates. Wolsong NPP Unit 1 has established 199 templates. In addition, the plant showed a web-based maintenance system where 254 function groups are included. The plant event notices are directly reported to the system. System engineer performs analysis based on the event notices. The analysis results will determine applicable maintenance activity, and further root cause analysis.

Data collection and record keeping

Wolsong NPP Unit 1 not only has inspection records from each individual outage inspection, but also has a report which summaries inspection results within 10 years interval, and provides useful information for long term operation.

Wolsong NPP Unit 1 has established an Enterprise Resource Planning (ERP) system so that design, fabrication, service conditions, and inspection results for each component are easily accessible. During the interview, availability of important design, fabrication and service condition data was checked on sample basis. The plant promptly provided design information (including drawings) on PHT pump and its subcomponents, as well as inspection results by using the ERP system.

Presentation and interviews about following projects and activities connected with LTO were carried out:

- The plant made a presentation titled "Overview of Wolsong NPP Unit 1 Maintenance Effectiveness Monitoring Program". Maintenance programs consist of maintenance rule, preventive maintenance template, and a mid-to long-term plant refurbishment plan. Maintenance rule is developed in accordance with the USNRC 10CFR50.65. Trends of maintenance results are continuously analyzed based on performance criteria specified in the maintenance rule.

Beside the scope the team has the following observations and comments: N/A

After the review the team found that the following areas need enhancements:

- Operating experince and research findings related to vibration fatigue for continual operation;
- Inspection plan on subcomponents of reactor assembly.

During the review the team identified the following good practices: N/A

As good performance team recognized Preventive Maintenance Templates.

Documents and information used during the review were:

- "Advance Information Package for IAEA SALTO Peer Review of Continued Operation for Wolsong NPP Unit 1", Korea Hydro & Nuclear Power Co., APRIL 2012;
- "Long Term In-service Inspection Plan for Wolsong NPP Unit 1", Korea Hydro & Nuclear Power Co., File # 59-03550-LTP-004;
- "Preventive Maintenance Template", Vol. 1-4, Korea Hydro & Nuclear Power Co., November 2008 (139 components);
- "Preventive Maintenance Template", Vol. 1-4, Korea Hydro & Nuclear Power Co., December 2006 (63 components);
- "A study on the evaluation of vibration effect and the development of vibration reduction method for Wolsong NPP Unit 1 Main Steam Piping", KEPRI-92G-J02, 1995.11;

- "Overview of Wolsong NPP Unit 1 maintenance Effectiveness Monitoring Program", June 2012;
- "PSR for Wolsong NPP Unit 1", Table II Analysis of Aging Mechanisms for each subcomponent of reactor assembly, LER E.3.2;
- "Periodic Review of Wolsong NPP Unit 1", Volume 2, Subsection 4.2.3.3 in Section 4.5 PHT Pump;
- "1st Round of 4th cycle of In-service Inspection Records of Non-Destructive Test of Components Pipe Structure, Wolsong NPP Unit 1", Mechanical 9-04, April, 2011;
- "Final Report of 1st Round of 4th cycle of ISI for Wolsong NPP Unit 1", Mechanical 9-04, June 2011;
- "Integrated Guidelines of Steam Generator Management Program, Rev. 1, September 2009;
- "Analysis of damage due to Vibration of Heat Transfer Purification System Pipe for Wolsong Unit 2", November 2003.

2.1.4. Review of ageing management programmes and related TLAAs for electrical and I&C components

The review area covered:

- Scoping and screening of SSCs for LTO;
- Review of Ageing management programmes;
- Original TLAAs;
- Design Basis information;
- Revalidation of TLAAs;
- Cable AMP, Equipment Qualification /as one of TLAAs;
- Data collection and record keeping.

The following topics were presented and discussed:

Nuclear safety categorisation of electrical and I&C equipment

Wolsong NPP Unit 1 changed the categorization from Q, T, R, S to Q, A, S. Some documents have till now the old categorization. It would be helpful to modify affected documents. This categorization is nearly the same like in the IEC Standards for I&C systems.

Scoping and screening of electrical and I&C equipment for LTO, PSR, EQ, no-EQ, TLAA, maintenance review, AMP, active- and passive components

The scoping and screening process is complicated, difficult to understand and communicate (to plant staff and for experts), because there are many parameters like: TLAA, EQ, no-EQ, AMP, LTO, active and passive components. The only important parameter could be the requirements concerning safety functions according the IAEA. This information leads then to the safety categorization Q, A or S and seismic classification I or II.
For LTO, Wolsong NPP Unit 1 uses the 3 criteria from IAEA [2]. For I&C and electrical components, the difference between active and passive components is not well defined. The only parameter is movable or not.

Environmental qualification files (EQ/ TLAA) from MOV-actuators (ISPL-03), SOV (ECBL-08), cables, splices and connectors

The files in paper version, which team have checked, have some mistakes or the information is incomplete as an example: MOV Actuator, List incomplete; SOV information concerning energized coil missing; wrong marking about radiation requirements for splices.
Evaluation report for safe shut down relay (no ID number), in the seismic spectra, it is mixed FRS with TRS.

Tool for the seismic qualification of old electrical equipment is a screening evaluation work sheet (SEWS)

The numbering of the pages is not in the paper version, and the number of the document is missing.

Maintenance method for I&C equipment and electrical equipment

The preventive replacement of electrolytic capacitors on I&C boards is professional. It is a reliable process to take care about the expiration of the life-time.
Overhaul (disassembling) of MOV actuators does not exist in the EQ/TLAA as a requirement for the maintenance. The result from the Arrhenius-calculation is 214 years qualified life time, but it is based on activation energy of 1.02 eV. The calculation is a big extrapolation from the pre-aging time to 214 years. To take care about those uncertainties, an overhaul after 16 years is suggested by manufacturer.
Discharge test for emergency batteries is according to IEEE.

Obsolescence for I&C equipment

Wolsong NPP Unit 1replaced the Digital Control Computer DCC 2009-10. They replaced also the Programmable Digital Comparator PDC 2001/4, the new equipment is redundant and diversified (PROCONTRO P13 and VM30).

Cable AMP for power cables

Wolsong NPP Unit 1 is establishing the indenter method; this method is promoted in the USA.
Many NPP in Europe established a cable deposit in the containment for LOCA cables. They record periodically the absolute elongation at break.

Database ERP (SAP)

Some fields are empty. They are not useable for the application Wolsong NPP Unit 1. NPP experts mentioned that the database is not customized for specific application in Wolsong NPP Unit 1.

Presentation and interviews about following projects and activities connected with LTO were carried out:

- Preventive replacement of electrolytic capacitors;
- Database ERP (SAP), Equipment files;
- Scoping and screening for AMP, EQ, LTO, TLAA, active and passive components

Beside the scope the team has the following observations and comments:

Secondary Control Area (SCA)

The SCA of Wolsong Unit 1 satisfies the design requirements of heavy water reactors defined in FSAR and design manual that the radiation dose of operators shall be below the allowable limit even in a worst condition and the shutdown of the plant shall not require a long-term habitation of operators. Nevertheless, the team encourages NPP to consider comments described below to provide a better environment conditions to operators.

It could be difficult to manage a serious event in the SCA because the radiation- and fire-protection is not sufficient. In case of a fire in the EPS DG room, smoke and toxic gas could penetrate to the SCA. The masks and air flasks for the protecting of the operators against internal contamination are stored in racks on the upper floor. It can take too long to get them.

SCA of unit 1 serves for 2 operators who shut down the unit in case the main control room is not habitable. Ventilation system has no filters and does not create overpressure in SCA and contaminated air in case of emergency my come in.

Measurement of radiological situation and other protective means are provided by health physicists according to RCA operational procedure RO-6-704. Necessary equipment for radiological measurement and protection is not available in the SCA, see part 2.1.6 of this report.

SCA (secondary control area) is the only emergency control room in the plant. It is placed beside EPS DGs. SCA has 3 entrances, which are from main control room, from outside, from EPS DG room. According to the DM-59-66600 and FSAR, the emergency operating procedures required operability and habitability of SCA for 2 people for 24 hours. The SCA has no chairs or table. One phone does not operate in the SCA. There are two hoses for the breathing air system on place.

The team encourages the plant to improve a habitability of the SCA to assure its function during emergency situations. It includes radiation protection of personnel in the area, suitable working conditions for required period and availability of operational documentation for all emergency situations.

Emergency Power Supply Diesel Generator (EPS DG)

A physical steel barrier between two generator set was seen in the EPS DG. The barrier was having a door opening for personal entry. There were vertical and horizontal slits also observed along the door opening and base. A small window has also been observed on the barrier near the control panel of the first EPS DG. This may lead to the risk of fire spread from one DG to the other generator set.

The fire protection door between the two generator sets is not locked. In the case of overpressure on one side, the door may open and spread the fire on the other generator set. The team encourages the plant to reinforce the fire barrier between EPS DG.

Status of the electrical installation in EPS DG

The electrical terminal bolts from the starter motor are not covered. During the start up from the generator set, it is a high risk for a short circuit which can destroy the starter. The generator set will be not available for the emergency power supply.

The IAEA team encourages insulating and protecting the terminal bolts of both EPS DG starter motors against the risk from an outside short circuit.

After the review the team found that the following areas need enhancements:

- Insufficient attributes of TLAA and EQ for MOV and cables;
- Seismic fixing of Electric/I&C equipment including appropriate procedures;
- Some EQ/ TLAA file must be modified concerning mistakes;
- Contents of the database ERP (SAP) open fields;
- Review of all EQ/TLAA file concerning mistakes.

During the review the team identified the following good practices:

- Procedure for electrolytic capacitor replacement.

As good performance team recognized medium voltage cable periodic diagnosis

Documents and information used during the review were:

- Computer database ERP (SAP);
- TLAA/EQ Files for MOV (ISPL-03), SOV (ECBL-08), cables, splices, connection;
- Screening evaluation work sheet (SEWS) no ID number;
- Seismic classification files DG-59-68000-002.

2.1.5. Review of ageing management programmes and related TLAAs for civil structures and components

The review area covered:

Ageing management programmes for civil structures and related TLAAs:

- Scoping and screening of SSCs for LTO;
- Review of Ageing management programmes;
- Original TLAAs;
- Design Basis information;
- Revalidation of TLAAs;
- Concrete ageing;
- Data collection and record keeping.

The following topics were presented and discussed:

Scoping and Screening of SSCs subject for LTO

In order to carry out the Ageing Management Program (AMP) for civil structures and buildings it has been seen all the civil structures and buildings have been identified, including reactor containment. In order to carry out the AMP a dedicated data collection and recording system has been defined by a comprehensive Structure Life Management System (SLMS) program as per clause 4.10 – 4.13 of Safety Guide NS-G-2.12.

Based on the SLMS it is seen that this system can demonstrate the effects of ageing degradation of structures and buildings under considerations for period of LTO as per the safety Report Series no. 57, 5.4.

The scope of LTO includes all the civil structures and buildings including whose failure may impact safety functions.

It is appearing well defined and comprehensive for the present pre-stress monitoring. Other AMP for different building and structures as per Advance Information Package has been reviewed and found comprehensive.

Scoping and screening processes are well documented.

Review of ageing management programmes

Based on the Safety Report Series No. 57 [2], nine attributes as referred in clause 5.3 have been considered for the estimation of the pre-stressed force in the tendon used in the reactor building containment. However, it has been noticed that with respect to the attribute 2 of the Table-2 of Safety Guide NS-G-2.12 [1], “Preventive action to minimize and control ageing degradation” is not being followed.

Based on the plant walk down, it has been observed that although the cracks were repaired and the ring beam of the containment has been painted, the containment wall and dome are not given any protection against exposure to environment which could accelerate the cracking of the containment concrete.

The ageing management program for following structures has been reviewed:

- Reactor containment building including containment wall, dome, base slab, ring beam internal structure including airlocks. The epoxy liner is also included in AMP. In addition, following safety related buildings are also covered in AMP:
    - Service Building;
    - Secondary control area;
    - High pressure emergency core cooling building;
    - Spent fuel pool building;
    - Emergency water pump room;
    - Turbine building;
    - Circulating water intake pump building;
    - Tritium removal facility building;
    - Radioactive Waste temporary storage building.

The base line data are available as per the SLMS for various AMP developed for all important civil buildings and structures as per Annex-II of NS-G-2.12.

Based on the information and discussions with team members it is seen that the operational data and information is available in the SLMS.

The procedures to assess degradation effects in concrete, reinforcement and pre-stressing steel are available. The AMPs were developed for following degradation mechanism:

- The measurement of Chloride attack as per ACI-222R-96;
- Carbonation in concrete as per Japanese Architect association -1997;
- Non-destructive testing (NDT) on concrete by Schmidt's hammer by ACI-301-96;
- NDT on concrete by ultra sonic Pulse velocity as per NIST-1997;
- Corrosion on reinforcing bars as per ASTM C-876 half cell potential measurements;
- Measurement of corrosion on reinforcing bars by natural electrodes;
- Cracking in concrete as per ACI-224R and ASME, Section-XIIWL 3221,3;
- Measurement of settlement of containment foundation.

Based on the discussions with the counterpart and his team members it has been observed that this scheme is being implemented from last 10 years and hence the assessment of the operating and maintenance history is included.

The SLMS has been developed that include maintenance history for all the building and structures under considerations.

One of the AMP for reactor containment building called monitoring of pre-stress force is being performed with the help of R&D activities. This needs to be demonstrated, as the loss of pre-stress in due course of time could have severe consequences on the overall safety of the plant.

As per the site walk-down and further discussions with the team members, it has been informed that the reactor containment to be maintained as it is. According plant information there is a restriction from KINS to carry out the painting on the containment wall and dome.

Existing and proposed plant programmes for ageing management

The alternate scheme to the original measurement scheme is being reviewed for determining the meeting of 9 attributes in general, however, for the reactor containment; the second attribute has not been followed. This means that as per the Safety Report Series No. 57 [2], clause 5,3 (b) there is no prevention of degradation for containment wall and dome of reactor building.

The reactor containment building is pre-stressed concrete structures with bonded tendons. The pre-stress loss needs to be assessed periodically. This AMP is being developed and followed with the help of R&D program.

Alternate schemes are being developed to support the assessment of reactor containment in future.

Documentation of the evaluation and demonstration for management of ageing effects

SLMS has been a very comprehensive program and being implemented for the data more than 10 years. The relevant documents are available.

The effect of ageing on the structures for the various degradations appearing manageable, however, it is being suggested to plan alternate schemes for the measurement of force and corrosion in pre-stressing strand in the future.

Original TLAAs

Based on the review of the documents followed by discussions with counterpart with his team, the following TLAA were identified:

- Containment tendon TLAA;
- In-service inspection (ISI) of concrete structures;
- Integrated leak rate test of the containment.

While, visual inspection is being carried out for cracking in civil structures and buildings, the leak rate test is performed periodically to the reactor containment building. Since, the reactor containment building is designed and constructed with pre-stressed concrete with bonded tendons; its pre-stress force needs to be monitored periodically to validate the design throughout its life time.

Presently, ISI is being followed. The reactor containment tendon TLAA is being carried out by carrying out destructive testing of the test beams which were cast at the time of construction of reactor containment building way back in late 70’s. To assess the corrosion and force in the pre-stressing tendons following is being done:

- Load test is being conducted to determine the deflections.
- Beam is cut to see the bond:
    - between sheath and grout;
    - between tendon and grout.
- Beam is further broken and state of reinforcing bar and pre-stressed tendons are assessed for corrosion.
- After cleaning, the pre-stressed tendons are taken for ultimate tensile testing.
- The concrete cores are taken to determine the concrete strengths.
- Schmidt's hammer tests are conducted to assess the subjective health of the concrete.
- The pre-stressing force is also being assessed with the re-stressing of three (3) beams with unbounded tendons.

Design Basis information

The Design basis information have been reviewed for Long term structural monitoring of buildings and structures including reactor containment, the Integrated leak rate test of reactor containment, The above bases were derived from the original Canadian design code and being followed till date.

The state of corrosion is also being followed as per Canadian`s approach.

Revalidation of TLAAs

In order to revalidate the TLAAs, original TLAAs are being planned to be supplemented with the outcome of periodic integrated leak rate test of reactor containment building. The periodicity has been worked out as per the codes being followed.

In addition, to validate and confirm the reactor containment design, the research and development program has been initiated to assess the pre-stress force and corrosion. This is more so as the load cell mounted on the test beams is not working and the re-stressing is being done to assess the pre-stress force.

Based on the discussion, it was informed that two different methods are being developed for revalidation of TLAAs for tendon pre-stressing assessment:

- Impact hammer test;
- System identification method.

Team encourages NPP to calibrate and validate those methods.

Concrete ageing

Concrete when cast, starts degrading initially by showing the shrinkage and thermal cracks. Later, when subjected to different exposure conditions, like coastal environment, chemical,

environment, subjected to extreme temperature ranges (low and high, during day/night and monthly/yearly variations), it starts degradation. The various degradations are as follows:

- Cracking due to chloride attack;
- Cracking due to carbonation;
- Cracking due to shrinkage;
- Cracking due to settlement of foundations;
- Freezing and thawing, etc.

In order to delay the de-grading mechanism in the concrete, team encourages to apply mitigating actions as protective coating, paints, etc.

Data collection and record keeping

The various data for different buildings and structures have been recorded and maintained with SLMS. The data for health assessment are being collected periodically and analyzed. The settlement data is being obtained on-line and being maintained in SLMS.

Presentation and interviews about following projects and activities connected with LTO were carried out:

- Layout of general description of the civil structures and buildings;
- KHNP Ageing Management Review for Civil structures and buildings;
- SLMS program for AMP of civil structures and buildings;
- Pre-operational proof and Leak rate testing of concrete containment building systems for CANDU NPP, CSA, N287.6, M80;
- Technical Specification on Proof and Leak rate testing of containment building-TS-XX-21080-1 R1 April 1997.

After the review the team found that the following areas need enhancements:

- The Reactor Containment Building is not being painted externally except at ring beam. The Degradation of the reactor containment may accelerate without external painting due to presence of salts in the coastal environment.
- The measurement of pre-stress force and corrosion in the tendons should be calibrated with respect to test results by the methods being developed by Research & Development for Validation/confirmation of the design of Reactor Building Containment.

During the review the team identified the following good practices: N/A

As good performance team recognized the following:

- Structure Life Management System (SLMS) that is being used for the Ageing Management Program is very detailed, comprehensive and covering various attributes as

per NS-G-2.12. This program is developed for all the civil engineering structures and buildings covering all the possible degrading mechanism applicable.

- The AMP for various structures and buildings are as per applicable design codes (mostly on CSA and ASME, ASTM, etc.) The various procedures developed are based on above codes / documents and are very detailed and self-sufficient.

Documents and information used during the review were:

- Advance Information Package – for IAEA SALTO Peer Review of Continued Operation for Wolsong NPP Unit 1, Prepared by Korea Hydro and Nuclear Power Co, April 2012;
- IAEA Safety Series 17, SALTO Guide Lines ; Guidelines for peer review of long term operation and ageing management of nuclear power plant, December 2008;
- IAEA Safety Standards (for protecting people and environment) Ageing management for Nuclear Power Plants, Safety Guide No. NS-G-2.12, January 2009, Table 2 "GENERIC ATTRIBUTES OF AN EFFECTIVEAGING MANAGEMENT PROGRAM" The attribute 2 and 5 suggest control and minimization of ageing degradation for structures;
- IAEA Safety Reports Series No.57 – Safe Long Term Operation of Nuclear Power Plants, October 2008;
- IAEA Tecdoc-1025;
- Reactor Building Containment Structure Stress Analysis Report (59-21020-02-DR_01);
- Reactor Building General Arrangement drawings:
  - 0.59-21000-7501-01-GA-E;
  - 0.59-21000-7503-01-GA-E;
- Report for Life Time Evaluation for major components of Wolsong NPP Unit 1 (Containment Tendon TLAA), Chapter III.5;
- Structure Life Management System, Ageing Management Program for Structures;
- Jeonggi-sul0-001: Examination of ageing phenomena of nuclear safety related concrete structures;
- Jeonggi-sul0-003: In service inspection of Reactor Building post tensioning system;
- Ministry of Education Science and technology (MEST) notice no. 2009-37 (Reactor.025) and (Reactor.026);
- Technical paper on Impact test hammer for pre-stressed force in bonded tendons at Wolsong NPP Unit 1.

2.1.6. Review of radiological environment impact

The review area covered:

- Radiation protection policy, limits, responsibilities, qualification;
- Quality assurance in radiation protection inter-comparison with other laboratories;
- Dose rate and contamination measurement;
- Instrumentation for effluents and radiological situation monitoring;
- Solid radioactive waste management;
- Gaseous and liquid discharges;
- Environmental monitoring and emergency monitoring support.

The following topics were presented and discussed:

Radiation protection policy, limits and responsibilities, qualification

NPP has limits for effluents given by KINS. According to Advanced Information Package and presented annual reports (2010 and 2011) Wolsong NPP Unit 1 proved that the releases are kept within authorized limits.

NPP uses a Gaussian plume model for calculation of dose from gaseous effluents to public. This model does not take into account the complex terrain in a close vicinity of NPP. The regulatory body requires this plume model because it is simple. But the Gaussian model is not suitable for such a complex terrain. NPP has not checked it yet.

Wolsong NPP Unit 1 uses for calculation of atmospheric dispersion and deposition factor XOQDOQ computer code which applies constant mean wind direction model of U.S. Regulatory Guide 1.111. This document on page 10 says that for all sites, a detailed discussion of the applicability and accuracy of the model and input data should be provided. NPP does not have any report about applicability of the model XOQDOQ for complex terrain in vicinity of Wolsong NPP Unit 1.

IAEA Safety Guide No. NS-G-3.2 [17] in point 2.41 says: “Calculation models for atmospheric dispersion should be chosen in accordance with the regulatory objective and, to the extent possible, site and/or plant specific characteristics should be taken into account“. One of the plant specific characteristics is complex terrain in vicinity of NPP. The complex terrain is not taken into account in model XOQDOQ for atmospheric dispersion.

NPP checks environmental factors (food consumption, dispersion of population, production of agricultural products) every 5 year. As for inhalation and ingestion conversion factors NPP uses factors given in ICRP 72 and as for conversion factors for external radiation NPP uses factors from ICRP 74.

NPP has job trainings according to annual plan and irregular week-long training in summer camp, which is not mandatory. There are 5 types of training for radiation emergency preparedness:

- initial training at the start of commissioning;
- unit's partial training on a quarterly basis;
- plant's annual training on a semi-annual basis;
- comprehensive training for all sites every 4 years
- national training (organized by regulatory body) once in 5 years.

The group for emergency monitoring consist of 8 people, who are trained twice a year for 8 hours in total on the use of emergency monitoring vehicle.

Adequate staffing was checked on off-site laboratory. Off-site laboratory has 7 employees plus 3 contractors (2 for maintenance, 1 for calculation of doses) which is an adequate number of persons for tasks they do.

Quality assurance in radiation protection inter-comparison with other laboratories

Radiological emergency monitoring plan (approved by KINS) is checked every year. The check is done by regulator. NPP incorporates regulators comments to revision.

Off-site laboratory uses Quality Assurance Procedure for Environmental Radiation Monitoring. Their QA system is based on standards given by KEPIC (Korea Electric Power Industry Code). QA system on offsite laboratory is reviewed by the regulatory body.

The plant and off-site laboratory documentation system (from top documents to lower ones) is as follows:

1. technical specifications;
2. final safety analysis report;
3. plans;
4. procedures;
5. guidelines.

Off-site KHNP environmental laboratory uses gamma spectrometry for measurement of environmental samples. Personnel check quality of measurement parameters like peak position, resolution and background. There are no proper records about resolution and background. Records about calibrations checks should incorporate criteria for successful check and result of the check and signature of person who did the check. All these records were missing. Related documents: Operational procedure for gamma spectrometry, Environment-4-002 and weekly checklist.

Calibration terms are determined in document Operating procedure for gamma spectrometry and LSC and a low level alpha beta counter (e.g. HPGe detectors are calibrated every 6 month). NPP has a person in charge that is responsible for calibration and this person does all calibrations in laboratory.

NPP has 10 on line monitors called RMS, which calibration is done externally and responsibility on providing this is on Senior Manager of Emergency Preparedness and Environment Team. It is checked by using a check list.

Inter-comparison measurements are done yearly. They compare 28 parameters with a university. For example, drinking water (tritium and gamma analysis) is compared every 3 months, within the margin of 20%. In the case that laboratory is out, NPP has to find out why. Results of years previous to 2011 were always 100% success, but in 2011 they were 93% (2 new employees). Nevertheless these results are excellent and they are even published in annual reports accessible to the public.

Dose rate and contamination measurement

During 1st walk-down (June 4th, 2012) to secondary control area (SCA) there was following concern: SCA of unit 1 serves for 2 operators who shut down the unit in case the main control room is not habitable. Ventilation system does not create overpressure in SCA and contaminated air in case of emergency may come in. Ventilation system does not remove activity from contaminated air. Air flasks serve as protective means against internal contamination. They are available only upstairs. Measurement of radiological situation and other protective means are provided by health physicists according to the Radiation Controlled Area (RCA) operation procedure RO-6-704. Necessary equipment for radiological measurement and protection is not available in SCA. So there is a possibility that radiation protection of operators in SCA will be not guaranteed completely and their doses overcome given limits.

During 2nd walk down (June 5th, 2012) to SCA, IAEA expert found out that following equipment required by Design manual DM-59-66600 Wolsong NPP Unit 1 Secondary control area is missing:

- Hand type radiation monitoring equipment (upstairs and downstairs) with an audible alarm to warn SCA occupants of increasing radiation levels in the SCA and in the area surrounding the SCA.
- Equipment for habitability of occupants for 24 hours as first aid equipment (only downstairs), tool kits and portable chemical toilet.

The main concern is about missing radiological situation and monitoring equipment and especially warning devices to tell the operators they should leave SCA. This equipment is necessary especially in case when technical provision against spread of air contamination coming inside SCA are missing (commonly used is overpressure and filtration of the air).

Measurement on the boarder of RCA (limits, equipment) was reviewed during walk-down on 31st May 2012. NPP's limits are set to 0.4 Bq/cm2 which is higher than TECDOC-855 [21] clearance value of 0.3 Bq/cm2. A Decree of MEST, art. 94 gives limit of surface beta/gamma contamination and low level alpha 4 Bq/cm2 and all other alpha 0.4 Bq/cm2. But IAEA document TS-R-1 [19] says in point 214 that: "Contamination shall mean the presence of a radioactive substance on a surface in quantities in excess of 0.4 Bq/cm2 for beta and gamma emitters and low toxicity alpha emitters, or 0.04 Bq/cm2 for all other alpha emitters."

Wolsong NPP Unit 1 uses this criterion because they consider it is for transport and document TS-R-1 is stronger than TECDOC-855 [21]. Reviewer agrees with NPP statement.

The contamination measurement is done in cpm (counts per minute), but NPP uses conversing factors on each device to convert cpm to Bq/cm2. Calibration is done by using Am-241 and Cs-

137 standard, which was verified on calibration report No. 0802_120945kc180 and procedure khnp-cri-cp-a07.

NPP does not do measurement of people, cars and their load on the gate to eliminate the spread of contamination and to avoid an illegal transport of radioactive sources. NPP provided information that once control on RCA boundary is implemented properly there is no need to measure at the gate. This is not consistent with the IAEA document Nuclear Security Recommendations on Radioactive Material and Associated Facilities [20] in point 4.33 says ”The movement of packages and/or conveyances containing radioactive material should be monitored appropriately”. To bring materials inside the plant, people need to report it and the security staff checks if it corresponds to the declared material visually not by radioactivity detector. Counterpart informed that all radioactive sources have a chip which sends a signal to KINAC about source`s GPS position.

Instrumentation for effluents and radiological situation monitoring

Wolsong NPP Unit 1-4 have 4 stacks and 2 stacks for Tritium removal facility (TRF), turbine building has no on-line monitor on main steam line, personnel takes only samples before opening the valve On condenser there is on-line monitor. Monitoring on secondary system is described in document Operational procedure for radiation monitoring, secondary system R1-2-720. NPP has a system “D2OinH2O leakage detector system”, which measures and detects the leakage of activity from primary to secondary system. NPP has a safety analysis report which predicts a source term for the case of a leakage from primary to secondary system.

For liquid effluents there are 5 tanks in service building (each 50 m3), before release they do sampling, measurement and comparison with limits.

During walk-down, IAEA expert visited waste laboratory (measurement samples from ventilation stack and control tanks) which has 2 semiconductor detectors for gamma spectrometry and 3 liquid scintillation counters. All of them were calibrated and labelled properly.

NPP control of alpha activity in liquid effluent is provided via gross alpha and beta counting. Till now results are under lower limit of detection. Possible escapes of activity to underground water are checked via system of monitoring wells which are placed properly. Monitoring wells are sampled monthly but NPP staff does composite sample for 3 months and this composite sample is measured. For example for system of rad-waste storage, there is monitoring well SP-12.

Solid radioactive waste management

Every year NPP makes a radioactive waste management program (goals for current year, evaluation of prev. year, estimates of radioactive generation for current year and management of disposal stability for radioactive waste).

Goals for 2012: under normal operation 140 drums and during outage 60 (200 litres). In more detail, 87 for mechanical teams, 28 for chemistry team, 4 for maintenance, 63 for industrial safety team, 11 for fuel team and 7 for radiation safety team.

NPP provided IAEA team with a comparison of plan and real production of solid radioactive waste for years 2007 till 2011, which shows that every year NPP fulfilled their plan. The

maximum of production of drums was 1350 drums in 2010 and minimum was 492 drums in 2007.

Sludge management is included in operating procedures rad-6-202 solid radioactive waste treatment procedure. Sludge is low active waste and most of activity remains on filters, NPP do not use evaporation.

During walk-down on 1st June, the team visited rad-waste storage, which stored drums with pressed solid materials. Drums stored on the floor were in a good condition. High active drums (with filters and resins) are stored in caves under the floor and they are shielded and the dose rate is continuously measured. In storage, the plant measures particulate concentration, surface contamination and tritium concentration weekly. Close to the rad-waste storage there is 1 monitoring place for on-line measurement of dose rate with display and the data is transmitted to main control room.

Gaseous and liquid discharges

NPP applies ALARA principle in this way: according to Wolsong NPP Unit 1 operational guidelines chapter 5.1.3 they apply only 3% of activity limit, which may be released to the sea and is required by regulator.

Procedures to control effluent releases are in place, and were reviewed during walk down in main control room. Output of on-line monitors of particulates, iodines and noble gases in ventilation stack is placed there. The operator is informed about overriding alarm or warning levels on panel Annunciation and DCCs. The appropriate measures which need to be taken are described in document Operation procedure OP 67883, which is available there.

All reviewed records (annual reports, calculation of releases from turbine hall and records from surface monitoring) are maintained adequately.

NPP does not measure organic form of radiocarbon in gaseous effluents. So, an important part of gaseous effluence might be omitted. Report "The development of monitoring techniques of radiocarbon from heavy water reactor issued on January 1998, chapter 2-7-1 C-14 measurement results in stack in gaseous effluents presents CO2 =543 Bq/m3, non CO2 40 Bq/m3 which are the results from 3-9/1997 for Wolsong NPP Unit 1. Since that time NPP have not checked the validity of the measurement. The plant has not made any changes in operational mechanism that could lead to a bigger release of non-CO2 forms or radiocarbon. The plant have a report about doses from radioactive methane (non-CO2 form) which makes about 1% of doses coming from CO2, which was taken from the report Doses from radioactive methane, A.W.Phipps, 1990, radiation protection dosimetry).

Environmental monitoring and emergency monitoring support

The off-site laboratory has suitable equipment availability. An emergency monitoring vehicle is assessed as a good performance. Environmental radiation monitoring vehicle is well equipped with portable on line monitoring of gamma/neutron dose rate, volume activity of particulates, iodine and noble gases, tritium bubbler, gamma spectrometry and meteorological data acquisition system. Measured data are transmitted to off-site laboratory and emergency response facility. It is still not very common that monitoring vehicles are equipped with on-line measurement of particulates, iodine and noble gases.

The off-site laboratory does not do measurements of high active samples, because it is close to power station (approx. 2 km) and is going to be evacuated in case the dose rate in laboratory will be higher than 1 mSv/hr. The personal does only sampling and samples are transported to university laboratory which is a contractor for emergency samples measurement.

However ranges of on-line monitoring device (particulate, iodines and noble gases) are sufficient enough for monitoring during emergency.

Monitoring results are trended. The plant provided with charts on volume activity of organic bound tritium (OBT) in rice and C-14 activity in milk and tritium activity in sea water and feed water. There are no rising trends.

Presentation and interviews about following projects and activities connected with REI were carried out:

- Interview with Principal Researcher KHNP Central Research Institute;
- Interview with Senior Manager Emergency Preparedness and Environmental Team KHNP;
- Interview with Senior Manager Radiation safety team, KHNP.

Beside the scope the team has the following observations and comments: N/A

After the review the team found that the following area needs enhancements:

Suitability of atmospheric dispersion model for gaseous releases.

During the review the team identified the following good practices: N/A

As good performance team recognized well equipped environmental radiation monitoring vehicle with all needed on-line measurements and data transfer during emergency.

Documents and information used during the review were:

- U.S. Regulatory Guide 1.111, July 1997;
- IAEA Safety Guide No. NS-G-3.2 Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants;
- Operational procedure for gamma spectrometry, Environment-4-002, weekly checklist;

- RCA operation procedure RO-6-704;
- IAEA-TECDOC-855, Clearance levels for radionuclides in solid materials, 1996;
- IAEA-TS-R-1: Regulations for the safe transport of radioactive material;
- Calibration report nr. 0802_120945kc180;
- Calibration procedure knhp-cri-cp-a07;
- Design manual DM-59-66600, Wolsong NPP Secondary Controlled Area;
- Nuclear Security Recommendations on Radioactive Material and Associated Facilities (IAEA Nuclear Security Series No. 14), 2011;
- Operational procedure for radiation monitoring, secondary system R1-2-720;
- Operation procedures rad-6-202 Solid radioactive waste treatment procedure;
- U1 operational guidelines chapter 5.1.3;
- Operation procedure OP 67883.

2.2.SPECIFIC RECOMMENDATIONS / SUGGESTIONS

2.2.1. Recommendations

- The current description in the CO report related to exclusion of SBO should be revised. Ageing of equipment to cope with SBO which will be added in the future after evaluating lessons learned from the Fukushima Dai-ichi accident should be adequately managed.
- Plant should seize the fixation and fix or fasten the not anchoraged equipment, tools and furniture and take out the equipment, tools and furniture from the rooms, if they are not necessary during the operation from the plant.
- The containment being the ultimate barrier between reactor and environment, it is recommended to strictly adhere to the IAEA guide NS-G-2.12 for Aging management Program. Additional efforts should be made to control and delay the degradation of concrete by external painting on wall and dome of reactor containment.
- The Pre-stressing tendons measurements for force and corrosion should be calibrated and validated by R&D programmes due to lack of adequate test beams in the future. The designed validation/confirmation should be available on line (after due validation/confirmation) throughout the life of the structures.
- Review applicability of the XOQDOQ code for complex terrain in vicinity of NPP Wolsong. If XOQDOQ code is not applicable use another model which is applicable.

2.2.2. Suggestions

- Consideration should be given to the total expected operational period and define this period explicitly in order to recognise and clearly define validity of FSAR. The FSAR should reflect the technical limitation existing by presence of both refurbished systems and original components in service. Consideration should be given to assess the most important limiting factors for coming period of CO.
- Consideration should be given to integrate all the maintenance record data for electric systems and equipment commodities groups into the ERP.
- Consideration should be given to keep full consistency between electronic and printed hardcopy version QA of the document management system.
- Consideration should be given to further facilitate the current activities to supplement and make the PSR consistent with the latest IAEA Safety Guide and finalize these activities as soon as possible. Consideration should also be given by the plant to incorporate activities to evaluate the Fukushima accident and set up necessary actions into PSR activities in the future.
- Consideration should be given to produce expanded matrixes that show how ageing degradations of subcomponents of all SSCs within the scope of the CO evaluation are managed by multiple programmes.
- Consideration should be given to add a table in the introduction part of Chapter II of the PSR report, which demonstrates that all nine attributes are incorporated into the overall evaluation process of programmes for active components.
- Consideration should be given to establish a systematic process to review and feedback operating experince and research findings related to vibration fatigue for continued operation.

- Consideration should be given to develop an inspection and monitoring plan for subcomponents of reactor assembly for long term operation based on CANDU utility's experiences.
- Consideration should be given to establish a cable deposit with samples for the recording of the elongation at break periodically as an indicator for ageing.
- Consideration should be given to schedule the overhaul (disassembling) of all MOVs in safety systems in harsh environment.
- Consideration should be given to establish a procedure on seismic fixing of equipment, tools and furniture and seismic walk-downs.

2.3. GOOD PRACTICES AND PERFORMANCE

2.3.1. Good practice

2.3. 1. 1. Procedure for electrolytic capacitor replacement

The electrolytic capacitors found to be susceptible are replaced every 5 cycles. Before being delivered to Wolsong NPP Unit 1, capacitors purchased for replacement are sent by manufacturer to the KHNP Central Research Institute (CRI). Commissioned by the CRI, the Korea Test Laboratory (KTL) performs several inspections including entrance inspection, visual inspection, leakage current inspection, and rated voltage and checks the manufacturing date. Wolsong NPP Unit 1 requires capacitor manufacturer to provide capacitors less than 6 month after manufacturing.

2.3.2 Good performance

2.3.2.1. Medium voltage cable periodic diagnosis

Electrical diagnostics for buried medium voltage cable were performed for safe operation and reliability of plant. Depending on the diagnostics results, degraded cables should be replaced. Suitable inspection items were used: Insulation resistance measurement, sheath insulation resistance measurement, commercial frequency, Tan-delta measuring, VLF (Vary Low Frequency) Tan-delta measuring, and VLF Partial discharge.2.3.2.2. Preventive Maintenance Templates

Wolsong NPP Unit 1 has established a total of 199 Preventive Maintenance Templates. Maintenance activities to be performed are well defined by "Preventive Maintenance Templates". Each type of components, such as horizontal pump, vertical pump, has a specific Preventive Maintenance Template. Maintenance schedule for each subcomponent is tabulated based on functions important to safety, impact on environment, performance criteria (considering reliability and availability), failure history, and feedback from operating and maintenance experience.

2.3.2.3. Systematic improvement process of maintenance programmes for CANDU reactors

Wolsong NPP Unit 1 has established a systematic improvement process of maintenance programmes using an effective maintenance performance programme and equipment reliability programme. Although it is based on the USA practices, it is the first case among CANDUs in the world. Also from practical point of view, the process is working well. Conservative conditions are used taking component failure rate of other CANDU reactors into account to set up necessary performance criteria. Precise "Failure Mode Evaluation and Criticality Analyses (FMECAs)" are performed taking into account all potential ageing degradation effects. According to the discussion with one of senior managers, this system is well understood by the maintenance staff members. They are well trained for maintenance programmes as well as ageing management programmes set up for the continued operation. Newly established procedures for AMPs are playing an important role.

2.3.2.4. Proactive activities to identify non-safety SSCs failure of which affects safety functions

The plant quickly incorporated recommendations for Kori 1 regarding to expand the scope of non-safety SSCs failure of which can affect safety functions. The plant people made a great effort to identify the SSCs in this scope.

2.3.2.5. Environmental radiation monitoring vehicle

Environmental radiation monitoring vehicle is well equipped with portable on line monitoring of gamma/neutron dose rate, volume activity of particulates, iodine and noble gases, tritium bubbler, gamma spectrometry and meteorological data acquisition system. Measured data are transmitted to offsite laboratory and emergency response facility.

2.3.2.6. Plant Design Basis Data Management

As a part of preparation for continued operation of the plant established modern and well equipped archive for safe storage of all available original design documents in form of original Design Reports and all information relevant to original design. The archived updated hardcopies of the design data were converted through verification process into electronic files. All data are also available electronically via ERP system and thus easily accessible via plant network. Systematic Design Change Procedure is implemented following specific procedure and 7 detailed guidelines under QA program assuring correctness of design data.

2.3.2.7. Structure Life Management System (SLMS)

Structure Life Management System (SLMS) that is being used for the Ageing Management Program is very detailed, comprehensive and covering various attributes as per NS-G-2.12. This program is developed for all the civil engineering structures and buildings covering all the possible degrading mechanism applicable.

2.3.2.8. Well-structured AMP in civil structures and buildings

The AMP for various structures and buildings are as per applicable design codes (mostly on CSA and ASME, ASTM, etc.). The various procedures developed are based on above codes / documents and are very detailed and self-sufficient.

3. ASSESSMENT OF THE SAFETY ISSUES

3.1. PRESENTATION AND TREATMENT OF THE SAFETY ISSUES

3.1.1. General

In this section of the report, the technical safety issues of the peer review performed by the IAEA Review Team are presented in detail, following a standard format for all Engineering Safety Review Services.

The safety issues are presented in sequence and numbered, with an "*issue sheet*" specific for each safety issue. Basically, each *"issue sheet*" consists of the following sections:

For the first review mission on the subject:

(1) Issue Identification;
(2) Issue Clarification;
(3) Counterpart views and measures (self-assessment by the counterpart);
(4) Assessment by the Review Team.

For the follow-up missions on the same subject (clarification: for each follow-up mission, new sections as 5 and 6 below are added, with sequential numbering):

(5) Counterpart actions;
(6) Follow-up assessment by the IAEA Review Team.

In the Issue Clarification section of each "*issue sheet*", a clear reference to the relevant corresponding paragraph in the IAEA Safety Standards used in the review is indicated, as it was used for the review.

If, as an outcome of a follow-up mission, a new safety issue appears with respect to the previous ones, a new "*issue sheet*" will be generated.

3.1.2. Comments on Sections 3 and 5 of "Issue Sheet"

The purpose of Sections 3 and 5 of the Issue Sheets is to reflect the views of and the measures taken by the Counterpart for the issue resolution, including the self-assessment.

3.1.3. Comments on Sections 4 and 6 of "Issue Sheet"

The purpose of Sections 4 and 6 of the Issue Sheets is to reflect the discussions with the Counterpart experts, to record the conclusions, to issue possible recommendations and to synthesize the expert's judgment on the resolution of the safety issue under discussion. In the present mission, the issues and recommendations from previous missions are considered as basic reference for the review.

Therefore, in these sections, included are the comments, recommendations/suggestions and documents reviewed by the IAEA Review Team, resulting from the assessment performed during the mission. As a result of such assessment, "comments", "recommendations" and "suggestions" are provided on the basis of the following criteria;

Comments: They are a summary of the findings of the review performed and of the discussions during the mission, including at the end the conclusions on the status of the issue under consideration.

Recommendation: This gives advice of the external experts of the IAEA Review Team, provided in order to resolve a deviation from the IAEA Safety Standards and/or from the international recognized practice in the subject.

Suggestion: A suggestion either is an additional proposal in conjunction with a recommendation or may stand on its own following a discussion of the pertinent background. It may indirectly contribute to improvements in the reviewed subject but is primarily intended to make useful expansions to existing programmes and to point out possible superior alternatives to on-going work.

Comments, recommendations and suggestions are numbered in a sequential order for further reference. The reviewed documents, corresponding specifically to the safety issue under consideration, are also listed.
Each recommendation and suggestion, whenever possible, is referenced to the relevant requirement/recommendation of respective IAEA safety standard, and other reference documents.

3.1.4. Main structure for the reviewed issues

The following six (6) main "*Reviewed Areas*" are considered to group the issues identified during the IAEA peer review missions, as follows:

Reviewed Area: A Organization and Functions, Configuration/ Modification Management;

Reviewed Area: **B** Safety analysis reports and existing plant programmes relevant for LTO;

Reviewed Area: C Review of ageing management programmes and related TLAAs for mechanical SCs;

Reviewed Area: D Review of ageing management programmes and related TLAAs for electrical and I&C components;

Reviewed Area: E Review of ageing management programmes and related TLAAs for civil structures and components;

Reviewed Area: F Review of radiological environmental impact.

The following table summarizes the situation of the issues:

Issue No.	**Issue Title**	**Rec.**	**Sug.**
Reviewed Area A: Organization and Functions, Configuration/ Modification Management			
A-1	Definition of lifetime in FSAR for continued operation	**-**	**1**
A-2	QA related to documentation and record keeping for LTO	**-**	**2**
Reviewed Area B: Safety analysis reports and existing plant programmes relevant for LTO			
B-1	Structure and comprehensiveness of the PSR	**-**	**1**
B-2	Scope of the CO evaluation	**1**	**-**
B-3	Coverage and interfaces of different programmes that manage ageing of SSCs in the scope of the CO evaluation	**-**	**1**
B-4	Evaluation of effectiveness of programmes to manage ageing of active subcomponents	**-**	**1**
Reviewed Area C: Review of ageing management programmes and related TLAAs for mechanical SCs			
C-1	Operating experince related to vibration fatigue	**-**	**1**
C-2	Reactor assembly subcomponents excluded from inspection	**-**	**1**
Reviewed Area D: Review of ageing management programmes and related TLAAs for electrical and I&C components			
D-1	Insufficient attributes of TLAA and EQ for MOV and cables	**-**	**2**
D-2	Seismic fixing of electric/I&C equipment	**1**	**1**
Reviewed Area E: Review of ageing management programmes and related TLAAs for civil structures and components			
E-1	Preventive actions to minimize and control ageing degradation of reactor building containment	**1**	**-**
E-2	Measurement of loss of pre-stress force and corrosion in the tendons for Reactor Building containment	**1**	**-**
Reviewed Area F: Review of radiological environmental impact			
F-1	Suitability of atmospheric dispersion model for gaseous releases	**1**	**-**

4. REFERENCES

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Ageing Management for Nuclear Power Plants, Safety Standards Series Safety Guide No. NS-G-2.12, IAEA, Vienna (2009).

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Safety Report Series No. 57, Safe long term operation of nuclear power plants, IAEA, Vienna (2008).

[3] INTERNATIONAL ATOMIC ENERGY AGENCY, Final Report of the Programme on Safety Aspects of Long Term Operation of Water Moderated Reactors, IAEA, Vienna (2007).

[4] INTERNATIONAL ATOMIC ENERGY AGENCY, Periodic Safety Review of Nuclear Power Plants, Safety Standards Series Safety Guide No. NS-G-2.10, IAEA, Vienna (2003).

[5] INTERNATIONAL ATOMIC ENERGY AGENCY, "Plant Life Management for Long Term Operation of Light Water Reactors", Technical Report Series No.448, IAEA, Vienna (2006).

[6] INTERNATIONAL ATOMIC ENERGY AGENCY, Equipment Qualification in Operational Nuclear Power Plants: Upgrading, Preserving and Reviewing, Safety Report Series No. 3, IAEA, Vienna (1998).

[7] INTERNATIONAL ATOMIC ENERGY AGENCY, Safety of Nuclear Power Plants: Design, Specific Safety Requirements No. SSR-2/1, IAEA, Vienna (2012).

[8] INTERNATIONAL ATOMIC ENERGY AGENCY, Maintenance, Surveillance and In-service Inspection of Nuclear Power Plants, Safety Standards Series Safety Guide No. NS-G-2.6, IAEA, Vienna (2002).

[9] INTERNATIONAL ATOMIC ENERGY AGENCY, Chemistry Programme for Water Cooled Nuclear Power Plants, Specific Safety Guide No. SSG-13, IAEA Vienna (2012).

[10] INTERNATIONAL ATOMIC ENERGY AGENCY, SALTO Guidelines, Guidelines for peer review of long term operation and ageing management of nuclear power plants, IAEA Services Series No. 17, IAEA, Vienna (2008).

[11] Preparatory Meeting Report, Terms of Reference for Peer Review Mission for Wolsong Nuclear Power Plant Unit 1 in Korea, IAEA, Vienna, Austria, February 2012.

[12] The Meeting Minutes of the kick-off meeting between IAEA and KHNP/ KEPCO E&C counterparts for IAEA Peer Review activities on "Safe Long Term Operation (SALTO) for Wolsong Nuclear Power Plant in the Republic of Korea (ROK)", IAEA, Vienna, Austria, 20–21 September, 2011.

[13] Minutes of the preparatory meeting between IAEA and Wolsong NPP for IAEA SALTO Peer-Review Mission, Wolsong NPP, Republic of Korea, 08 – 09 February, 2012.

[14] Advance Information Package for IAEA SALTO Peer Review of Continued Operation for Wolsong NPP Unit 1, KHNP, Republic of Korea, April 2012.

[15] INTERNATIONAL ATOMIC ENERGY AGENCY, Periodic Safety Review of Operational Nuclear Power Plants, Safety Series No. 50-SG-012, IAEA, Vienna (1994).

[16] INTERNATIONAL ATOMIC ENERGY AGENCY, Safety of Nuclear Power Plants: Commissioning and Operation, Specific Safety Requirements No. SSR-2/2, IAEA, Vienna (2011).

[17] INTERNATIONAL ATOMIC ENERGY AGENCY, Safety Guide No. NS-G-3.2 Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants

[18] INTERNATIONAL ATOMIC ENERGY AGENCY, Safety Report Series No. 19, Generic Models for Use in Assessing the Impact of Discharges of Radioactive Substances to the Environment, IAEA, Vienna (2001).

[19] INTERNATIONAL ATOMIC ENERGY AGENCY, Regulations for the Safe Transport of Radioactive Material, Safety Requirements No. TS-R-1, IAEA, Vienna (2003).

[20] INTERNATIONAL ATOMIC ENERGY AGENCY, Nuclear Security Recommendations on Radioactive Material and Associated Facilities, Nuclear Security Series No. 14, IAEA, Vienna (2011).

[21] INTERNATIONAL ATOMIC ENERGY AGENCY, Clearance Levels for Radionuclides in Solid Materials, TECDOC-855, IAEA, Vienna (1996).

5. ABBREVIATIONS AND GLOSSARY FOR THE MISSION

AMAT	Ageing Management Review Team
AMP	Ageing management programme
AMR	Ageing management review
ASME	American Society of Mechanical Engineers
CFR	US Code of Federal Regulations
CRI	Central Research Institute
CO	Continued operation (equivalent to the IAEA term “LTO”)
EBP	Extra-budgetary programme
ERP (SAP)	Enterprise recourse planning
EPS DG	Emergency power supply diesel generator
EQ	Equipment qualification
FRS	Fragility response spectra
FSAR	Final Safety Analysis Report
IAEA	International Atomic Energy Agency
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IRRS	Integrated Regulatory Review Service
ISI	In-service inspection
I&C	Instrumentation & control
KINS	Korean Institute of Nuclear Safety
KHNP	Korea Hydro & Nuclear Power Co.
LBB	Leak before break concept
LTO	Long term operation
MEST	Ministry of Education, Science and Technology
MOV	Motor Operated Valve
NDT	Non-destructive testing
NEI	Nuclear Energy Institute
NPP	Nuclear power plant
NRC	Nuclear Regulatory Commission
NSSC	Nuclear Safety & Security Commission
PSR	Periodic safety review
RCA	Radiation controlled area
REI	Radiological environmental impact
SALTO	Safety aspects of long term operation
SBO	Station black-out
SC	Structures and components

SCA	Secondary control area
SLMS	Structure Life Management System
SOV	Solenoid operated valve
SSC	Systems, structures and components
USNRC	United States Nuclear Regulatory Commission
TLAA	Analysis using time limiting assumptions (Time limited ageing analysis)
TRS	Test response spectrum

Ageing

General process in which characteristics of a structure, system or component gradually change with time or use.

Ageing Management

Engineering, operations and maintenance actions to control within acceptable limits ageing degradation and wear out of structures, systems or components.

- Examples of engineering actions include design, qualification, and failure analysis. Examples of operations actions include surveillance, carrying out operational procedures within specified limits, and performing environmental measurements.
- Life management (or life cycle management) is the integration of ageing management with economic planning to: (1) optimize the operation, maintenance and service life of structures, systems and components; (2) maintain an acceptable level of performance and safety; and (3) maximize return on investment over the service life of the facility.

Design Basis

The range of conditions and events taken explicitly into account in the design of a facility, according to established criteria, such that the facility can withstand them without exceeding authorized limits by the planned operation of safety systems.

Design life

Period during which a System, Structure or Component is expected to function within criteria

Licensing Basis

A set of regulatory requirements, applicable to a nuclear facility.

Periodic Safety Review

A systematic reassessment of the safety of a nuclear power plant carried out at regular intervals to deal with the cumulative effects of ageing, modifications, operating experience, technical developments and site aspects that are aimed at ensuring a high level of safety throughout plant service life.

Analysis using time limited assumptions (TLAA)

Plant specific calculations and safety analysis (Time Limited Ageing Analysis or Residual Life Assessment) using time limited assumptions that are based on an explicitly assumed time of plant operation or design life. The licensee calculations and analyses:

- Involve systems, structures, and components within the scope of license renewal or life extension;
- Consider the effects of ageing;
- Involve time-limited assumptions defined by the current operating term, for example, 40 years;
- Were determined to be relevant by the licensee in making a safety determination;
- Involve conclusions or provide the basis for conclusions related to the capability of the system, structure, and component to perform its intended functions; and
- Are contained or incorporated by reference in the Current Licensing Basis.

APPENDIX I - LIST OF PARTICIPANTS

I.1. IAEA REVIEW TEAM

IAEA STAFF MEMBER:		
1. KRIVANEK, Robert	Team Leader	**IAEA/NSNI/ Operational Safety Section**
2. LIPAR, Miroslav	IAEA representative for exit meeting and press conference	**IAEA/NSNI/ Operational Safety Section Head**
IAEA EXTERNAL EXPERTS:		
3. LISZKA, Ervin	Reviewer A	**Sweden, Swedish Radiation Safety Authority**
4. INAGAKI, Takeyuki	Reviewer B	**Japan, TEPCO**
5. ZENG, Zhaojing	Reviewer C	**Canada, CNSC**
6. THOMA, Kurt	Reviewer D	**Switzerland, Consultant**
7. SHRIVASTAVA, Arvind	Reviewer E	**India, Nuclear Power Corporation of India Limited**
8. POSPICHAL, Jiri	Reviewer E	**Czech Republic, CEZ**

I.2. KOREAN AND OTHER ORGANIZATIONS

REGULATORY BODY : KINS (KOREA INSTITUTE OF NUCLEAR SAFETY)		
Auh, Geun-Sun	Project Manager for Wolsong NPPs Safety Review	
KHNP (HEAD OFFICE)		
BAN, Sung-Hwan	General Manager for Continued Operation of Wolsong NPP Unit 1	
JEONG, Yeong Sik	Senior Manager for Continued Operation of Wolsong NPP Unit 1	
KHNP (CENTRAL RESEARCH INSTITUTE)		
LEE, Sang-Joon	General Manager PSR Team	
YUN, Bong-Yo	Wolsong NPP Counterpart of Review Area A	
WON, Se-Youl	Wolsong NPP Counterpart of Review Area B	
LEE, Kyoung-Soo	Wolsong NPP Counterpart of Review Area C	
PARK, Kyung-Heum	Wolsong NPP Counterpart of Review Area D	
HA, Chew-Wung	Wolsong NPP Counterpart of Review Area D	
JOO, Kwang-Ho	Wolsong NPP Counterpart of Review Area E	
LEE, Gab-Bock	Wolsong NPP Counterpart of Review Area F	
KIM, Sung-Min	Wolsong NPP Counterpart of Review Area F	
KHNP (WOLSONG NUCLEAR POWER PLANT)		
SEO, Un-Sik	Wolsong NPP HPP	

HA, Soo-Young	Wolsong NPP Site Co-ordinator	
KIM, Kang-Hyun	Wolsong NPP Counterpart of Review Area A	
KIM, Woo-Il	Wolsong NPP Counterpart of Review Area B	
JUNG, Won-Soo	Wolsong NPP Counterpart of Review Area C	
LIM, Sam-Rok	Wolsong NPP Counterpart of Review Area D	
PARK, Tae-Yoon	Wolsong NPP Counterpart of Review Area D	
KIM, Hyun-Woo	Wolsong NPP Counterpart of Review Area E	
LEE, Sang-Ik	Wolsong NPP Counterpart of Review Area F	
SUH, Euy-Suk	Wolsong NPP Counterpart of Review Area F	
KEPCO E&C		
JUNG , Sung-Gyu	Project Manager for PSR Area A	
OH, Young-Jin	Senior Engineer Area A	
YANG, Yun-Young	Senior Engineer Area B	
ROH, Heui-Young	Senior Engineer Area B	
Kim, Hyun-Su	Senior Engineer Area C	
OH, Chang-Kyun	Senior Engineer Area C	

PARK, Jin-Seok	Senior Engineer Area C	
YOO, Mo-Sang	Senior Engineer Area D	
WANG, Soon-Myun	Senior Engineer Area E	
HYUNDAI ENGINEERING		
Lim, Young-Kyu	Lead Engineer Area F	
PONU TEC		
LEE, Pil-Ju	Engineer Area D	

APPENDIX II - MISSION PROGRAMME

Day 1, Monday 28 May	AM	Arrival of team members to Incheon airport in Seoul till noon
	PM	13:00 Transportation from Incheon airport to the hotel from airport organized by counterpart Arrival of residual team members to Ulsan airport 17:00 Transportation from Ulsan airport to the hotel organized by counterpart Accommodation in Hyundai hotel in Gyeongju 20:00 **IAEA team briefing**, preparatory activities Pre-meeting with counterparts (main counterparts)
Day 2, Tuesday 29 May	AM	8:30 Departure from the hotel 9:00 – 9:30 Blood tests in a hospital in Gyeongju 10:15 – 10:30 Entrance procedure in NPP 10:30 – 12:30 **IAEA team training – 1. part**
	PM	13:30 **Interview for Korean TV** – Team Leader 14:00 – 16:00 **Entry meeting** 16:00 – 17:30 **IAEA team training – 2. part** 17:30 – 18:00 **Initial Working Group meeting** – planning for Wednesday 18:00 Departure to the hotel
Day 3, Wednesday 30 May	AM	7:40 Departure from the hotel 8:30 – 12:30 **Parallel sessions- Groups A - F** (review)
	PM	13:30 – 16:00 **Parallel sessions - Groups A - F** – interview and discussion 16:00 – 16:30 Preparation for Team meeting 16:30 – 17:30 **Team Meeting with main counterpart** 18:00 Departure to the hotel
Day 4, Thursday 31 May	AM	7:40 Departure from the hotel 8:30 – 12:30 **Parallel sessions - Groups A - F** – interview and discussion
	PM	13:30 – 16:00 All the groups - **Plant Walk-down** (in 4 groups) 16:00 – 16:30 Preparation for Team meeting 16:30 – 17:30 **Team Meeting with main counterpart** 18:00 Departure to the hotel
Day 5, Friday 1 June	AM	7:40 Departure from the hotel 8:30 – 12:30 **Parallel sessions - Groups A - F** – interview and discussion
	PM	13:30 – 16:00 **Parallel sessions - Groups A - F** – interview and discussion 16:00 – 16:30 Preparation for Team meeting 16:30 – 17:30 **Team Meeting with main counterpart** 18:00 Departure to the hotel
Day 6, Saturday 2 June	AM	Work day – **Team meeting** - discussion of interim review results Start draft Technical Notes
	PM	Drafting of Technical Notes, bilateral discussions of team members,

		Team Meeting
Day 7, Sunday 3 June		Free
Day 8, Monday 4 June	AM	7:40 Departure from the hotel 8:30 – 12:30 **Parallel sessions - Groups A - F** – interview and discussion
	PM	13:30 – 16:00 **Parallel sessions - Groups A - F** – interview and discussion 16:00 – 16:30 Preparation for Team meeting 16:30 – 17:30 **Team Meeting with main counterpart** - discussion of the overall findings 18:00 Departure to the hotel
Day 9, Tuesday 5 June	AM	7:40 Departure from the hotel 8:30 – 12:30 **Team Meeting** - Discussion of the draft report within the team
	PM	13:30 – 16:30 **Preparation of the mission report** 16:30 – 17:30 **Team Meeting with main counterpart** 18:00 Departure to the hotel
Day10, Wednesday 6 June	AM	7:40 Departure from the hotel 8:30 – 12:30 **Preparation of the mission report, counterparts review the draft simultaneously**
	PM	13:30 – 15:00 **Discussion of the draft report with counterparts** 15:00 – 16:30 **Revision of the draft based on counterpart's comments** 16:30 – 17:30 **Agree the issues and recommendations/suggestions between the team and the counterparts** 18:00 Departure to the hotel
Day 11, Thursday 7 June	AM	7:40 Departure from the hotel 8:30 – 10:00 **Concluding session** (all Counterparts/ IAEA team members) 10:30 – 11:30 **Exit meeting** - (including plant management, regulatory 11:30 – 12:00 **Press Conference**
	PM	13:00 Transportation of the team to the hotel

Reference timetable:
AM: 8:30-12:00
PM: 13:00-16:00
Preparation for team meeting including arrangement for the next day with counterpart: 16:00-16:30
Daily IAEA team meeting with representative counterpart (max. 2 persons): 16:30-17:30

APPENDIX III - ISSUE SHEETS

ISSUE SHEET		
1. ISSUE IDENTIFICATION	Issue Number:	**A - 1**
NPP: Wolsong		
Unit: 1		
Reviewed Area: Organization and Functions, Configuration/Modification management		
Issue Title: Definition of lifetime in final safety analysis report (FSAR) for continued operation		
2. ISSUE CLARIFICATION		
2.1 - ISSUE DESCRIPTION: Definition of life time for LTO is used in respect of continued operation in an unsuitable way.		
2.2 - REFERENCE TO IAEA SAFETY STANDARDS • GS-G-4.1 (2004) • NS-G-2.10 • NS-G-2.12(2009) • SR 57 (2008)		
3. COUNTERPART VIEWS AND MEASURES (self-assessment by the Counterpart)		
The counterpart agrees with this issue. C1) Article 36 of Enforcement Decree of Nuclear Safety Act states that continued operation refers to extension of operation of reactor facilities after their "Design Life" is expired. So, the sentence mentioning "Design Life of 30 years" can't be corrected. However, we can include the phrase of "the total expected operation period" in the revised FSAR for CO as the reviewer suggested. C2) It was confirmed that design life of major facilities was extended due to replacement of major facilities including pressure tubes and that continued operation of additional 10 years for safety-related facilities is possible through ageing assessment and TLAA. Revised FSAR submitted for approval of the regulatory body states results of the aging assessment and TLAA. It, also, states that the integrity of relevant facilities can be managed. As the reviewer mentioned in his comment like the following, "FSAR should reflect the technical limitation existing by presence of both updated (refurbished) systems together with original components in service", we can reflect that under the agreement of the regulatory body.		

4. ASSESSMENT BY THE IAEA REVIEW TEAM	Date:	07/06/2012

4.1 – COMMENTS:

C1) Draft FSAR used for application for CO is stating period of further operation in relation to original design life and additional 10 years. Definition of design life as limiting factor for operation is no more valid for such period as it will continue beyond period of time during which plant was expected to perform according to the original technical specifications to which it was produced.

C2) In the draft FSAR impact of refurbishment performed is mentioned (exchange of calandria tubes), but in this plant new state an overall limiting factor for further safe operation should be related to original components and their TLAAs for period of CO.

4.2 – RECOMMENDATIONS/SUGGESTIONS:

S1) Consideration should be given to the total expected operational period and define this period explicitly in order to recognise and clearly define validity of FSAR. The FSAR should reflect the technical limitation existing by presence of both refurbished systems and original components in service. Consideration should be given to assess the most important limiting factors for coming period of CO.

4.3 – DOCUMENTS REVIEWED:

- AIP SALTO Wolsong 1, 2012
- Flow chart – design changes, KHNP Corporate standard for maintenance (2002)
- QA programme Wolsong 1 – presentation
- Draft FSAR / 2 pages
- Current FSAR /2 pages

5. COUNTERPART ACTIONS	Date:	

n.a.

6. FOLLOW-UP ASSESSMENT BY THE IAEA REVIEW TEAM	Date:	

6.1 – COMMENTS:

C1) n.a.

6.2 – RECOMMENDATIONS/SUGGESTIONS:

R1) n.a.

S1) n.a.

6.3 – DOCUMENTS REVIEWED:

n.a.

STATUS OF THE ISSUE			**Date: 07/06/2012**	**Date: D2/M2/Y2**
1 – Resolution Degree:				
1.	**No action**	*The issue was not identified by the Counterpart, or having been identified, no action was taken to resolve it.*		n.a.
		No progress in the resolution of the issue, or unsatisfactory resolution.	n.a.	n.a.
2.	**Action under way**	*The issue was identified by the Counterpart, but the actions did not comply with IAEA SSS.*	X	n.a.
		The issue was identified by the Counterpart and work has started to resolve it.	n.a.	n.a.
3.	**Issue partially resolved**	*The issue was identified by the Counterpart and actions are underway but no results are available yet.*		n.a.
		The implemented actions meet partially the intent of recommendations of previous IAEA review.	n.a.	n.a.
4.	**Issue resolved**	*The issue was identified by the Counterpart and the solution provided is fully satisfactory. Issue closed.*	n.a.	n.a.
		The intent of recommendations of previous IAEA review is fully met. Issue closed.	n.a.	n.a.
2 – Urgency degree:				
I	The issue should be addressed before the actual date of the LTO (November 21st, 2012)		X	n.a.
II	The issue should be addressed before (*indicate a key date*)			n.a.

n.a.: not applicable for the present mission.

ISSUE SHEET		
1. ISSUE IDENTIFICATION	Issue Number:	**A – 2**
NPP: Wolsong		
Unit: 1		
Reviewed Area: Organization and Functions, Configuration/Modification management		
Issue Title: QA related to documentation and records` keeping for LTO		
2. ISSUE CLARIFICATION		
2.1 - ISSUE DESCRIPTION: Lack in maintenance records and quality assurance checks and use of unauthorized documents.		
2.2 - REFERENCE TO IAEA SAFETY STANDARDS • GS-G-3.1 • NS-G-2.6 • NS-G-2.7 • NS-G-2.12 • SR 57		
3. COUNTERPART VIEWS AND MEASURES (self-assessment by the Counterpart)		
The counterpart disagrees with reviewer's comment as below: C1) Documents of KHNP have been managed in accordance with Pyojungihang (procedure of corporation)-JaRhyou-02 "document management", following relevant regulation. Document management system of KHNP describes which document should be managed electronically and which document should be managed in hard copies. When it comes to the data before 2003, KHNP uses conservatively the generic data for reliability analysis. That is why there is no problem in managing reliability analysis of the facilities. In addition, this issue is not related to QA because all data is being properly managed by relevant procedures. C2) This comment is not related to our status. In addition, counterpart had no chance to correct the reviewer's misunderstanding. The electronic approval system in ERP of KHNP stores and manages documents after receiving of approval from the person in charge of each document. The ERP system can store the documents only with approval. The reviewer only saw some parts of document except for its cover sheet which include the signature of approval This issue, therefore, is not related to QA (refer to the attachment 1: QA approval document)		

C3) For proper operation of gamma spectroscopy, environment-4-0002, operational procedure documents have been made and, based on that procedure, the status of the measuring equipment has been checked regularly. Calibration and measurement documents proving the integrity of gamma spectroscopy have been stored electronically and managed, So the QA has been managed properly.

S1) Even though current QA system is appropriate enough for the CO, all the maintenance record data before 2003 will be integrated into the ERP as electronic file of photocopy for the improvement of QA,

S2) As an aspect of the QA document management system, KHNP always makes a best effort to keep full consistency between electronic and printed hardcopy version. Therefore, the counterpart disagrees with suggestion 2 of this issue sheet A-2.

4. ASSESSMENT BY THE IAEA REVIEW TEAM	Date:	07/06/2012

4.1 – COMMENTS:

C1) The maintenance records of electric equipment/components are stored in two different systems. Until 2004 record keeping has been in hardcopy after that stored electronically in ERP. It is hard to make reliable analysis for failure rate in the view of LTO.

C2) Inconsistence of electronic and hardcopy versions of documents. QA checklists in hardcopy are missing signatures while electronic versions have evidence of approval and are also electronically signed. Some of documents with regulatory requirements do not have document numbers in hardcopy version. The Screening Evaluation Work Sheet in electric department has no document number, the numbering of pages is also missing. The referenced documentation like walk down reports is not identified by id numbers.

C3) Lack in quality assurance of checks and/or records on off-site RP laboratory - Off-site KHNP environmental laboratory uses gamma spectrometry for measurement of environmental samples. Laboratory staff checks quality of measurement parameters like peak position, resolution and background. They are no records about resolution and background.

4.2 – RECOMMENDATIONS/SUGGESTION:

S1) Consideration should be given to integrate all the maintenance record data for electric systems and equipment commodities groups into the ERP.

S2) Consideration should be given to keep full consistency between electronic and printed hardcopy version QA of the document management system.

4.3 – DOCUMENTS REVIEWED:

- The Screening Evaluation Work Sheet (SEWS)
- Integrated Guidelines of SG Management Programme – 2009.9
- Operational procedure for gamma spectrometry, Environment-4-002, weekly checklist

5. COUNTERPART ACTIONS	Date:	
n.a.		
6. FOLLOW-UP ASSESSMENT BY THE IAEA REVIEW TEAM	Date:	
6.1 – COMMENTS: **C1)** n.a.		
6.2 – RECOMMENDATIONS/SUGGESTIONS: **R1)** n.a. **S1)** n.a.		
6.3 – DOCUMENTS REVIEWED: n.a.		

STATUS OF THE ISSUE			**Date:** **07/06/2012**	**Date:** **D2/M2/Y2**
1 – Resolution Degree:				
1.	**No action**	*The issue was not identified by the Counterpart, or having been identified, no action was taken to resolve it.*	X	n.a.
		No progress in the resolution of the issue, or unsatisfactory resolution.	n.a.	n.a.
2.	**Action under way**	*The issue was identified by the Counterpart, but the actions did not comply with IAEA SSS.*		n.a.
		The issue was identified by the Counterpart and work has started to resolve it.	n.a.	n.a.
3.	**Issue partially resolved**	*The issue was identified by the Counterpart and actions are underway but no results are available yet.*		n.a.
		The implemented actions meet partially the intent of recommendations of previous IAEA review.	n.a.	n.a.
4.	**Issue resolved**	*The issue was identified by the Counterpart and the solution provided is fully satisfactory. Issue closed.*	n.a.	n.a.
		The intent of recommendations of previous IAEA review is fully met. Issue closed.	n.a.	n.a.
2 – Urgency degree:				
I	The issue should be addressed before the actual date of the LTO (November 21st, 2012)			n.a.

II	The issue should be addressed before 31 December 2013.	X	n.a.

n.a.: not applicable for the present mission.

ISSUE SHEET		
1. ISSUE IDENTIFICATION	Issue Number:	**B - 1**
NPP: Wolsong		
Unit: 1		
Reviewed Area: Safety analysis reports and existing plant programmes relevant for LTO		
Issue Title: Structure and comprehensiveness of the PSR		
2. ISSUE CLARIFICATION		
2.1 - ISSUE DESCRIPTION: The current PSR is not along with the latest IAEA Safety Guide on PSR.		
2.2 - REFERENCE TO IAEA SAFETY STANDARDS • IAEA Specific Safety Requirements, No. SSR-2/2, Safety of Nuclear Power Plants: Commissioning and Operation, 4.46 • IAEA Safety Guide on PSR (NS-G-2.10) 4.1		
3. COUNTERPART VIEWS AND MEASURES (self-assessment by the Counterpart)		
The counterpart agrees with this issue. The three factors (plant design, PSA, and hazard analysis) were assessed in other sections of PSR or in a separate report even though KHNP didn't assess the three factors as an independent factor. KHNP has set up Post-Fukushima action items in a prompt and systematic way. In 4.3 Document Review section Document Number change from 1227207050 7002-1 5.1 to Anjeon(pyon)75615-699 for The Report on "How to apply the new IAEA PSR Safety Guide to Korean NPPs" (August 2011) This issue will be addressed by April 30, 2013.		
4. ASSESSMENT BY THE IAEA REVIEW TEAM	Date:	07/06/2012
4.1 – COMMENTS: **C1)** The current PSR report has 11 safety factors while the latest IAEA Safety Guide on PSR recommends 14 safety factors. "Plant Design" is not an independent factor and one factor		

"Safety Analysis" is used instead of the three factors, i.e. "Deterministic Safety Analysis", "Probabilistic Safety Analysis (PSA)" and "Hazard Analysis".

C2) This issue is basically due to the Korean regulatory requirements which refer to the previous IAEA Safety Guide. The IAEA IRRS team for the Korean Regulatory Body suggested revise the requirements to make them along with the latest IAEA Safety Guide.

C3) The plant performed a comparison study of the current PSR contents against the 14 safety factors prescribed in the latest Safety Guide. The result of the study was that plant had performed necessary analyses, such as the hazard analysis and PSA, and acquired necessary information to meet the 14 factors. They are currently either shown in the different sections of the current PSR report or preserved in documents such as a PSA report that are independent from the PSR.

C4) The plant has also commenced activities to further improve the necessary information for the 14 factors.

C5) Evaluation of the Fukushima accident and setting up necessary actions are currently performed separately from the PSR due to the time constraint, although these activities are important elements of the PSR.

4.2 – RECOMMENDATIONS/SUGGESTIONS:

S1) Consideration should be given to further facilitate the current activities to supplement and make the PSR consistent with the latest IAEA Safety Guide and finalize these activities as soon as possible. Consideration should also be given by the plant to incorporate activities to evaluate the Fukushima accident and set up necessary actions into PSR activities in the future.

4.3 – DOCUMENTS REVIEWED:

- Advanced Information Package
- The PSR report (May 2003)
- The PSR report (Dec 2009)
- The Report on "How to apply the new IAEA PSR Safety Guide to Korean NPPs" (August 2011), 1227207050 7002-1 5.1
- The draft interim report on comparison the PSR to the latest IAEA Safety Guide (May 2012)

5. COUNTERPART ACTIONS	Date:	
n.a.		
6. FOLLOW-UP ASSESSMENT BY THE IAEA REVIEW TEAM	Date:	

6.1 – COMMENTS:

C1) n.a.

6.2 – RECOMMENDATIONS/SUGGESTIONS:

R1) n.a.

S1) n.a.

6.3 – DOCUMENTS REVIEWED:

n.a.

STATUS OF THE ISSUE			**Date: 07/06/2012**	**Date: D2/M2/Y2**
1 – Resolution Degree:				
1.	**No action**	*The issue was not identified by the Counterpart, or having been identified, no action was taken to resolve it.*		n.a.
		No progress in the resolution of the issue, or unsatisfactory resolution.	n.a.	n.a.
2.	**Action under way**	*The issue was identified by the Counterpart, but the actions did not comply with IAEA SSS.*		n.a.
		The issue was identified by the Counterpart and work has started to resolve it.	n.a.	n.a.
3.	**Issue partially resolved**	*The issue was identified by the Counterpart and actions are underway but no results are available yet.*	X	n.a.
		The implemented actions meet partially the intent of recommendations of previous IAEA review.	n.a.	n.a.
4.	**Issue resolved**	*The issue was identified by the Counterpart and the solution provided is fully satisfactory. Issue closed.*	n.a.	n.a.
		The intent of recommendations of previous IAEA review is fully met. Issue closed.	n.a.	n.a.
2 – Urgency degree:				
I	The issue should be addressed before the actual date of the LTO (November 21st, 2012)			n.a.
II	The issue should be addressed before April 30, 2013.		X	n.a.

n.a.: not applicable for the present mission.

ISSUE SHEET		
1. ISSUE IDENTIFICATION	Issue Number:	**B - 2**
NPP: Wolsong		
Unit: 1		
Reviewed Area: Safety analysis reports and existing plant programmes relevant for LTO		
Issue Title: Scope of the Continued Operation (CO) evaluation		
2. ISSUE CLARIFICATION		
2.1 - ISSUE DESCRIPTION: Station black-out (SBO) is excluded from consideration because of the reason that the plant has redundant diesel generator systems.		
2.2 - REFERENCE TO IAEA SAFETY STANDARDS • IAEA Safety Guide, "Ageing Management for Nuclear Power Plants", NS-G-2.12, 5.1 • IAEA Safety Report Series No. 57, 4.1 SCOPE SETTING PROCESS		
3. COUNTERPART VIEWS AND MEASURES (self-assessment by the Counterpart)		
The counterpart agrees with this issue. Even though SBO is not included in the scope as Wolsong NPP Unit 1 has redundant diesel generator system, SBO evaluation has been separately conducted before Fukushima accident and some of the Post-Fukushima follow items are being implemented.		
4. ASSESSMENT BY THE IAEA REVIEW TEAM	Date:	07/06/2012
4.1 – COMMENTS: **C1)** The CO report and AIP say that as Wolsong NPP Unit 1 is a heavy water reactor NPP, the CO scope excludes pressurized thermal shock, anticipated transients without scram, and station blackout. **C2)** This issue is basically due to the Korean regulatory requirements which exclude SBO for pressurized heavy water reactors (PHWR). The basis of this exclusion is that PHWR is equipped with emergency power supply diesel generators (EPS DGs), two of them are for two units, in addition to the stand-by diesel generators, two of them are for each unit. **C3)** Although these redundant systems would make probability of SBO lower, it is impossible to completely eliminate possibility of SBO.		

C4) The fire protection wall between DG rooms has gaps and openings and the door on the wall is not locked. They are not sufficient to prevent a common cause failure of the EPS DGs due to fire.

C5) The plant has been evaluating the Fukushima Dai-ichi NPP accident and planning to have alternative mobile power supply equipment but this action is separated from the CO evaluation.

4.2 – RECOMMENDATIONS/SUGGESTIONS:

R1) The current description in the CO report related to exclusion of SBO should be revised. Ageing of equipment to cope with SBO which will be added in the future after evaluating lessons leaned from the Fukushima Dai-ichi accident should be adequately managed.

4.3 – DOCUMENTS REVIEWED:

- Advanced Information Package
- The PSR report (Dec 2009)
- The Notice of the Nuclear Safety and Security Commission (NSSC) No. 2012-25

5. COUNTERPART ACTIONS	Date:	
n.a.		

6. FOLLOW-UP ASSESSMENT BY THE IAEA REVIEW TEAM	Date:	

6.1 – COMMENTS:

C1) n.a.

6.2 – RECOMMENDATIONS/SUGGESTIONS:

R1) n.a.

S1) n.a.

6.3 – DOCUMENTS REVIEWED:

n.a.

STATUS OF THE ISSUE			**Date: 07/06/2012**	**Date: D2/M2/Y2**
1 – Resolution Degree:				
1.	**No action**	*The issue was not identified by the Counterpart, or having been identified, no action was taken to resolve it.*	X	n.a.
		No progress in the resolution of the issue, or unsatisfactory resolution.	n.a.	n.a.

2.	**Action under way**	*The issue was identified by the Counterpart, but the actions did not comply with IAEA SSS.*		n.a.
		The issue was identified by the Counterpart and work has started to resolve it.	n.a.	n.a.
3.	**Issue partially resolved**	*The issue was identified by the Counterpart and actions are underway but no results are available yet.*		n.a.
		The implemented actions meet partially the intent of recommendations of previous IAEA review.	n.a.	n.a.
4.	**Issue resolved**	*The issue was identified by the Counterpart and the solution provided is fully satisfactory. Issue closed.*	n.a.	n.a.
		The intent of recommendations of previous IAEA review is fully met. Issue closed.	n.a.	n.a.
2 – Urgency degree:				
I	The issue should be addressed before the actual date of the LTO (November 21st, 2012)		X	n.a.
II	The issue should be addressed before (*indicate a key date*)			n.a.

n.a.: not applicable for the present mission.

ISSUE SHEET		
1. ISSUE IDENTIFICATION	Issue Number:	**B - 3**
NPP: Wolsong		
Unit: 1		
Reviewed Area: Safety analysis reports and existing plant programmes relevant for LTO		
Issue Title: Coverage and interfaces of different programmes that manage ageing of SSCs in the scope of the CO evaluation		
2. ISSUE CLARIFICATION		
2.1 - ISSUE DESCRIPTION: Unclear demonstration how ageing of all SSCs is fully and adequately managed and how different programmes effectively manage ageing of these SSCs.		
2.2 - REFERENCE TO IAEA SAFETY STANDARDS • IAEA Safety Guide, "Ageing Management for Nuclear Power Plants", NS-G-2.12, 4.15 • IAEA Safety Report Series No. 57, 4.1 SCOPE SETTING PROCESS, 4.2 SCREENING PROCESS		
3. COUNTERPART VIEWS AND MEASURES (self-assessment by the Counterpart)		
The counterpart agrees with this issue. This issue will be addressed before the IAEA SALTO Follow-up mission.		
4. ASSESSMENT BY THE IAEA REVIEW TEAM	Date:	07/06/2012
4.1 – COMMENTS: **C1)** The plant established a combined evaluation process of SSCs which consists of the following elements: - ageing management reviews performed in the PSR part; - scoping/screening process, evaluation of ageing management programmes (AMPs) and time limited ageing analyses (TLAAs) including environmental qualification (EQ) programmes performed in the Life Time Evaluation part; - effective maintenance performance programme which evaluates effectiveness of maintenance, inspection and testing progarammes.		

C2) Consequently ageing of subcomponents of SSCs in the scope of the CO is managed by various programmes, e.g. :

- AMPs for passive long-lived subcomponents and structures;
- TLAAs including EQ programmes;
- Preventive maintenance programmes, in-service inspection programmes, in-service testing programmes for active subcomponents.

C3) Volume II of the draft PSR report provided matrixes which show which kind of ageing for subcomponents of all SCs in the scope, either in a specific component or structure level or in a commodity group level and that ageing of each subcomponent is managed by maintenance programme or subjected to AMR and managed by AMP. The final report, however, provides such matrixes only for electric and I&C equipment.

C4) While ageing of each subcomponents of all SCs in the scope is managed either by one programme or by combination of programmes, it is difficult to have a clear picture on whether ageing of all SSCs are fully and adequately managed and how different programmes are effectively managing ageing of those SSCs within the scope. The above mentioned matrixes shown in the draft report did not fully support comprehensive understanding, although all necessary information is available in different parts of the report.

C5) To cope with ageing of passive and long-lived subcomponents, 44 AMPs have been established. Some of them are not satisfied with all attributes necessary for ageing management by themselves alone. For example, AMP 1 "ISI programme for Safety Class Components" does not require preventive actions. It is difficult to understand how AMPs work together to cover the all necessary attributes.

4.2 – RECOMMENDATIONS/SUGGESTIONS:

S1) Consideration should be given to produce expanded matrixes that show how ageing degradations of subcomponents of all SSCs within the scope of the CO evaluation are managed by multiple programmes.

4.3 – DOCUMENTS REVIEWED:

- Advanced Information Package
- The PSR report (Dec 2009): final version submitted to the regulatory body
- The draft PSR report
- Presentations on scoping/ screening processes, AMPs, effective maintenance performance programme

5. COUNTERPART ACTIONS	Date:	
n.a.		
6. FOLLOW-UP ASSESSMENT BY THE IAEA REVIEW TEAM	Date:	

6.1 – COMMENTS:

C1) n.a.

6.2 – RECOMMENDATIONS/SUGGESTIONS:

R1) n.a.

S1) n.a.

6.3 – DOCUMENTS REVIEWED:

n.a.

STATUS OF THE ISSUE			**Date: 07/06/2012**	**Date: D2/M2/Y2**
1 – Resolution Degree:				
1.	**No action**	*The issue was not identified by the Counterpart, or having been identified, no action was taken to resolve it.*	X	n.a.
		No progress in the resolution of the issue, or unsatisfactory resolution.	n.a.	n.a.
2.	**Action under way**	*The issue was identified by the Counterpart, but the actions did not comply with IAEA SSS.*		n.a.
		The issue was identified by the Counterpart and work has started to resolve it.	n.a.	n.a.
3.	**Issue partially resolved**	*The issue was identified by the Counterpart and actions are underway but no results are available yet.*		n.a.
		The implemented actions meet partially the intent of recommendations of previous IAEA review.	n.a.	n.a.
4.	**Issue resolved**	*The issue was identified by the Counterpart and the solution provided is fully satisfactory. Issue closed.*	n.a.	n.a.
		The intent of recommendations of previous IAEA review is fully met. Issue closed.	n.a.	n.a.
2 – Urgency degree:				
I	The issue should be addressed before the actual date of the LTO (November 21st, 2012)			n.a.
II	The issue should be addressed before December 31st, 2013.		X	n.a.

n.a.: not applicable for the present mission.

ISSUE SHEET		
1. ISSUE IDENTIFICATION	Issue Number:	**B - 4**
NPP: Wolsong		
Unit: 1		
Reviewed Area: Safety analysis reports and existing plant programmes relevant for LTO		
Issue Title: Evaluation of effectiveness of programmes to manage ageing of active subcomponents		
2. ISSUE CLARIFICATION		
2.1 - ISSUE DESCRIPTION: For the evaluation process of effectiveness of programmes to manage ageing of active subcomponents introduced in the plant, the CO report does not provide satisfactory descriptions to justify the current method is satisfied with the necessary attributes for ageing management.		
2.2 - REFERENCE TO IAEA SAFETY STANDARDS • IAEA Safety Guide, "Ageing Management for Nuclear Power Plants", NS-G-2.12, 4.32 • IAEA Safety Report Series No. 57, 5.3 REVIEW OF EXITING PLANT PROGRAMMES AND PROPOSED PROGRAMMES FOR AGEING MANAGEMENT		
3. COUNTERPART VIEWS AND MEASURES (self-assessment by the Counterpart)		
The counterpart agrees with this issue.		
4. ASSESSMENT BY THE IAEA REVIEW TEAM	Date:	07/06/2012
4.1 – COMMENTS: **C1)** To monitor and evaluate the effectiveness of programmes to manage ageing of active subcomponents, the plant has established an effective maintenance performance monitoring programme, which is based on the maintenance rule used in the USA. **C2)** Along with the programme, failure mode, effects and criticality analysis (FMECA) has been performed for active components important to safety, which takes ageing effects and relevant programmes into account. Current status data are also collected and used to improve the maintenance programmes. **C3)** Therefore effectiveness of programmes to manage ageing degradations of active		

components/subcomponents, such as a pump shaft, impeller and seal, is being evaluated through the above mentioned programme.

C4) However, description to justify that shows the above programme is satisfied with or equivalent comparing to the attributes necessary for AMPs is missing from the CO report.

4.2 – RECOMMENDATIONS/SUGGESTIONS:

S1) Consideration should be given to add a table in the introduction part of Chapter II of the PSR report, which demonstrates that all nine attributes are incorporated into the overall evaluation process of programmes for active components.

4.3 – DOCUMENTS REVIEWED:

- Advanced Information Package
- The report on continued operation (Dec 2009)
- Presentations on Scoping/Screening Processes, effective maintenance performance programme

5. COUNTERPART ACTIONS	Date:	

n.a.

6. FOLLOW-UP ASSESSMENT BY THE IAEA REVIEW TEAM	Date:	

6.1 – COMMENTS:

C1) n.a.

6.2 – RECOMMENDATIONS/SUGGESTIONS:

R1) n.a.

S1) n.a.

6.3 – DOCUMENTS REVIEWED:

n.a.

STATUS OF THE ISSUE			**Date: 07/06/2012**	**Date: D2/M2/Y2**
1 – Resolution Degree:				
1.	**No action**	*The issue was not identified by the Counterpart, or having been identified, no action was taken to resolve it.*	X	n.a.
		No progress in the resolution of the issue, or unsatisfactory resolution.	n.a.	n.a.

2.	**Action under way**	*The issue was identified by the Counterpart, but the actions did not comply with IAEA SSS.*		n.a.
		The issue was identified by the Counterpart and work has started to resolve it.	n.a.	n.a.
3.	**Issue partially resolved**	*The issue was identified by the Counterpart and actions are underway but no results are available yet.*		n.a.
		The implemented actions meet partially the intent of recommendations of previous IAEA review.	n.a.	n.a.
4.	**Issue resolved**	*The issue was identified by the Counterpart and the solution provided is fully satisfactory. Issue closed.*	n.a.	n.a.
		The intent of recommendations of previous IAEA review is fully met. Issue closed.	n.a.	n.a.
2 – Urgency degree:				
I	The issue should be addressed before the actual date of the LTO (November 21st, 2012)		X	n.a.
II	The issue should be addressed before (*indicate a key date*)			n.a.

n.a.: not applicable for the present mission.

ISSUE SHEET		
1. ISSUE IDENTIFICATION	Issue Number:	**C - 1**
NPP: Wolsong		
Unit: 1		
Reviewed Area: Review of Ageing Management and other LTO related activities for mechanical components		
Issue Title: Operating experince related to vibration fatigue		
2. ISSUE CLARIFICATION		
2.1 - ISSUE DESCRIPTION: Vibration fatigue is a potential degradation mechanism, but is excluded from assessment in the plant continued operation plan.		
2.2 - REFERENCE TO IAEA SAFETY STANDARDS • "Ageing Management for Nuclear Power Plants", Safety Standard Series, Safety Guide No NS-G-2.12, IAEA, Vienna (2009). • "Safe Long Term Operation of Nuclear Power Plants", Safety Reports Series No. 57, IAEA, Vienna (2008).		
3. COUNTERPART VIEWS AND MEASURES (self-assessment by the Counterpart)		
The counterpart agrees with this issue. Wolsong-1 will consider the review and feedback of operating experinces and research findings related to vibration fatigue in addition to the previous activities. *All piping of Wolsong 1 was designed in accordance with ASME Sec. III and B31.1 Codes. Temperature and pressure transients were considered in the piping design analysis based on the concept of the ASME code. No nuclear power plant has considered vibration fatigue in their TLAAs. * Wolsong NPP Unit 1 operates a nuclear information system called KONIS, which receives information from WANO, INPO, IAEA, COG, EPRI, etc. The information in KONIS is systemically reveiwed in terms of applicability to Wolsong NPP Unit 1 and follow-up actions are taken in the plant as necessary. Along the process, Wolsong Unit 1 reviewed the information related to vibration fatigue in Pickering Unit 4 and concluded that the design of Wolsong NPP Unit 1 is different from that of Pickering Unit 4 and the possibility of vibration fatigue in Wolsong NPP Unit 1 is extremely low. * Vibration is not much related with aging but with design condition. When abnormal vibration is observed in the plant, measurements and the analyses are performed to determine		

whether it is allowable or not, and corrective actions are implented as necessary. Concerned locations of vibration such as main steam piping are continually being monitored in Wolsong NPP Unit 1.
* Wolsong-1 will continue to make best efforts to ensure that information from overseas experiences are all incorporateed into the operation of the plant.

4. ASSESSMENT BY THE IAEA REVIEW TEAM	Date:	07/06/2012

4.1 – COMMENTS:

C1) Metal Fatigue Analysis is one of the plant TLAAs. But only pressure and temperature transients were considered in the analyses.

C2) Vibration fatigue is a potential degradation mechanism, but was excluded from the assessment in the plant continued operation plan.

C3) Vibration has caused degradation/failures in some of CANDU pipes.

C4) Wolsong NPP Unit 1 evaluated vibration effect and developed vibration reduction method for Wolsong NPP Unit 1 Main Steam Piping [2], but systematic review and feedback of external operation experience related to vibration fatigue has not been performed yet.

4.2 – RECOMMENDATIONS/SUGGESTIONS:

S1) Consideration should be given to establish a systematic process to review and feedback operating experince and research findings related to vibration fatigue for continued operation.

4.3 – DOCUMENTS REVIEWED:

- "Advance Information Package for IAEA SALTO Peer Review of Continued Operation for Wolsong NPP Unit 1", Korea Hydro & Nuclear Power Co., APRIL 2012.
- "A study on the evaluation of vibration effect and the development of vibration reduction method for Wolsong NPP Unit 1 Main Steam Piping", KEPRI-92G-J02, 1995.11.

5. COUNTERPART ACTIONS	Date:	

n.a.

6. FOLLOW-UP ASSESSMENT BY THE IAEA REVIEW TEAM	Date:	

6.1 – COMMENTS:

C1) n.a.

6.2 – RECOMMENDATIONS/SUGGESTIONS:

R1) n.a.

S1) n.a.

6.3 – DOCUMENTS REVIEWED:

n.a.

STATUS OF THE ISSUE			**Date: D1/M1/Y1**	**Date: D2/M2/Y2**
1 – Resolution Degree:				
1.	**No action**	*The issue was not identified by the Counterpart, or having been identified, no action was taken to resolve it.*	X	n.a.
		No progress in the resolution of the issue, or unsatisfactory resolution.	n.a.	n.a.
2.	**Action under way**	*The issue was identified by the Counterpart, but the actions did not comply with IAEA SSS.*		n.a.
		The issue was identified by the Counterpart and work has started to resolve it.	n.a.	n.a.
3.	**Issue partially resolved**	*The issue was identified by the Counterpart and actions are underway but no results are available yet.*		n.a.
		The implemented actions meet partially the intent of recommendations of previous IAEA review.	n.a.	n.a.
4.	**Issue resolved**	*The issue was identified by the Counterpart and the solution provided is fully satisfactory. Issue closed.*	n.a.	n.a.
		The intent of recommendations of previous IAEA review is fully met. Issue closed.	n.a.	n.a.
2 – Urgency degree:				
I	The issue should be addressed before the actual date of the LTO (November 21st, 2012)			n.a.
II	The issue should be addressed before 31 December 2013.		X	n.a.

n.a.: not applicable for the present mission.

ISSUE SHEET		
1. ISSUE IDENTIFICATION	Issue Number:	**C - 2**
NPP: Wolsong		
Unit: 1		
Reviewed Area: Review of Ageing Management and other LTO related activities for mechanical components		
Issue Title: Reactor assembly subcomponents excluded from inspection		
2. ISSUE CLARIFICATION		
2.1 - ISSUE DESCRIPTION: Subcomponents of reactor assembly are excluded from inspection program in the plant.		
2.2 - REFERENCE TO IAEA SAFETY STANDARDS • "Ageing Management for Nuclear Power Plants", Safety Standard Series, Safety Guide No NS-G-2.12, IAEA, Vienna (2009). • "Safe Long Term Operation of Nuclear Power Plants", Safety Reports Series No. 57, IAEA, Vienna (2008).		
3. COUNTERPART VIEWS AND MEASURES (self-assessment by the Counterpart)		
The counterpart disagrees with this issue. CSA and/or regulatory requirements for inspection of subcomponents of reactor assembly are incorporated in the inspection program of Wolsong-1. Wolsong NPP Unit 1 has been incorporating CANDU utilities experiences in inspection and monitoring for subcomponents of reactor assembly. Wolsong NPP Unit 1 is performing periodic inspection and maintenance for rupture disc of reactor assembly in consideration of Canadian utilities experiences. Wolsong NPP Unit 1 is a member of CANDU Owners Group (COG), and receives operating information and research results from COG. Wolsong NPP Unit 1 conducted a visual inspection and confirmed the integrity of the subcomponents of reactor assembly. Up to now, no additional CANDU utilities experiences is identified with regard to the inspection of the subcomponents of reactor assembly. However, if identified in the future, Wolsong NPP Unit 1 will review the operating experience and take actions as necessary.		
4. ASSESSMENT BY THE IAEA REVIEW TEAM	Date:	07/06/2012

4.1 – COMMENTS:

C1) The TLAA for Life Assessment of Reactor Assembly and Fuel Channel actually only covers Fuel Channel.

C2) Aging management program of Safety Class Components In-service Inspection (AMP 1) does not cover inspection of subcomponents of reactor assembly, but this satisfies both CSA N285.4 and Regulatory requirements.

C3) Aging management program "Reactor Assembly" (AMP 4) specifies water chemistry control as preventive, monitoring, and mitigate actions, but does not specify any inspection requirement for internal and external subcomponents of reactor assembly.

C4) Wolsong NPP Unit 1 ascertains that inspection for internal subcomponents of reactor assembly was performed during refurbishment.

C5) Degradation mechanisms, such as flow induced vibration fatigue for moderator inlet nozzle and piping, have been identified as credible in CANDU nuclear utilities.

C6) Canadian utilities have established Life Cyclic Management Plan (LCMP). Some of LCMP programs, such as UT for moderator inlet piping, are to be useful for Wolsong NPP Unit 1.

4.2 – RECOMMENDATIONS/SUGGESTIONS:

S1) Consideration should be given to develop an inspection and monitoring plan for subcomponents of reactor assembly for long term operation based on CANDU utility's experiences.

4.3 – DOCUMENTS REVIEWED:

- "Advance Information Package for IAEA SALTO Peer Review of Continued Operation for Wolsong NPP Unit 1", Korea Hydro & Nuclear Power Co., APRIL 2012.
- "Long Term In-service Inspection Plan for Wolsong NPP Unit 1", Korea Hydro & Nuclear Power Co., File # 59-03550-LTP-004.

5. COUNTERPART ACTIONS	Date:	
n.a.		
6. FOLLOW-UP ASSESSMENT BY THE IAEA REVIEW TEAM	Date:	

6.1 – COMMENTS:

C1) n.a.

6.2 – RECOMMENDATIONS/SUGGESTIONS:

R1) n.a.

S1) n.a.

6.3 – DOCUMENTS REVIEWED:

n.a.

STATUS OF THE ISSUE			**Date: 07/06/2012**	**Date: D2/M2/Y2**
1 – Resolution Degree:				
1.	**No action**	*The issue was not identified by the Counterpart, or having been identified, no action was taken to resolve it.*	X	n.a.
		No progress in the resolution of the issue, or unsatisfactory resolution.	n.a.	n.a.
2.	**Action under way**	*The issue was identified by the Counterpart, but the actions did not comply with IAEA SSS.*		n.a.
		The issue was identified by the Counterpart and work has started to resolve it.	n.a.	n.a.
3.	**Issue partially resolved**	*The issue was identified by the Counterpart and actions are underway but no results are available yet.*		n.a.
		The implemented actions meet partially the intent of recommendations of previous IAEA review.	n.a.	n.a.
4.	**Issue resolved**	*The issue was identified by the Counterpart and the solution provided is fully satisfactory. Issue closed.*	n.a.	n.a.
		The intent of recommendations of previous IAEA review is fully met. Issue closed.	n.a.	n.a.
2 – Urgency degree:				
I	The issue should be addressed before the actual date of the LTO (November 21st, 2012)			n.a.
II	The issue should be addressed before 31 December 2013.		X	n.a.

n.a.: not applicable for the present mission.

ISSUE SHEET		
1. ISSUE IDENTIFICATION	Issue Number:	**D – 1**
NPP: Wolsong		
Unit: 1		
Reviewed Area: Review of Ageing Management and other LTO related activities for electrical and I&C components		
Issue Title: Insufficient attributes of time limited ageing analysis (TLAA) and environmental qualification (EQ) for motor operated valves (MOV) and cables		
2. ISSUE CLARIFICATION		
2.1 - ISSUE DESCRIPTION: LTO could be a problem, if there is not a cable on-going AMP like deposit to support the Arrhenius calculation and an overhaul from MOV after 30 years operation.		
2.2 - REFERENCE TO IAEA SAFETY STANDARDS • Safety report series No. 3 (Equipment Qualification in Operational NPP) Chapter: 2.3 and 5.3.1		
3. COUNTERPART VIEWS AND MEASURES (self-assessment by the Counterpart)		
The counterpart disagrees with this issue. C1) MOV actuators inside containment are all Limitorque SMB series (refer to the attachment 3: MOV document). "NUGEQ Report on Limitorque EQ Clarification" specifies the following: Page55: "Limitorque does not require any equipment qualification maintenance activities or periodic parts replacement. All actuators were designed and tested to provide, without component replacement, a 40 years qualified life." "Limitorque valve actuators qualification report B0058" specifies the following: Page32: "The need for major maintenance on Limitorque equipment occurs when some operational deficiency is evident." We cannot find the requirements or recommendations about disassembly of Limitorque actuator in various documents. MOV actuators are being overhauled periodically by		

mechanical and electrical staffs in every outage. Also they are function tested in every outage by MOV test program and they are in IST (In-Service Test) program. Even though there is no recommendation, we disassembled 2 representative MOV actuators to check if they need disassembly maintenance activities and we found they don't need it. If the actuators show or are expected to have a problem in our maintenance and test activities, we will disassemble and overhaul them.

C2) Wolsong NPP Unit 1 adopted indenting method as cable condition monitoring instead of cable deposit according to NRC Reg. Guides and have a plan to test indenting in every outage.

(refer to the attachment 4: Cable deposit document)

"NRC Reg, Guide 1.211" specifies "condition monitoring programs may include any appropriate technique"

"NRC Reg, Guide DG-1240" specifies "condition monitoring methods are elongation at break or indenter test"

Cable deposit method and indenting method have both strong and weak points in our experience. Furthermore, KHNP is researching advanced cable condition monitoring technology like reflectrometry (TDR, FDR, JTFDR) as a member of IAEA cable research group.

Although we are planning to test indenter, we will adopt cable deposit method for cable condition monitoring according to reviewer's suggestion. Both indenting method and cable deposit method will be used to evaluate cable ageing periodically.

4. ASSESSMENT BY THE IAEA REVIEW TEAM	Date:	07/06/2012

4.1 – COMMENTS:

C1) In the LTO program for MOV actuators which are in harsh environment, an overhaul (disassembling and replacement of aging sensitive parts) is not made till today in the plant and not scheduled in a future time.

C2) To analyse the progress of cables ageing and support the Arrhenius analysis, a cable deposit with cable pieces and material samples (Insulation- and jacket material) inside the containment is not established.

C3) A cable deposit with samples from insulation and jacket material for the recording of the elongation at break periodically as an indicator for ageing is not established in NPP. That additional information to the Arrhenius calculation is useful and state of the art to for LTO. That method is established and proven in European countries. The acceptable limit for LOCA cables is today for the most of the cables material around 50% absolute elongation at break.

C4) The overhaul (disassembling) from all MOV in safety systems in harsh environment is not scheduled. After 30 years in operation, it is important to disassemble the actuator by experienced specialists and replace all soft parts, springs, electrical contacts and lubricants.

Sealing and grease can harden, the contact surface will have corrosion and erosion and the springs can soften. After that work, it is important to test the functionality and the set- points from the torque switches.

4.2 – RECOMMENDATIONS/SUGGESTION:

S1) Consideration should be given to establish a cable deposit with samples for the recording of the elongation at break periodically as an indicator for ageing.

S2) Consideration should be given to schedule the overhaul (disassembling) of all MOVs in safety systems in harsh environment.

4.3 – DOCUMENTS REVIEWED:

- Following files for: MOV (TLAA3; ISPL-03) and cables (TLAA1; ECBL-01).

5. COUNTERPART ACTIONS	Date:	
n.a.		

6. FOLLOW-UP ASSESSMENT BY THE IAEA REVIEW TEAM	Date:	

6.1 – COMMENTS:

C1) n.a.

6.2 – RECOMMENDATIONS/SUGGESTIONS:

R1) n.a.

S1) n.a.

6.3 – DOCUMENTS REVIEWED:

n.a.

STATUS OF THE ISSUE			**Date: 07/06/2012**	**Date: D2/M2/Y2**
1 – Resolution Degree:				
1.	**No action**	*The issue was not identified by the Counterpart, or having been identified, no action was taken to resolve it.*	X	n.a.
		No progress in the resolution of the issue, or unsatisfactory resolution.	n.a.	n.a.
2.	**Action**	*The issue was identified by the Counterpart, but the actions did not comply with IAEA SSS.*		n.a.

	under way	*The issue was identified by the Counterpart and work has started to resolve it.*	n.a.	n.a.
3.	**Issue partially resolved**	*The issue was identified by the Counterpart and actions are underway but no results are available yet.*		n.a.
		The implemented actions meet partially the intent of recommendations of previous IAEA review.	n.a.	n.a.
4.	**Issue resolved**	*The issue was identified by the Counterpart and the solution provided is fully satisfactory. Issue closed.*	n.a.	n.a.
		The intent of recommendations of previous IAEA review is fully met. Issue closed.	n.a.	n.a.

2 – Urgency degree:

I	The issue should be addressed before the actual date of the LTO (November 21st, 2012)		n.a.
II	The issue should be addressed before 30 June 2013.	X	n.a.

n.a.: not applicable for the present mission.

ISSUE SHEET		
1. ISSUE IDENTIFICATION	Issue Number:	**D – 2**
NPP: Wolsong		
Unit: 1		
Reviewed Area: Review of Ageing Management and other LTO related activities for electrical and I&C components		
Issue Title: Seismic fixing of electric/ I&C equipment		
2. ISSUE CLARIFICATION		
2.1 - ISSUE DESCRIPTION: Different equipment and furniture which are in different rooms that have installed equipment for nuclear safety is not fixed against the impact from earth quake.		
2.2 - REFERENCE TO IAEA SAFETY STANDARDS • Safety report Series No. 3 Equipment Qualification in Operational NPPs: Upgrading, Preserving and Reviewing, IAEA, 1998		
3. COUNTERPART VIEWS AND MEASURES (self-assessment by the Counterpart)		
Counterparts agree with this issue. C1, C2, C3 & C4: Agree Regarding this issue, we don't currently have a procedure. We will establish a procedure for proper management. We will take proper actions based on your comments.		
4. ASSESSMENT BY THE IAEA REVIEW TEAM	Date:	07/06/2012
4.1 – COMMENTS: **C1)** In the UPS room, the battery discharge equipment is not fixed on the floor, in the case from an earth quake it can damage safety systems and hurt peoples. **C2)** Some chairs and desks are not fixed on the floor in the following rooms: UPS, High Voltage distribution and CER. **C3)** In the SCA room the cabinet with the emergency documentation is not fixed or fastened.		

C4) Wolsong NPP Unit 1 has no rule on fixing the temporary equipment, tools and furniture against the impact from an earth quake. But Wolsong NPP Unit 1 has design requirements to fix the equipment, tools and furniture which are subject to seismic qualification or can impact seismic qualification.

4.2 – RECOMMENDATIONS/SUGGESTION:

R1) Plant should seize the fixation and fix or fasten the not anchoraged equipment, tools and furniture and take out the equipment, tools and furniture from the rooms, if they are not necessary during the operation from the plant.

S1) Consideration should be given to establish a procedure on seismic fixing of equipment, tools and furniture and seismic walk-downs.

4.3 – DOCUMENTS REVIEWED:

- Walk down Friday the first 2012

5. COUNTERPART ACTIONS	Date:	
n.a.		

6. FOLLOW-UP ASSESSMENT BY THE IAEA REVIEW TEAM	Date:	

6.1 – COMMENTS:

C1) n.a.

6.2 – RECOMMENDATIONS/SUGGESTIONS:

R1) n.a.

S1) n.a.

6.3 – DOCUMENTS REVIEWED:

n.a.

STATUS OF THE ISSUE			**Date:** **07/06/2012**	**Date:** **D2/M2/Y2**
1 – Resolution Degree:				
1.	**No action**	*The issue was not identified by the Counterpart, or having been identified, no action was taken to resolve it.*	X	n.a.
		No progress in the resolution of the issue, or unsatisfactory resolution.	n.a.	n.a.
2.	**Action**	*The issue was identified by the Counterpart, but the actions did not comply with IAEA SSS.*		n.a.

	under way	*The issue was identified by the Counterpart and work has started to resolve it.*	n.a.	n.a.
3.	**Issue partially resolved**	*The issue was identified by the Counterpart and actions are underway but no results are available yet.*		n.a.
		The implemented actions meet partially the intent of recommendations of previous IAEA review.	n.a.	n.a.
4.	**Issue resolved**	*The issue was identified by the Counterpart and the solution provided is fully satisfactory. Issue closed.*	n.a.	n.a.
		The intent of recommendations of previous IAEA review is fully met. Issue closed.	n.a.	n.a.
2 – Urgency degree:				
I	The issue should be addressed before the actual date of the LTO (November 21st, 2012)		X	n.a.
II	The issue should be addressed before (*indicate a key date*)			n.a.

n.a.: not applicable for the present mission.

ISSUE SHEET		
1. ISSUE IDENTIFICATION	Issue Number:	**E – 1**
NPP: Wolsong		
Unit: 1		
Reviewed Area: Review of Ageing Management and other LTO related activities for civil structures		
Issue Title: Preventive actions to minimize and control ageing degradation of reactor building containment		
2. ISSUE CLARIFICATION		
2.1 - ISSUE DESCRIPTION: The reactor containment building is not being painted externally except at ring beam. The degradation of the concrete containment may accelerate without external painting due to presence of salts in the coastal environment.		
2.2 - REFERENCE TO IAEA SAFETY STANDARDS: • IAEA Safety Guide NS-G-2.12, Table 2 "GENERIC ATTRIBUTES OF AN EFFECTIVEAGING MANAGEMENT PROGRAM" The attribute 2 and 5 suggest control and minimization of ageing degradation for structures. • IAEA Tecdoc-1025, Assessment and management of ageing of major nuclear power plant components important to safety: Concrete containment buildings, June 1998.		
3. COUNTERPART VIEWS AND MEASURES (self-assessment by the Counterpart)		
The counterpart disagrees with this issue. External wall of reactor building has periodically been inspected and repaired to maintain structural integrity. In some countries including the U.S., there are few cases that external wall of reactor building is painted. In accordance with IAEA GUIDE NS-G-2.12, it does not suggest painting as a preventive action of structural degradation. Also, in accordance with NUREG-1801 of the U.S AMP guideline, structure AMP is not required for specific preventive actions because structure AMP is monitoring program. So, carrying out periodic inspection and repair can effectively manage degradation of external wall of reactor building, and additional actions would not need to be taken. However, when it comes to aging management, Ring beam of Wolsong NPP Unit 1 reactor building is painted to continue to analyze the effectiveness of aging management. Based on		

the results, whether the external wall of the reactor building is painted or not would be reviewed.

Mentioning the Korean regulatory body in this issue has nothing to do with the original intension, so it is not appropriate to mention KINS in issue sheet.

4. ASSESSMENT BY THE IAEA REVIEW TEAM	Date:	07/06/2012

4.1 – COMMENTS:

C-1) The AMP developed for reactor building containment, service building, spent fuel building, turbine building, etc. reviewed. While repair and maintenance is being carried out for structures, the external surface of containment has been left for as-in where-in condition. If the containment is left as it is and not painted externally, this may further spoil the health of the containment in future.

C-2) As reported the KINS is not allowing KHNP to carry out the external painting for maintenance. Being, utility, containment structure health will detoriate in future due to following:

- Wolsong NPP Unit 1 reactor has single containment, which is the ultimate barrier to environment.
- This is being the pre-stressed containment.
- Located in coastal environmental. Presence of chlorides and sulphates, which are not good for concrete and steel.
- Direct exposure to solar radiation.
- Exposed to thermal loads variation due to low and high temperature of -13.1 to 37 degree Celsius.
- Freezing and thawing aspects

C-3) The following attributes were reviewed for measurements of different structures and buildings:

- The measurement of Chloride attack as per ACI-222R-96
- Carbonation in concrete as per Japanese Architect association -1997
- NDT on concrete by Schimdt's hammer by ACI-301-96.
- NDT on concrete by ultra sonic Pulse velocity as per NIST-1997
- Corrosion on reinforcing bars as per ASTM C-876 half cell potential measurements
- Measurement of corrosion on reinforcing bars by natural electrodes
- Cracking in concrete as per ACI-224R and ASME, Section-XIIWL 3221,3

4.2 – RECOMMENDATIONS/SUGGESTION:

R1) The containment being the ultimate barrier between reactor and environment, it is recommended to strictly adhere to the IAEA guide NS-G-2.12 for Aging management Program. Additional efforts should be made to control and delay the degradation of concrete by external painting on wall and dome of reactor containment.

4.3 – DOCUMENTS REVIEWED:

- Structure Life Management System (SLMS)

5. COUNTERPART ACTIONS	Date:	
n.a.		

6. FOLLOW-UP ASSESSMENT BY THE IAEA REVIEW TEAM	Date:	

6.1 – COMMENTS:

C1) n.a.

6.2 – RECOMMENDATIONS/SUGGESTIONS:

R1) n.a.

S1) n.a.

6.3 – DOCUMENTS REVIEWED:

n.a.

STATUS OF THE ISSUE			**Date: 07/06/2012**	**Date: D2/M2/Y2**
1 – Resolution Degree:				
1.	**No action**	*The issue was not identified by the Counterpart, or having been identified, no action was taken to resolve it.*		n.a.
		No progress in the resolution of the issue, or unsatisfactory resolution.	n.a.	n.a.
2.	**Action under way**	*The issue was identified by the Counterpart, but the actions did not comply with IAEA SSS.*	X	n.a.
		The issue was identified by the Counterpart and work has started to resolve it.	n.a.	n.a.
3.	**Issue partially resolved**	*The issue was identified by the Counterpart and actions are underway but no results are available yet.*		n.a.
		The implemented actions meet partially the intent of recommendations of previous IAEA review.	n.a.	n.a.
4.	**Issue resolved**	*The issue was identified by the Counterpart and the solution provided is fully satisfactory. Issue closed.*	n.a.	n.a.
		The intent of recommendations of previous IAEA review is fully met. Issue closed.	n.a.	n.a.

2 – Urgency degree:			
I	The issue should be addressed before the actual date of the LTO (November 21st, 2012)		n.a.
II	The issue should be addressed before 30 June 2013.	X	n.a.

n.a.: not applicable for the present mission.

ISSUE SHEET		
1. ISSUE IDENTIFICATION	Issue Number:	**E – 2**
NPP: Wolsong		
Unit: 1		
Reviewed Area: Review of Ageing Management and other LTO related activities for civil structures		
Issue Title: Measurement of loss of pre-stress force and corrosion in tendons for reactor building containment		
2. ISSUE CLARIFICATION		
2.1 - ISSUE DESCRIPTION: The measurement of pre-stress force and corrosion in the tendons should be calibrated with respect to test results by the methods being developed by Research & Development for Validation/confirmation of the design of reactor building containment.		
2.2 - REFERENCE TO IAEA SAFETY STANDARDS: • IAEA-N-SG-2.12 Annex-III examples of significant ageing mechanism and susceptible materials and component, described based on the section 4 ageing management in operation. • IAEA TECDOC-1025, Assessment and management of ageing of major nuclear power plant components important to safety: Concrete containment buildings, June 1998.		
3. COUNTERPART VIEWS AND MEASURES (self-assessment by the Counterpart)		
The counterpart agrees partially with this issue. The counterpart cannot accept E-2 as a recommendation. This issue has to be a suggestion in accordance with article 1.3.4. 'Reporting and Documenting' of IAEA SALTO guidelines. R&D activities were carried out as an alternative method of in-service inspection using test beams to evaluate measurement of pre-stressed tendon force of reactor building. To utilize the results for evaluating measurement of pre-stressed tendon force, additional R&D will be needed. The additional R&D will be performed until 2016 because it needs test data during integrated leak rate test of reactor building.		

4. ASSESSMENT BY THE IAEA REVIEW TEAM	Date:	07/06/2012

4.1 – COMMENTS:

C1) Structure Life Management System, which is a comprehensive Ageing Management Program for Structures, has been reviewed in the related degradation. In addition, documents listed in section 4.3 of this issue sheet were reviewed.
C2) The containment structure of Wolsong NPP Unit 1 has been designed as Pre-stressed concrete structures. The containment being the ultimate barrier between reactor and environment, its design needs validation/confirmations.
C3) In due course of time, as the pre-stress force induced in the tendon reduces due to pre-stressing losses, the monitoring of pre-stress force becomes the most important parameter in its design validation/confirmation.
C4) Since the Wolsong NPP Unit 1 reactor containment has been pre-stressed with bonded tendons, its monitoring for pre-stress force and corrosion is difficult. To know the status of the pre-stress force and the corrosion in the tendon, periodic test beams, which were cast at the time of concreting of the containment, needed to be sacrifice.
C5) The two methods and their methodologies, as discussed during meetings are being developed by necessary research and development program by KHNP. These methods should be calibrated with respect to test results for design validation throughout the design life of reactor containment building.
C6) During the plant walk down, the water ingrace was observed at few places in the tendon gallery, that needs to be attended, as this may lead to the stress corrosion in the pre-stressed tendon in long run.

4.2 – RECOMMENDATIONS/SUGGESTION:

R1) The Pre-stressing tendons measurements for force and corrosion should be calibrated and validated by R&D programmes due to lack of adequate test beams in the future. The designed validation/confirmation should be available on line (after due validation/confirmation) throughout the life of the structures.

4.3 – DOCUMENTS REVIEWED:

- Jeonggi-sul0-001: Examination of ageing phenomena of nuclear safety related concrete structures.
- Jeonggi-sul0-003: In service inspection of Reactor Building post tensioning system.
- Ministry of Education Science and technology (MEST) notice no. 2009-37 (Reactor.025) and (Reactor.026)

5. COUNTERPART ACTIONS	Date:	
n.a.		

6. FOLLOW-UP ASSESSMENT BY THE IAEA REVIEW TEAM	Date:	

6.1 – COMMENTS:

C1) n.a.

6.2 – RECOMMENDATIONS/SUGGESTIONS:

R1) n.a.

S1) n.a.

6.3 – DOCUMENTS REVIEWED:

n.a.

STATUS OF THE ISSUE			**Date: 07/06/2012**	**Date: D2/M2/Y2**
1 – Resolution Degree:				
1.	**No action**	*The issue was not identified by the Counterpart, or having been identified, no action was taken to resolve it.*		n.a.
		No progress in the resolution of the issue, or unsatisfactory resolution.	n.a.	n.a.
2.	**Action under way**	*The issue was identified by the Counterpart, but the actions did not comply with IAEA SSS.*	X	n.a.
		The issue was identified by the Counterpart and work has started to resolve it.	n.a.	n.a.
3.	**Issue partially resolved**	*The issue was identified by the Counterpart and actions are underway but no results are available yet.*		n.a.
		The implemented actions meet partially the intent of recommendations of previous IAEA review.	n.a.	n.a.
4.	**Issue resolved**	*The issue was identified by the Counterpart and the solution provided is fully satisfactory. Issue closed.*	n.a.	n.a.
		The intent of recommendations of previous IAEA review is fully met. Issue closed.	n.a.	n.a.
2 – Urgency degree:				
I	The issue should be addressed before the actual date of the LTO (November 21st, 2012)			n.a.
II	The issue should be addressed before (December 31, 2014).		X	n.a.

n.a.: not applicable for the present mission.

ISSUE SHEET		
1. ISSUE IDENTIFICATION	Issue Number:	**F - 1**
NPP: Wolsong		
Unit: 1		
Reviewed Area: Radiological Environmental Impact		
Issue Title: Suitability of atmospheric dispersion model for gaseous releases		
2. ISSUE CLARIFICATION		
2.1 - ISSUE DESCRIPTION: Atmospheric dispersion model for gaseous releases does not take into account complex terrain in vicinity of Wolsong NPP Unit 1.		
2.2 - REFERENCE TO IAEA SAFETY STANDARDS • IAEA Safety guide No. NS-G-2.7, Radiation Protection and Radioactive Waste Management in the Operation of Nuclear Power Plants • IAEA Safety Guide No. NS-G-3.2 Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants		
3. COUNTERPART VIEWS AND MEASURES (self-assessment by the Counterpart)		
The counterpart agrees with this issue. We will review applicability the Gaussian plume model.		
4. ASSESSMENT BY THE IAEA REVIEW TEAM	Date:	07/06/2012
4.1 – COMMENTS: **C1)** Gaussian model for population doses, respectively its part called XOQDOQ for calculation of factors for atmospheric dispersion and deposition, does not take into account terrain in vicinity of NPP. **C2)** Code XOQDOQ applies "constant mean wind direction model" of U.S. Regulatory Guide 1.111. This document on page 10 says that for all sites a detailed discussion of the applicability and accuracy of the model and input data should be provided. Such a report about applicability of XOQDOQ model for complex terrain in vicinity of Wolsong NPP Unit 1 does not exist**.** **C3)** IAEA Safety Guide No. NS-G-3.2 in point 2.41 says that computing models for		

atmospheric dispersion should be chosen in accordance with the regulatory objective and, to the extent possible, site and/or plant specific characteristics should be taken into account. One of the important site characteristics is complexity of terrain in vicinity of NPP, which should be taken into account according to NS-G-3.2.

4.2 – RECOMMENDATIONS/SUGGESTIONS:

R1) Review applicability of the XOQDOQ code for complex terrain in vicinity of NPP Wolsong. If XOQDOQ code is not applicable use another model which is applicable.

4.3 – DOCUMENTS REVIEWED:

- Advanced information package
- U.S. Regulatory Guide 1.111: Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors
- KINS/GR-199, APPENDIX 1: ODCM Guideline and INDAC User Manual
- M.E. Berljand: Asobenosti rasprastranenija primesej v peresecennoj mjestnosti

5. COUNTERPART ACTIONS	Date:	
n.a.		

6. FOLLOW-UP ASSESSMENT BY THE IAEA REVIEW TEAM	Date:	

6.1 – COMMENTS:

C1) n.a.

6.2 – RECOMMENDATIONS/SUGGESTIONS:

R1) n.a.

6.3 – DOCUMENTS REVIEWED:

n.a.

STATUS OF THE ISSUE			**Date: 07/06/2012**	**Date: D2/M2/Y2**
1 – Resolution Degree:				
1.	**No action**	*The issue was not identified by the Counterpart, or having been identified, no action was taken to resolve it.*	X	n.a.
		No progress in the resolution of the issue, or unsatisfactory resolution.	n.a.	n.a.
2.	**Action**	*The issue was identified by the Counterpart, but the actions did not comply with IAEA SSS.*		n.a.

	under way	*The issue was identified by the Counterpart and work has started to resolve it.*	n.a.	n.a.
3.	**Issue partially resolved**	*The issue was identified by the Counterpart and actions are underway but no results are available yet.*		n.a.
		The implemented actions meet partially the intent of recommendations of previous IAEA review.	n.a.	n.a.
4.	**Issue resolved**	*The issue was identified by the Counterpart and the solution provided is fully satisfactory. Issue closed.*	n.a.	n.a.
		The intent of recommendations of previous IAEA review is fully met. Issue closed.	n.a.	n.a.

2 – Urgency degree:			
I	The issue should be addressed before the actual date of the LTO (November 21st, 2012)		n.a.
II	The issue should be addressed before 30 June 2015.	X	n.a.

n.a.: not applicable for the present mission.