IAEA-EBP-LTO-18
150605

EXTRABUDGETARY PROGRAMME ON SAFETY ASPECTS OF LONG TERM OPERATION OF WATER MODERATED REACTORS

MINUTES OF THE PROGRAMME'S THIRD WORKING GROUP 2 MEETING

30 May-2 June 2005

INTERNATIONAL ATOMIC ENERGY AGENCY

1. INTRODUCTION

The number of Member States giving high priority to extending the operation of nuclear power plants beyond their initial license is increasing. Decisions on long term operation (LTO) involve the consideration of a number of factors. While many of these decisions concern economic viability, all are grounded in the premise of maintaining plant safety. The IAEA recognized this new industry initiative; therefore, in the 1990's, it developed comprehensive generic guidance on how to manage the safety aspects of physical ageing. It was recognized, however, that internationally agreed-upon, comprehensive guidance was needed to assist regulators and operators in dealing with the unique challenges associated with the LTO issue.

In response, the IAEA initiated this Extrabudgetary Programme (Programme) on Safety aspects of long term operation of water moderated reactors (original title was Safety aspects of long term operation of pressurized water reactors). The Programme's objective is to establish recommendations on the scope and content of activities to ensure safe long term operation of water moderated reactors. The Programme should assist regulators and operators of water moderated reactors, and, in particular WWERs, in ensuring that the required safety level of their plants is maintained during long term operation, should provide generic tools to support the identification of safety criteria and practices at the national level applicable to LTO, and should provide a forum in which MS can freely exchange information.

The Programme activities are guided by the Programme Steering Committee (SC), follow the overall SC Programme Workplan and SC Terms of Reference, [1], and are implemented in 4 Working Groups (WG). The WGs focus on:

- general LTO framework (WG 1);
- mechanical components and materials (WG 2);
- electrical components and I&C (WG 3);
- structures and structural components (WG 4).

Further detailed information on the Programme could be found at: http://www-ns.iaea.org/nusafe/s_projects/salto_int.htm .

The purpose of the third meeting of WG 2 was to:

- Discuss Scoping Process and Agree upon Timeline to complete the Final WG reports.
- Using the First Draft Report of WG4 as a template – Discuss what information is missing from CIRs - If possible provide a list of questions to Country Representative and agree when the information will be forth coming.
- Assign action items (finalising the report on Task 2; elaboration of Final Working Group Report)

The Agenda for the Meeting is provided in Appendix I. The list of WG 2 participants is provided in Appendix II and the presentations made during the meeting are provided in Appendix III.

The third WG 2 meeting was organized jointly with the third WG 3 meeting and hosted at Oskarshamn, Sweden by the Swedish International Project Nuclear Safety and the Oskarshamn NPP, 30 May to 2 June 2005. During the meeting, a plant visit and a visit to the SKB spent fuel storage facility CLAB and the hard rock laboratory was also organized.

2. MEETING SUMMARY

2.1. OPENING PLENARY SESSION

Mr. Radim Havel, the Programme Scientific Secretary, opened the meeting, which started as a joint session of WG 2 and WG 3. Mr. Havel provided an overview of the Programme's status and outlined the expected outcomes from the meeting.

Mr. Havel stated that, with 18 months to go it appears that the program is in principle on schedule. Currently we have:

- Completed the Country Information Reports (CIR)
- Completed the initial CIR reviews

For the completion of the program we must yet:

- Complete the CIR review and draft the final WG reports
- Develop the Programme Final Report for review by the Steering Committee (SC)

Mr. Havel also reported that Netherlands had joined the Programme and Japan considers joining (participated at the last SC meeting as an observer). The specific expectations and tasks identified by the SC in its April 2005 meeting for the WGs are:

- Identify the LTO pre-conditions
- Define the LTO Scoping Process
- Define the attributes of an acceptable LTO programme
- WG 2,3,4 to define and develop a list of Aging Management Programme (AMP) attributes
- Develop a consensus definition of LTO
- Produce uniform and consistent Final WG Reports by 5 December 2005
- Both Final WG Reports and the Programme Final Report should be focused on LTO aspects; these should address water moderated reactor LTO and distinctions necessitated by the design or materials of PWR, VVER or BWR designs should be noted as necessary, but should not necessitate separate guidelines
- CIRs are to remain restricted, no general revisions should take place, only missing information is to be requested on a case by case basis where applicable.address information relative to LTO only

Mr. Havel then stated that the Working Groups need to have a schedule developed and an associated action plan by the end of the meeting (Thursday). At that point he turned the meeting over to Mr. Tom Taylor, the new Working Group Leader for WG2 who then chaired the remainder of the joint session.

Mr. Taylor presented the work to date of WG2 including a general presentation of the scoping process flowchart derived at the previous SC meeting (see Appendix IV). The agreed upon objective of this process is to have a consistent set of SSCs that will be reviewed for LTO in each country. Mr. Taylor further discussed the expected outcomes of the meeting of WGs 2 and 3:

- It is apparent when reviewing the Country information reports that there was not a consistent methodology for determining the scope of Systems, Structures and Components (SSCs) among member states that would be subject to an LTO review. The Steering Committee requested that the Working groups work to develop a process or logic diagram that when followed would lead member states to develop a consistent set of SSCs that belonged within the scope of LTO.
- The Steering Committee requested that as Working Groups developed the content of their final reports, the reports focus only on aspects of LTO appropriate for each Working Group.
- The Steering Committee requested that each Working Group develop a schedule that would lead to completion of an initial draft for the Steering Committee review by December 5th.

Mr. Duchac then provided an overview of the WG 3 status of reviews of the Country Information Reports (CIRs) and preparation of the WG3 Final Report. All CIRs have been received and have been given an accelerated review (Duchac and Jarrell). Full WG3 participation will follow. Principal findings are that there is no consistency in the definition of LTO or the listing of SSCs generated for application of LTO in each country. There is a similar Equipment Qualification (EQ) practice for TLAAs, but they are done on differing equipment lists.

It was agreed that each working group would review the set of system functional descriptions given in the presentation.

The Working Groups then split into individual sessions to proceed with their afternoon agendas.

2.2. WORKING GROUP 2 MEETING SUMMARY

Mr. Vladimir Piminov and Mr. Havel announced organizational changes to Working Group 2. Mr. Piminov informed the WG 2 members that due to a promotion and duties at work he would no longer be able to act as leader for WG 2. Mr. Havel requested Mr. Taylor and Ms. Ribarska to serve as WG 2 leader and secretary respectively and both of them kindly accepted. Mr. Havel thanked on behalf of the Agency to Mr. Piminov excellent work done.

Mr. Havel then turned the meeting over to Mr. Tom Taylor, the new Working Group Leader for WG2 who then chaired the meeting.

Scoping process

Working group 2 and Working Group 3 reviewed and discussed at length several aspects of the scoping process that was develop during the April Steering Committee and included the draft report IAEA-EBP-LTO-15. During the discussion the following major changes to the Scoping Process were recommended by the joint Working Groups.

The process documented in IAEA-EBP-LTO-15 really represents both a scoping and a screening process so the working groups recommended that the logic diagram be separated into two diagrams one for Scoping and the other for Screening.

The Working group wanted to see the issue of Time Limited Aging Assessment and Aging Management developed into two parallel paths.

The final Scoping and Screening logic diagrams are included in Appendix IV of this report.

Final WG 2 Report preparation

Each of the review groups provided a brief discussion of their review of the CIRs and members of Working Group 2 agree that the content of the final report for WG 2 in each section should be revised as follows.

Chapter 1. Regulations
The following has been decided:

- The chapter is kept. However, it has to be shortened in order to include only regulations on SSCs relevant to WG2 and LTO
- The differences among the country practices should be highlighted
- The need for a minimum regulations in the field of LTO should be identified

Chapter 2. Scope of LTO
The following has been decided:

- The final report will contain a written description of the of the Scoping and Screening Logic diagram that has been developed and provide a statement explaining that the logic diagrams were developed as a result of the large variability noted in the CIRs when Scoping was discussed.
- The chapter will not be arranged into subchapters since all most all of the Groups of SSCs are the same between WWERs and PWRs for WG2.
- The definition of the following functions that are with in the scope of LTO will be clearly identified.
  1. To ensure integrity of reactor coolant pressure boundary,
  2. To ensure the capability to shut down the reactor and maintain it in a safe shutdown condition, and
  3. To ensure offsite radioactive exposures less than, or comparable to, limits specified in the regulations of individual MS by preventive or mitigate measures.
  4. NonSafety related SSCs whose failure impacts safe operation

An initial draft of the definitions and the systems included in the preceding functions is presented in APPENDIX V.

Chapter 3. Operational Approaches Applicable to Long Term Operation

3.1 Normal Operational Practice/Programs Applicable to Aging Management

3.1.1 In-service Inspection Practices for passive Components

3.1.1.1Augmented inspection programs that address issues such as erosion/corrosion,

3.1.1.2 Augmented inspection of steam generator tubing or

3.1.1.3 Augmented inspection for specific degradation mechanisms such as Intergranular stress corrosion cracking

The members of WG2 agree with the following conclusion that would be included in the final report for Section 3.1.1.

1. All applied country-specific ISI systems are based on common safety approaches
2. Basic requirements for the in-service inspections are available in Regulatory Guides. The range, periods, methods, evaluation etc. of in-service inspections are mostly defined in a deterministic way coming from designer, manufacturer and utilities experience by specific NPP rules.
3. NDT inspections system qualification is recognized as a crucial condition to ensure reliable results of ISI. In some countries this process has advanced in others it has been currently under way.
4. RI-ISI procedures are applicable to define “more reasonably” the scope and periods of ISI (mainly piping). RI-ISI is broadly and successfully utilized in USA. In Europe, Sweden and Finland adopted this approach in their regulatory documents and operation practice. Pilot studies have been performed in several countries recently too.
5. Future effort should be concentrated on damage mechanisms understanding, new ISI detection and evaluation methods and systems development and the development of the application of the RI ISI.
6. The augmented ISI programs covering erosion-corrosion damage mechanism are highly developed and broadly and successfully applied at present.
7. Augmented ISI of steam generator tubing are solved as the combination of ISI carried out by eddy current method, leakage tests, deposit formation checking and impurities measurement. Future effort should be aimed to develop real chemistry measurement methods in crevices, to develop and apply eddy-current inspection procedures and evaluation techniques enabling better defect dimensions determination (both depth and length). Necessary further damage mechanism analysis of SG tubing.

Other augmented inspections are carried out in case when standard inspections provide unsatisfactory results or new damage phenomenon occurred. Methods are different depending on actual problem.

3.1.2 Maintenance Codes or Practices for Active Components

The members of WG2 agree with the following conclusion that would be included in the final report for Section 3.1.2.

There were found following observations or common topics during review of chapter 3.1.2 of CIRs:

1. Maintenance activities are based on national regulatory body legislation
2. Maintenance records are stored
3. Long term maintenance plan is developed
4. Preventive maintenance is introduced
5. Evaluation of maintenance records
6. Connection of maintenance programs and ageing management
7. Monitoring of the effectiveness of the maintenance activities
8. Dependence of maintenance frequency on plant experience
9. Monitoring of the performance or condition of SSC
10. Risk-informed evaluation of maintenance

Following proposals for common approach in the area of maintenance codes and practices are based on those observations:

1. Maintenance activities should be based on national regulatory body legislation and international standards.
2. Long term maintenance plans are recommended to be developed.
3. Preventive maintenance programs should be a standard part of the safety important system's maintenance.
4. Maintenance programs and ageing management should have direct interface.
5. Maintenance records should be stored for optimization of maintenance and for extended operation.
6. Evaluation of maintenance records is necessary for optimization of maintenance and for LTO.
7. Optimization of maintenance frequency should be result of evaluation of maintenance records.
8. Monitoring of the effectiveness of the maintenance activities is recommended way of maintenance optimization.
9. Monitoring of the performance or condition of safety important SSC is recommended.

3.1.3 Equipment Qualification Practices

The members of WG2 agree with the following conclusion that would be included in the final report for Section 3.1.2.

1. Procedures to maintain qualification during the installed life of the equipment
2. System is based on approaches in accordance with common international practice
3. List of equipment is based on the fulfilment of safety functions
4. Qualification reports and other supporting documents are available
5. Combination of different methods is used to demonstrate the equipment qualification status
6. All components or elements, which are connected with respect to their functions or which affect each other, has to be qualified
7. Program of equipment qualification is approved by regulatory body
8. Qualified SSC shall be capable of operating under design-basis environmental conditions

Following proposals for common approach in the area of equipment qualification are based on those observations:

1. Qualification programs should be based on international standards.

2. Program of equipment qualification should be approved by regulatory body.
3. Environmental and seismic qualification should be required of components important for nuclear safety.
4. Qualified SSC shall be capable of operating under design-basis environmental and seismic conditions.
5. The equipment qualification status should be demonstrated by tests, analyses or other methods.
6. Qualification reports and other supporting documents should be available for operators.
7. Procedures to maintain qualification during the installed life of the equipment shall be introduced.

3.1.4 Component function tests
The members of WG2 discussed component functional test and agreed that such test were an important part of safe operation of nuclear power plants, however, WG2 members felt that a Component Functional Testing Program should be a pre-condition to Long Term Operation (LTO).

3.1.5 Applied diagnostic systems
WG2 members felt that applied diagnostic systems were an important part of LTO. CIRs did not contain much information on diagnostic system details so at this time it is not possible to develop a set of common attributes. After discussion the WG2 members felt that it would be very useful to develop a recommended outline that would describe the important elements of an effective diagnostic system. Tom Taylor indicated that Don Jarrell of WG3 could help develop such a written description.

3.1.6 Surveillance specimen program (irradiation damage, corrosion, loops)
The members of WG2 discussed Surveillance Specimen Programs and agreed that such test were an important part of safe operation of nuclear power plants. However, WG2 members felt that a Surveillance Specimen Program should be a pre-condition to LTO.

3.1.7 Nondestructive material properties tests (hardness measurement etc.)
The CIRs reports indicated that currently the only material property that is measured via nondestructive testing is "Hardness". After discussion WG2 members felt that it would be useful to mention what areas of research should be supported to develop the necessary NDE testing methods to support LTO.

3.1.8 Destructive tests and material research carried out during NPP operation
The CIRs contained little information on material research programs. Claude Rieg committed to provide a summary of research in France. Tom Taylor agreed to summarize the research in the U.S. It was noted that much the research in the U.S. is carried out by EPRI which and therefore is available only to EPRI members.

3.1.9 Special loading measurement systems (temperature, deformation etc.) combined with damage calculation (e.g. on-line and off-line fatigue monitoring)

There was very little information in the CIRs concerning "Special Load Measurement Systems". The systems that are in common use include systems to monitor fatigue and temperature. WG2 members felt that it would be useful to mention what areas of research should be supported to develop the necessary Special Load Measurement Systems methods to support LTO.

3.1.10 Chemical regimes monitoring
Primary and Secondary water chemistry is controlled by technical specifications. WG2 members felt that water chemistry monitoring was very important to LTO.

2.3. CLOSING PLENARY SESSION

The revised scoping and screening processes were discussed and agreed upon.

The definition of LTO was also discussed and it was agreed to maintain the original LTO definition as provided in the report IAEA-EBP-LTO-03, Rev.1, since the new proposals both from SC as well as from WGs did not provide further clarification or better definition ('what') but rather elaborated on 'how' should LTO be conducted (safely, in line with national requirements).

3. ACTION ITEMS

The following action items were agreed:

No.	Review Group	Assigned CIR Sections	Completion Date
1	Group 1 – Bulgaria, Hungary and EC Group Leader – Sandor Ratkai	Sections 1.0 & 2.0 and Section 3.2	August 5th ,2005
	Group 2- Czech Republic and Slovak Republic Group Leader – Robert Krivanek	Section 3.1.1 to 3.1.3	July 14th, 2005
	Group 3 – Russia and Ukraine Group Leader – Sergey Malkov	Sections 3.1.4 to 3.1.7	July 20th, 2005
	Group 4 – Finland and Sweden Group Leader - Fredrik Barnekow	Sections 3.1.8 to Sections 3.1.10	July 25th, 2005
2	Complete initial Draft of Complete WG2 report and Submit for Members review – T. Taylor Lead		August 26, 2005
3	Receive comments for WG2 Members on Draft		September 23. 2005
4	Incorporate Members Comments		October 14, 2005
5	Final WG2 Meeting to Resolve Issues (Vienna, if necessary)		October 31st – November 2, 2005
6	Provide list of LTO pre-conditions to WG 1 (P-T Kuo); Tom Taylor		immediately

APPENDIX I.
AGENDA

29 May 2005
Arrival to Stockholm, transfer of participants to Oskarshamn (bus departs at 18:00)

30 May 2005 (Monday)

	Joint Meeting of WG2 and WG3	
9:00 – 9:30	Opening, 3rd Steering Committee Mtg. results	(R. Havel)
9:30 – 10:30	Discussion of Status of CIRs and Action Items from April Steering Committee -definition of LTO -SSC table-an example of approach	(T. Taylor, and A. Duchac)
10:30 – 11:00	Coffee Break	
11:00 – 12:30	Discussion on Content of WG2 and WG3 Final Reports	(All)
12:30 – 14:00	LUNCH	
	After Lunch Each Working Group will meet separately	
14:00 – 14:45	Review Group 1 (CIR sections 2.0, 3.2) Potential Problems with Final Report What Information is missing?	(S.Ratkai)
14:45 – 15:30	Review Group 2 (CIR sections 3.1.1 – 3.1.3) Potential Problems with Final Report What Information is missing?	(R.Krivanek)
15:30 – 16:00	Coffee Break	
16:00 – 16:45	Review Group 3 (CIR sections 3.1.4 – 3.1.7) Potential Problems with Final Report What Information is missing?	(S.Malkov)
16:45 – 17:30	Review Group 4 (CIR sections 3.1.8 – 3.1.10) Potential Problems with Final Report What Information is missing?	(F.Barnekow)

31 May 2005 (Tuesday)

9:00 – 17:00	Plant visit	

1 June 2005 (Wednesday) Break-out Sessions for WG2

9:00 – 12:30	Break-out Sessions for Review Groups 1, 2, 3 and 4 Develop Outline for the Final Report and identify what Information is needed from WG members to complete report	
10:30 – 11:00	Coffee Break	
11:00 – 12:30	Continue Break-out Sessions	
12:30 – 14:00	LUNCH	
14:00 – 15:30	Continue Break-out Sessions	
15:30 – 16:00	Coffee Break	
16:00 – 17:30	Provide Working Group Leaders and Secretaries with detailed outline and list of action items that have been agreed to with WG members	

2 June 2005 (Thursday)

9:00 – 12:30	Discuss any remaining issues for Final Report	
10:30 – 11:30	Coffee Break	
11:45 – 12:30	Continue with discussion	
12:30 – 14:00	LUNCH	
	Joint Meeting of WG2 and WG3	
14:00 – 16:00	Wrap Up Discussion; Agree on Assignments	(A. Duchac, T. Taylor)
16:00	Departure to Stockholm	

APPENDIX II.
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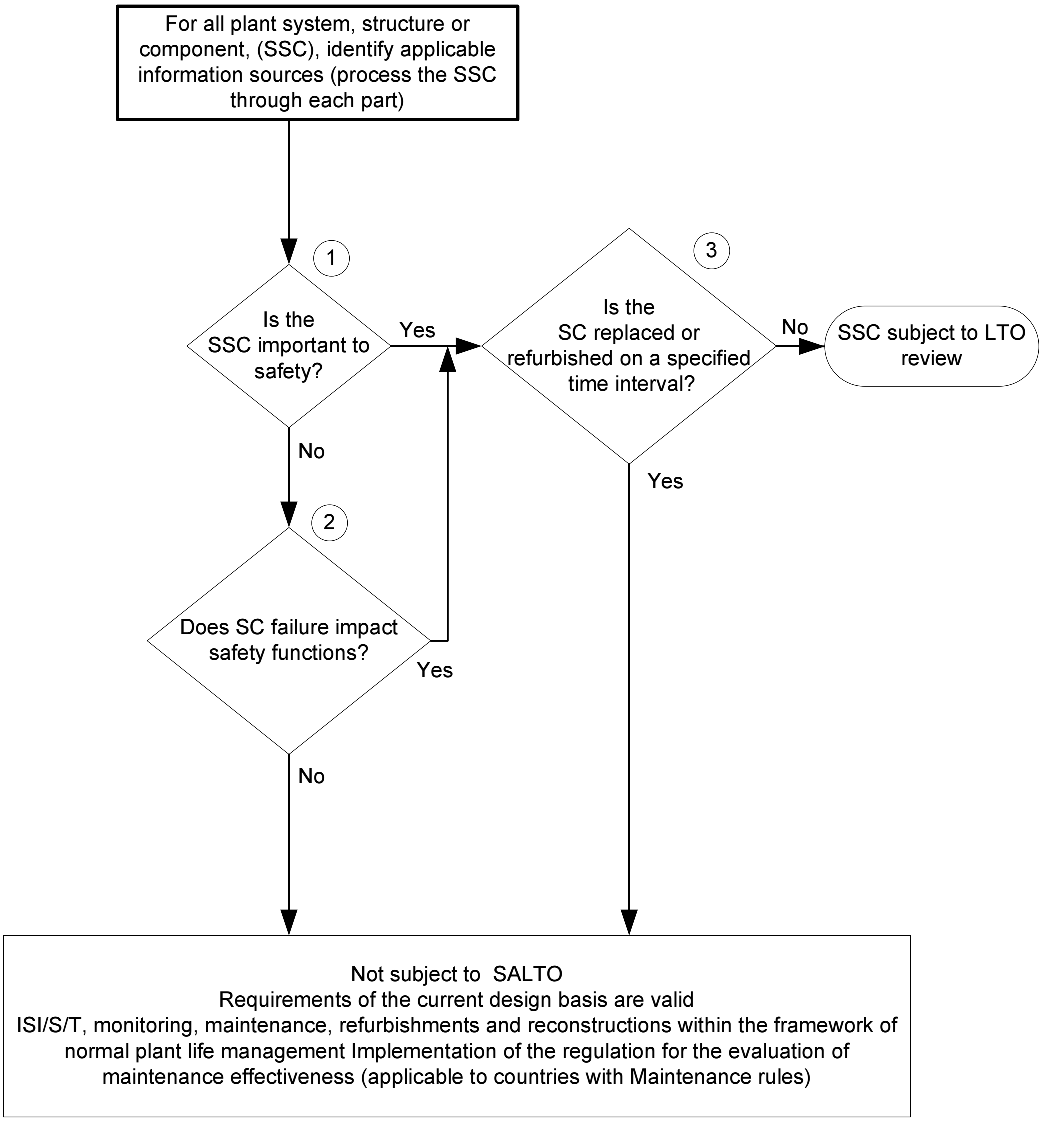
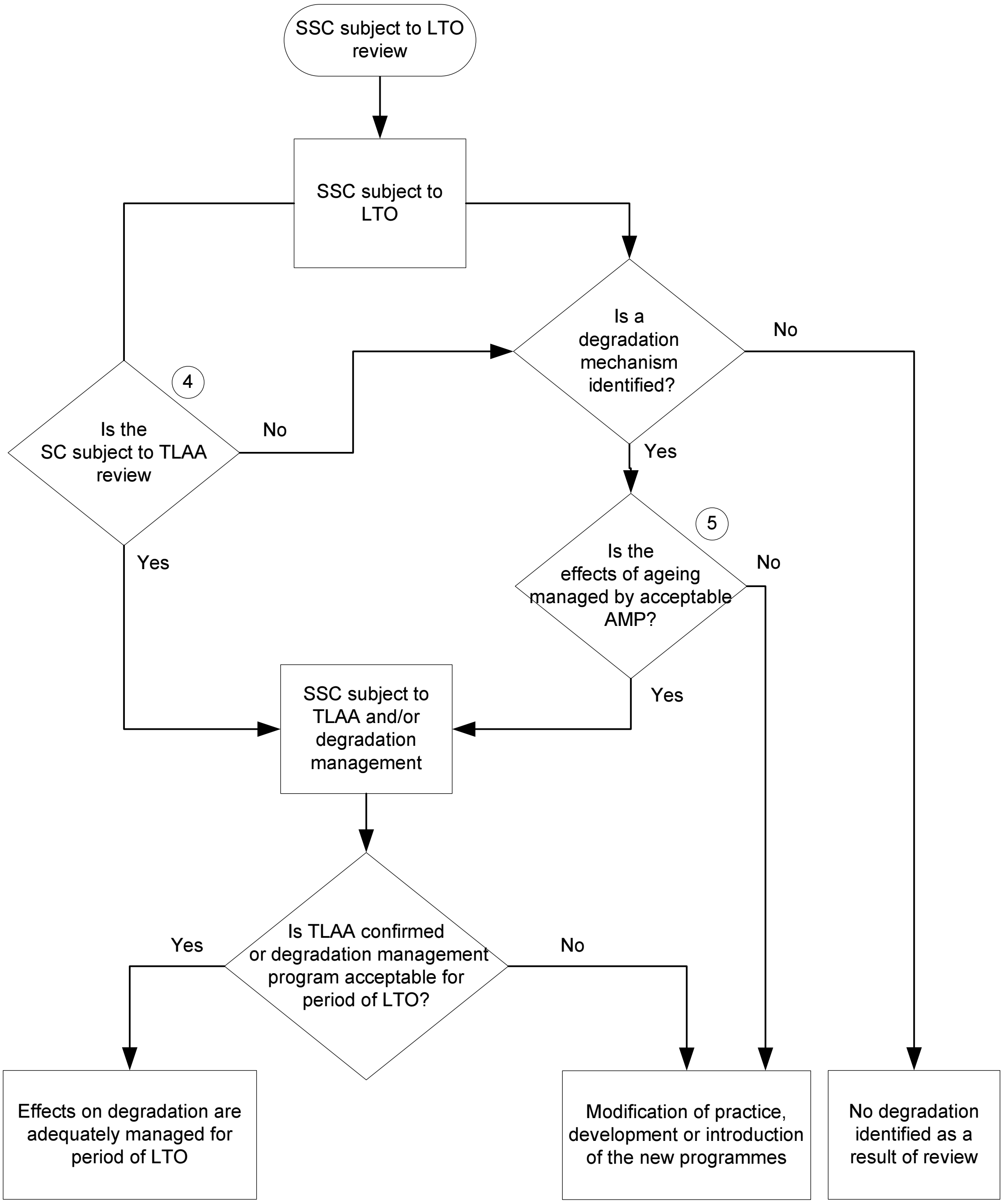
APPENDIX III
PRESENTATIONS

APPENDIX IV.
SCOPING PROCESS FOR LTO



APPENDIX V.
SCREENING PROCESS FOR LTO



SCOPING FLOW CHART NOTES

1. SAFETY-RELATED SSC

SSCs that perform the following functions:

1. To ensure integrity of reactor coolant pressure boundary,
2. To ensure the capability to shut down the reactor and maintain it in a safe shutdown condition, and
3. To ensure offsite radioactive exposures less than, or comparable to, limits specified in the regulations of individual MS by preventive or mitigate measures.

2. NON SAFETY SSCS WHOSE FAILURE IMPACTS SAFETY FUNCTION

The function of a safety system, structure or component may be compromised by failure of a non-safety related structure or component. One example is the failure of fire protection piping that leads to electric failure of an electrical panel that controls the current to a motor operated valve performing a safety engineered function, where the fire protection piping is a non-safety related component and the electrical panel is a safety component. The selection criterion includes but not limited to SSCs which perform a function to satisfy the requirements for the following:

Anticipated transient without scram (ATWS)
Station blackout (SBO)
Pressurized Thermal Shock (PTS)
Environmental Qualification (EQ)
Fire Protection (FP)

3. IS THE SC ON A REPLACEMENT SCHEDULE OR REFURBISHMENT SCHEDULE

For SSCs are replaced based on a qualified life or specified time period; it is not necessary to include the SSCs in an aging management review or subject the SSCs to an Aging Management Program.

4. TIME LIMITED AGING ANALYSIS (TLAAS)

Time Limited Aging Analysis (TLAAs) are plant calculations and analyses that consider the effects of aging, involve time-limited assumptions defined by the current operating term,, for example, 40 years; and involve conclusions or provide the basis for conclusions related to the capability of a system, structure, or component to perform its intended function(s). The six general criteria listed below may be used to determine what analyses are TLAAs that relate to LTO.

1. Involve systems, structures, and components within the scope of license renewal. The Scoping and Screening process outlined in section 2.0 and the functional descriptions provided for SSCs in the scope of LTO provides some guidance on a plant level for various systems SSCs level that may be affected by TLAAs.
2. Consider the effects of aging. The effects of aging include, but are not limited to: loss of material, loss of toughness, loss of prestress, settlement, cracking, and loss of dielectric properties.
3. Involve time-limited assumptions defined by the current operating term (for example, 40 years). The defined operating term should be explicit in the analysis. Simply asserting that a component is designed for a service life or plant life is not sufficient. The assertion should be supported by calculations or other analyses that explicitly include a time limit.
4. Were determined to be relevant by the plant owner or regulator in making a safety determination. A calculation or analysis is relevant if it can be shown to have a direct bearing on action(s) taken for safe operation as a result of the analysis performed. Analyses are also relevant if they provide the basis for a safety determination and, in the absence of the analyses, a different safety conclusion may have been reached.
5. Show capability of the system, structure, or component to perform its intended function(s). Analyses that do not affect the intended functions of systems, structures, or components are not TLAAs.

6. Are contained or incorporated by reference in the current license basis. Plant-specific documents contained or incorporated by reference in the CLB include, but are not limited to: Final Safety Analysis Report, Topical Safety Analysis Reports, Technical Specifications, the fire protection plan/hazards analyses, correspondence to and from the regulator and the quality assurance plan. Calculations and analyses that are not in the CLB or not incorporated by reference are not TLAAs.

5. ACCEPTABLE AGEING MANAGEMENT PROGRAMS

An acceptable ageing management program should contain the following attributes:

1. A defined program scope,
2. Identification of preventive actions or parameters to be monitored or inspected,
3. Detection of ageing degradation /effects,
4. Monitoring and trending including frequency and methodologies,
5. Pre-established acceptance criteria,
6. Corrective actions if a component fail to meet the acceptance criteria,
7. Confirmation that required actions have been taken,
8. Administrative controls that document the program's implementation and actions taken, and
9. Operating experience feedback.

APPENDIX VI.

DESRIPTION OF SYSTEMS IN THE SCOPE OF LTO

SSCs THAT ENSURE INTEGRITY OF REACTOR COOLANT PRESSURE BOUNDARY

The PWR Reactor Coolant Pressure boundary has three (3) major functions:
- Ability to Transfer the heat from the reactor for the steam generator
- Maintain the pressure within acceptable limits
- Maintain the integrity of pressure boundary

The Reactor Coolant System consists of the following major components other than the reactor:
- Reactor Pressure Vessel
- Reactor Pressure Vessel – upper part
- Reactor Control Drive Housing & Control Rod Drive
- Reactor Pressure Vessel Internals
- Instrumentation Nozzles
- Hot Leg Piping
- Steam Generator
- Cold Leg Piping
- Reactor Coolant Pump
- Piping between the Hot Leg and the Pressurizer (Surge Line)
- Pressurizer
- Piping between the Cold Leg and the Pressurizer
- Piping of Auxiliary and Safety Systems which are under Primary Pressure
- Relief line Piping on top of the Pressurizer.
- Pressurizer Relief Valve
- Containment Isolation Valves (should be in safety systems)
- Loop isolation valves (VVER 440 only)
- Claddings and welds should be included

Reactor Pressure Vessel -The reactor vessel is designed to contain the fuel assemblies, direct the flow of coolant around the fuel assemblies to assure heat transfer and to prevent uncovering of the fuel assemblies.

Reactor Coolant Primary Piping – The primary piping is designed and manufactured such that it will withstand all loadings arising from power station operation, while remaining within safety limits.

Reactor Coolant Pump - The Reactor Coolant Pump circulates the water through the Reactor Coolant System.

Steam Generator - The function of the steam generator is to transfer the heat from the reactor cooling system to the secondary side of the tubes which contain feedwater. As the feedwater passes the tube, it picks up heat and gets converted to steam. The steam generators also contain a steam separation region, described below.

Pressurizer – The pressurizer has three main functions:
- maintain a constant primary pressure during normal operation,
- limit and compensate for variations in primary pressure during operation,
- ensure the integrity of the primary circuit by means of the safety valves connected to the top of the pressurizer.

Sensing and Controls, cabling for instrumentation and power supply for all of the reactor coolant system.

SSCs THAT SHUT DOWN THE REACTOR AND MAINTAIN IT IN A SAFE SHUTDOWN CONDITION (Including Emergency Systems)

Residual Heat Removal - The RHR is designed to perform the following functions:

- ensure, once the reactor has been sufficiently cooled (177ºC) and the coolant pressure has been reduced to 2.8 MPa, that the reactor gradually is brought to cold shutdown condition prior to removal of the reactor vessel head. The RHR is designed to maintain this condition during fuel unloading and loading and maintenance operations,
- ensure, once the reactor has been sufficiently cooled (177ºC) and the coolant pressure has been reduced to 2.8 MPa, that the reactor is gradually brought to cold shutdown condition after a small LOCA or a steam line break.
- circulate reactor coolant during startup operations until minimum required NPSH conditions are achieved for reactor coolant pump operation, . transfer the refuelling water from the reactor cavity to the refuelling water storage tank of the reactor cavity and spent fuel pit cooling system (PTR) (not applicable to VVER),

Main Steam System - The function of the main steam piping is to convey the required steam flow from the steam generators to the turbine, and remove normal and residual (via the GCT system) heat from the reactor coolant system.

Condensate - Feedwater Systems - The Safety function of the Feedwater System is to provide adequate high quality water to the steam generator for removal of excess heat from the reactor core.

Auxilary Feedwater System (Emergency Feedwater system) - The Safety function of the Auxilary Feedwater System is to provide adequate high quality water to the steam generator for removal of excess heat from the reactor core in the event that the main feedwater system fails.

Chemical Volume Control System - The major functions are:

- Controlling slow variations in reactivity by adjusting the boron (soluble poison) concentration in the reactor coolant. These adjustments are carried out in conjunction with the reactor boron and water make-up system (REA),
- keeping coolant volume at preset levels during steady-state operation and controlling reactor coolant volume changes under transient conditions (e.g., during reactor startup),
- maintaining proper coolant chemistry including control of pH and dissolved oxygen, in conjunction with the REA system,
- limiting reactor coolant radioactivity levels arising from both activation products and fission and daughter products that may escape from the fuel; this is done via filtration and through fixation of radioactive materials on mixed and cation bed demineralisers,
- cooling reactor coolant pump lower bearings (n/a for VVER 440/230),
- controlling seal leakage of reactor coolant pumps (n/a for VVER 440/230)

Fuel Handling System - The fuel handling system consists of the mechanisms and tools used in handling new, spent fuel, and changing fuel assemblies during refuelling operations. This ensures the effective cooling necessary for the removal of the residual heat of the assemblies; in addition it allows visual checking of the progress of the operation, whilst affording protection against radiation. Soluble boron in the water ensures sub-criticality at all times.
Associated Sensing and Controls, cabling for instrumentation and power supply for the reactor shutdown.

Emergency Safety Systems Defense in Depth

Emergency Core Cooling - Emergency core cooling systems (high and low pressure) areprovided to cope with any loss of coolant accident due to a pipe rupture in the primary

coolant system. Abundant cooling water is available in such an emergency case to transfer heat from the core at a rate sufficient to maintain the fuel rod cladding t° whitin the limits.
Reactor Protection - The Reactor Protection Systems are designed to shutdown the reactor and maintain it shutdown when needed. These systems are automatically actuated and may be manually actuated. The Engineered Safety Feature Actuation Systems are designed to provide cooling for the reactor and to reduce the potential for offsite releases of radioactive materials. These systems are automatically actuated and may be manually actuated.

Accident Monitoring Instrumentation - The function of the Accident Monitoring Equipment is to provide accurate indication for the operator following design basis events.

Cooling Water Systems - Service Water Systems at any power plant have one major function which is to transfer the heat to the ultimate heat sink by means of cooling the multitude of heat exchangers or coolers. In this function the service water system may cool many essential safety related pieces of equipment. This system is referred to by a variety of names - Service Water, Cooling Water , Salt Water. Sometimes the system is broken into separate building systems as Turbine Building, Auxiliary Building, Reactor Building. Often the system is broken into safety and non-safety portions. For a number of plants the safety portion is referred to as the Essential Service Water System. The equipment in the safety portion of the system is powered by independent sources, e.g. diesel-driven pumps and diesel generators to supply electrical power.

Emergency Ventilation - The function of this system is to exhaust air from the penetration areas separating the reactor building from the fuel building, the nuclear auxiliary building, and the electrical building. This system prevents the uncontrolled release of airborne fission byproducts from the reactor building in the event that a containment overpressure condition occurs concurrently with a loss of containment integrity.

Vacuum Building - The single function of these systems in to remove the heat and reduce the pressure in the containment building during a postulated accident. (n/a for VVER)

Containment Spray System – The function of this system is to provide and spray boron solution in to the containment in order to reduce the pressure there.

Essential electricity Power Supplies   ?

Auxiliary power supply (transformers) ?

SSCs TO ENSURE OFFSITE RADIOACTIVE EXPOSURES ARE WITHIN LIMITS

Air Removal System and Reactor Building Ventilation System - This system prevents the uncontrolled release of airborne fission byproducts from the reactor building in the event that a containment overpressure condition occurs concurrently with a loss of containment integrity.

Post Loss of Coolant Hydrogen Control – The function of this system is to prevent the collection of hydrogen and thus the possibility of a hydrogen explosion after a Loss of Coolant Accident

Liquid Radioactive Waste System – This system prevents the uncontrolled release of liquid radioactive products in the environment.

Gaseous Radioactive Waste System – This system prevents the uncontrolled release of gaseous and airborne radioactive products in the environment.

Spent Fuel System - The spent fuel system serves 2 purposes:

- It serves as a shield to reduce the radiation levels that people working above may be exposed to.
- It cools the fuel assemblies that continue to produce heat (called decay heat) for some time after removal.

Associated Sensing and Controls, cabling for instrumentation and power supply for radiation protection

NON SAFETY SSCS WHOSE FAILURE IMPACTS SAFETY FUNCTION

Fire Protection – The function of the fire protection system is to detect, extinguish and prevent the spread of fire.

Diesel Generator Mechanical System – The function of the diesel generator is to provide emergency electrical power in the event that all offsite electrical power is lost

Component Cooling Water System – the function of the component cooling water system is to cool the multitude of heat exchangers or coolers in the power plant.

Associated Sensing and Controls, cabling for instrumentation and power supply for non safety SSC

APPENDIX VII
SSCS THAT ENSURE INTEGRITY OF REACTOR COOLANT PRESSURE BOUNDARY
Working Group 2
System Summary Table for LTO (including Degradation Mechanisms and Current Practice)

Component Grouping	**Safety Function**	**Materials**	**Environment or Stressors**	**Degradation Mechanism/Aging Effect**	**Safety Strategy**	**Practice for Inspection or Testing**
Reactor Vessel	Pressure Boundary; Contain fission Products	SA302-Gr B, SA533-Gr B, SA336, SA508 with Stainless steel cladding	Chemically treated borated water Up 270 to 340°C (644°F) ; Two phase steam in accident condition to 856°C ; Fission products environment barrier;	Cumulative fatigue damage/ Fatigue	Conservative Analysis provides technical justification for that Fatigue will not be a problem during the period of extended operation	Fatigue in U.S. is a time-limited aging analysis TLAA) to be evaluated for the period of extended operation, and, for Class 1 components, environmental effects on fatigue are to be addressed.
		15H2MFA ; 15H2NMFA				
				Loss of Fracture Toughness due to Embrittlement and Nuetron Flux	Conservative Analysis provides technical justification for that Embrittlement will not be a problem during the period of extended operation Vessel Material surveillance program	Fatigue in U.S. is a time-limited aging analysis TLAA) to be evaluated for the period of extended operation, and, for Class 1 components, environmental effects on fatigue are to be addressed.
				Loss of material/	Nondestructive examination	Boric Acid Corrosion Program

				Boric acid corrosion of external surfaces	of External surfaces	
				Loss of material/ Wear	Nondestructive examination to detect, quantify and trend damage	Chapter XI.M1, "ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD," for Class 1 components
				Flow Induced Vibration	Nondestructive examination to detect, quantify and trend damage	Chapter XI.M1, "ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD," for Class 1 components
				Crack initiation and growth/ Primary water stress corrosion cracking	Nondestructive examination to detect, quantify and trend damage	Chapter XI.M11, "Ni-alloy Nozzles and Penetrations," Chapter XI.M2, "Water Chemistry," for PWR primary water in EPRI TR-105714 Chapter XI.M1, "ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD," for Class 1 components
Reactor Vessel Control Rod Drive	Control Reactivity; Shutdown reactor	Type 403 and 316 stainless steel; type 304 stainless steel or cast austenitic stainless steel CF-8;	Chemically treated borated water up to 340°C (644°F) For VVER potential Acid Environment Check Water	Crack initiation and growth/ Primary water stress corrosion cracking	Control Water Chemistry Nondestructive examination to detect, quantify and trend damage For VVER Check Water Chemistry – generally Primary coolant is at pH of 6	Chapter XI.M11, "Ni-alloy Nozzles and Penetrations," Chapter XI.M2, "Water Chemistry," for PWR primary water in EPRI TR-105714 Chapter XI.M1, "ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD," for Class 1

		SA 508 class 2 with alloy 82/182 cladding	Chemistry			components
				Wear of Moving Components	???	???
				Cumulative fatigue damage/ Fatigue	Conservative Analysis provides technical justification for that Fatigue will not be a problem during the period of extended operation	Fatigue in U.S. is a time-limited aging analysis TLAA) to be evaluated for the period of extended operation, and, for Class 1 components, environmental effects on fatigue are to be addressed.
Reactor Vessel Internals	Control Reactivity; Contain fission products; Pressure Boundary; Maintain Coolant Core geometry	Stainless steel	Chemically treated borated water Up 270 to 340 644°F)	Crack initiation and growth/ Stress corrosion cracking, irradiation assisted Stress corrosion cracking	Control Water Chemistry and Nondestructive Testing to detect, monitor and trend damage	Chapter XI.M16, "PWR Vessel Internals," and Chapter XI.M2, "Water Chemistry," for PWR primary water in EPRI TR-105714
				Changes in dimensions/ Void Swelling	This program has not been fully developed – The components of the program will include all a attributes of an acceptable Aging Management Program	A plant-specific aging management program is to be evaluated. The applicant is to provide a plant-specific AMP or participate in industry programs to investigate aging effects and determine appropriate AMP. Otherwise, the applicant is to provide the basis for concluding

						that void swelling is not an issue for the component.
				Cumulative fatigue damage	Conservative Analysis provides technical justification for that Fatigue will not be a problem during the period of extended operation	Fatigue in U.S. is a time-limited aging analysis TLAA) to be evaluated for the period of extended operation, and, for Class 1 components, environmental effects on fatigue are to be addressed.
				Loss of preload/ Stress relaxation	Monitor and trend neutron flux Nondestructive testing to detect, monitor and trend damage	Chapter XI.M1, “ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD,” for Class 1 components and either Chapter XI.M14, “Loose Part Monitoring,” or Chapter XI.M15, “Neutron Noise Monitoring”
				Loss of fracture toughness/ Thermal aging and neutron Irradiation embrittlement, void swelling	The program has not been fully develop – program will contain Conservative Analysis provides technical justification for that Fatigue will not be a problem during the period of extended operation; Program ill include all a attributes of an acceptable Aging Management Program	Chapter XI.M13, “Thermal Aging and Neutron Irradiation Embrittlement of Cast Austenitic Stainless Steel (CASS)” Reactor Vessel Internals Program
				Loss of material/ Wear	Nondestructive Testing to detect, monitor and trend damage	Chapter XI.M1, “ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD,” for Class 1 components

Pressurizer Shell/heads	Pressure Boundary	Low-alloy steel with stainless steel or alloy 600 Cladding; 22K (VVER)	Chemically treated borated water or saturated steam 270-343°C (554-650°F)	Cumulative fatigue damage/ Fatigue	Conservative Analysis provides technical justification for that Fatigue will not be a problem during the period of extended operation	Fatigue in U.S. is a time-limited aging analysis TLAA) to be evaluated for the period of extended operation, and, for Class 1 components, environmental effects on fatigue are to be addressed.
				Loss of material/ Boric acid corrosion of external surfaces	Nondestructive testing to detect, monitor and trend damage	Boric Acid Corrosion Program
				Crack initiation and growth/ Stress corrosion cracking, cyclic loading	Control Water Chemistry and Nondestructive Testing to detect, monitor and trend damage	Chapter XI.M1, “ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD,” for Class 1 components Chapter XI.M2, “Water Chemistry,” for PWR primary water in EPRI TR-105714
Steam Generators						
Pressure boundary and structural	Pressure Boundary; Heat exchange - Remove excess heat from Core	Carbon steel, low-alloy steel	Up to 300°C (572°F) steam	Cumulative fatigue damage/ Fatigue	Conservative Analysis provides technical justification for that Fatigue will not be a problem during the period of extended operation	Fatigue in U.S. is a time-limited aging analysis TLAA) to be evaluated for the period of extended operation, and, for Class 1 components, environmental effects on fatigue are to be addressed.
				Loss of material/ General, pitting, and crevice	Control Water Chemistry and Nondestructive Testing to detect, monitor and trend	Chapter XI.M1, “ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD,” for Class 2

				corrosion	damage	components Chapter XI.M2, "Water Chemistry," for PWR secondary water in EPRI TR-102134
				Wall thinning/ Flow-accelerated corrosion	Control environmental conditions of temperature and chemistry – Also include Nondestructive Testing to detect, monitor and trend damage	Erosion Corrosion Program and/or Flow Accelerated Corrosion Program
				Loss of section thickness/ Erosion	Nondestructive Testing to detect, monitor and trend damage	Plant Specific Program
				Loss of material/ Boric acid corrosion of external surfaces	Nondestructive Testing to detect, monitor and trend damage	Boric Acid Corrosion Program
Tube bundle Tubes and sleeves	Pressure Boundary; Heat exchange - Remove excess heat from Core y	Alloy 600	Chemically treated borated water up to 340°C 644°F) and 15.5 MPa	Crack initiation and growth/ Primary water stress corrosion Cracking; Outer diameter stress corrosion Cracking and Loss of section thickness/Fretting	Control Water Chemistry and Nondestructive Testing to detect, monitor and trend damage	Chapter XI.M19, "Steam Generator Tubing Integrity" and Chapter XI.M2, "Water Chemistry," for PWR primary water in EPRI TR-105714 All PWR licensees have committed voluntarily to a SG degradation management program described in NEI 97-06
				Cumulative fatigue damage/ Fatigue	Conservative Analysis provides technical justification for that Fatigue will not be a problem during the period of extended	Fatigue in U.S. is a time-limited aging analysis TLAA) to be evaluated for the period of extended operation, and, for Class 1 components,

					operation	environmental effects on fatigue are to be addressed.
				Sludge or Fouling leading to loss of heat transfer	Control Water Chemistry and Nondestructive Testing to detect, monitor and trend damage	Chapter XI.M19, "Steam Generator Tubing Integrity" and Chapter XI.M2, "Water Chemistry," for PWR primary water in EPRI TR-105714 All PWR licensees have committed voluntarily to a SG degradation management program described in NEI 97-06
Reactor coolant pressure boundary components						
Piping and Fittings	Pressure Boundary	Stainless Steel; Stainless Steel clad and Carbon Steel	288°C (550°F) reactor coolant water or steam	Crack initiation and growth/ Stress corrosion cracking, intergranular Stress corrosion cracking, thermal and mechanical loading	Control Water Chemistry and Nondestructive Testing to detect, monitor and trend damage	Chapter XI.M2, "Water Chemistry," for BWR water in BWRVIP-29 (EPRI TR-103515) Chapter XI.M1, "ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD," for Class 1 components
				Cumulative fatigue damage/ Fatigue	Conservative Analysis provides technical justification for that Fatigue will not be a problem during the period of extended operation	Fatigue in U.S. is a time-limited aging analysis TLAA) to be evaluated for the period of extended operation, and, for Class 1 components, environmental effects on fatigue

						are to be addressed.
				Wall thinning/ Flow-accelerated corrosion	Control environmental conditions of temperature and chemistry – Also include Nondestructive Testing to detect, monitor and trend damage	Chapter XI.M17, “Flow-Accelerated Corrosion”
		Cast Stainless Steel		Loss of fracture toughness/ Thermal aging embrittlement	Conservative Analysis provides technical justification for that Fatigue will not be a problem during the period of extended operation	Chapter XI.M12, “Thermal Aging Embrittlement of Cast Austenitic Stainless Steel (CASS)”
Primary nozzles and safe ends	Pressure Boundary	Carbon steel with stainless steel cladding, safe ends: stainless Steel (NiCrFe buttering, And stainless steel or NiCrFe weld)	Chemically treated borated water up to 340°C (644°F)	Crack initiation and growth/ Stress corrosion cracking, primary water stress corrosion cracking	Control water chemistry and Nondestructive Testing to detect, monitor and trend damage	Chapter XI.M1, “ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD,” for Class 1 components Chapter XI.M2, “Water Chemistry,” for PWR primary water in EPRI TR-105714
Pump Casings	Pressure Boundary	Cast austenitic stainless steel, stainless steel	288°C (550°F) reactor coolant water or steam	Cumulative fatigue damage/ Fatigue	Conservative Analysis provides technical justification for that Fatigue will not be a problem during the period of extended operation	Fatigue in U.S. is a time-limited aging analysis TLAA) to be evaluated for the period of extended operation, and, for Class 1 components, environmental effects on fatigue

						are to be addressed.
				Crack initiation and growth/ stress corrosion cracking, intergranular stress corrosion cracking	Control water chemistry and Nondestructive Testing to detect, monitor and trend damage	Chapter XI.M2, "Water Chemistry," for BWR water in BWRVIP-29 (EPRI TR-103515) Chapter XI.M1, "ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD," for Class 1 components
				Cavitation	Operational procedures to avoid cavitation Nondestructive testing to detect, monitor and trend damage	Chapter XI.M1, "ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD," for Class 1 components
				Loss of fracture toughness/ Thermal aging embrittlement	Conservative Analysis provides technical justification for that Fatigue will not be a problem during the period of extended operation and Nondestructive Testing to detect, monitor and trend damage	Chapter XI.M12, "Thermal Aging Embrittlement of Cast Austenitic Stainless Steel (CASS)"
Valve Bodies	Pressure Boundary	Carbon steel, cast austenitic stainless steel, stainless steel	288°C (550°F) reactor coolant water or steam	Cumulative fatigue damage/ Fatigue	Conservative Analysis provides technical justification for that Fatigue will not be a problem during the period of extended operation	Fatigue in U.S. is a time-limited aging analysis TLAA) to be evaluated for the period of extended operation, and, for Class 1 components, environmental effects on fatigue are to be addressed.
				Loss of fracture	Conservative Analysis	Chapter XI.M1, "ASME Section XI

				toughness/ Thermal aging embrittlement	provides technical justification for that Fatigue will not be a problem during the period of extended operation and Nondestructive Testing to detect, monitor and trend damage	Inservice Inspection, Subsections IWB, IWC, and IWD," for Class 1 components
				Wall thinning/ Flow-accelerated Corrosion, Corrosion, Wear	Control environmental conditions of temperature and chemistry – Also include Nondestructive Testing to detect, monitor and trend damage	Erosion Corrosion Program and/or Flow Accelerated Corrosion Program
Bolting	Pressure Boundary	Flange: stainless steel; bolting: High strength low-alloy Steel; carbon steel	Air with metal temperature up to 288°C 550°F) also boric acid spray on external side of components	Loss of material/ Wear	Nondestructive Testing to detect, monitor and trend damage	Bolting Integrity Chapter XI.M1, "ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD," for Class 1 components
				Loss of preload/ Stress relaxation	Nondestructive Testing to detect, monitor and trend damage	Bolting Integrity Chapter XI.M1, "ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD," for Class 1 components
				Cumulative fatigue damage/ Fatigue	Conservative Analysis provides technical justification for that Fatigue	Fatigue in U.S. is a time-limited aging analysis TLAA) to be evaluated for the

					will not be a problem during the period of extended operation and Nondestructive Testing to detect, monitor and trend damage	period of extended operation, and, for Class 1 components, environmental effects on fatigue are to be addressed.
Hangers and Piping Supports		Stainless steel and Carbon Steel	Air with metal temperature up to 288°C 550°F)	Loss of material/ Wear Structural Distress	Nondestructive Testing to detect, monitor and trend damage	Chapter XI.M1, "ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD," for Class 1 components

APPENDIX VIII
SSCs THAT SHUT DOWN THE REACTOR AND MAINTAIN IT IN A SAFE SHUTDOWN CONDITION
(Including Emergency Systems)
Working Group 2
System Summary Table for LTO (including Degradation Mechanisms and Current Practice)

Component Group	**Safety Function**	**Materials**	**Environment or Stressors**	**Degradation Mechanism/Aging Effect**	**Safety Strategy**	**Practice for Inspection or Testing**
Vessels						
Core Flood Tank	Emergency Core Shutdown	Stainless Steel	Chemically Treated borated water At temperature < 93°C 200°F)	Crack initiation and growth/ Stress corrosion cracking	Control Water Chemistry Nondestructive examination to detect, quantify and trend damage	Chapter XI.M2, “Water Chemistry,” for PWR primary water in EPRI TR-105714 ASME Section XI Inservice Inspection
Refueling Water Storage Tank	Emergency Water Storage	Stainless Steel	Chemically Treated borated water At temperature < 93°C 200°F)	Crack initiation and growth/ Stress corrosion cracking	Control Water Chemistry Nondestructive examination to detect, quantify and trend damage	Chapter XI.M2, “Water Chemistry,” for PWR primary water in EPRI TR-105714 ASME Section XI Inservice Inspection
Condensate Storage Tank	Emergency Water Storage	Stainless Steel	Chemically Treated borated water At temperature < 93°C 200°F)	Crack initiation and growth/ Stress corrosion cracking	Control Water Chemistry Nondestructive examination to detect, quantify and trend damage	Chapter XI.M2, “Water Chemistry,” for PWR primary water in EPRI TR-105714 ASME Section XI Inservice Inspection

Piping, fittings and miscellaneous items						
Piping and fittings such as Temperature elements/indicators Strainers	Pressure Boundary for Emergency Cooling Water	Stainless steel	Chemically Treated borated water At temperature < 93°C 200°F)	Crack initiation and growth/ Stress corrosion cracking	Control Water Chemistry Nondestructive examination to detect, quantify and trend damage	Chapter XI.M2, "Water Chemistry," for PWR primary water in EPRI TR-105714 ASME Section XI Inservice Inspection
Containment spray system Eductors	Control containment pressure during severe postulated accidents	Stainless steel	Chemically treated borated water at Temperature < 93°C (200°F)	Crack initiation and growth/ Stress corrosion cracking	Control Water Chemistry	Chapter XI.M2, "Water Chemistry," for PWR primary water in EPRI TR-105714
Headers and spray nozzles	Control containment pressure during severe postulated accident	Carbon steel	Air	Loss of material/ General corrosion	Augment Erosion Corrosion Program	A plant-specific aging management program is to be evaluated.
Hangers and Piping Supports	Structural Support for Pressure Boundary	Stainless steel and Carbon Steel	Air with metal temperature up to 288°C 550°F)	Loss of material/ Wear Structural Distress	Nondestructive examination to detect, quantify and trend damage	Chapter XI.M1, "ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD," for Class 1 components
Heat Exchangers						
Heat exchanger Tubing	Remove Excess heat	Carbon steel,	Chemically treated	Loss of material/ General and	Control Water Chemistry	Chapter XI.M20, "Open-Cycle Cooling Water System" or

Shell Case/cover		stainless steel	borated water on one side and opencycle Cooling water (raw water) on the other side	microbiologically Influenced corrosion and biofouling	Nondestructive examination to detect, quantify and trend damage	Chapter XI.M20, “Closed-Cycle Cooling Water System”
Pumps						
Pump Bowl/casing Internal Surface	Provide Water for both normal Shutdown and Emergency Shut conditions	Stainless Steel; Carbon Steel	Chemically treated borated water at Temperature < 93°C (200°F)	Crack initiation and growth/Stress corrosion cracking Loss of material/ Erosion	Control Water Chemistry Nondestructive examination to detect, quantify and trend damage	Chapter XI.M2, “Water Chemistry,” for PWR primary water in EPRI TR-105714 ASME Section XI Inservice Inspection Plant specific program
Bowl/casing External Surface	Provide Water for both normal Shutdown and Emergency Shut conditions	Casing: carbon steel with stainless steel cladding	Air, leaking chemically Treated borated water	Loss of material/Boric acid corrosion	Nondestructive examination of External surfaces	Chapter XI.M10**, “**Boric Acid Corrosion**”**
				Cumulative fatigue damage/Fatigue	Conservative Analysis provides technical justification for that Fatigue will not be a problem during the period of extended operation	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period extended operation.
				Loss of fracture toughness/Thermal aging embrittlement	Conservative Analysis provides technical justification	Chapter XI.M12, “Thermal Aging Embrittlement of Cast Austenitic Stainless Steel

					for that Fatigue will not be a problem during the period of extended operation and Nondestructive testing to detect monitor and trend damage	(CASS)”
Valves						
Valves Body and bonnet	Containment Isolation and Pressure Boundary	Stainless steel	Chemically treated borated water at Temperature < 93°C (200°F)	Crack initiation and growth/Stress corrosion cracking	Control Water Chemistry Nondestructive examination to detect, quantify and trend damage	Chapter XI.M2, “Water Chemistry,” for PWR primary water in EPRI TR-105714 ASME Section XI Inservice Inspection
	Containment Isolation and Pressure Boundary	Carbon steel, stainless steel	Inside surface: treated or raw water, liquid waste; outside surface: ambient air	Loss of material/ General and microbiologically Influenced corrosion and biofouling	Augmented Erosion Corrosion Program	A plant-specific aging management program is to be evaluated. See IN 85-30 for evidence of microbiologically influenced corrosion.
				Cumulative fatigue damage/Fatigue	Conservative Analysis provides technical justification for that Fatigue will not be a problem during the period of extended operation	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period extended operation.
				Loss of fracture toughness/Thermal aging embrittlement	Conservative Analysis provides technical justification for that Fatigue will	Chapter XI.M12, “Thermal Aging Embrittlement of Cast Austenitic Stainless Steel (CASS)”

					not be a problem during the period of extended operation and Nondestructive testing to detect, monitor and trend damage	
Bolting						
Bolting at Flanges	Pressure Boundary	Carbon steel, low-alloy steel	Air, leaking chemically Treated borated water	Loss of material/ Boric acid corrosion	Nondestructive examination to detect, quantify and trend damage	Chapter XI.M10, "Boric Acid Corrosion" ASME Section XI Inservice Inspection
Bolting at Pumps	Pressure Boundary	Carbon steel, low-alloy steel	Air, leaking chemically Treated borated water	Loss of material/ Boric acid corrosion	Nondestructive examination of External surfaces	Chapter XI.M10, "Boric Acid Corrosion"
Bolting at Valves	Pressure Boundary	Carbon steel, low-alloy steel	Air, leaking chemically Treated borated water	Loss of material/ Boric acid corrosion	Nondestructive examination of External surfaces	Chapter XI.M10, "Boric Acid Corrosion"

APPENDIX IX
SSCs TO ENSURE OFFSITE RADIOACTIVE EXPOSURES ARE WITHIN NATIONAL LIMITS
Working Group 2
System Summary Table for LTO (including Degradation Mechanisms and Current Practice)

Component Group	**Safety Function**	**Materials**	**Environment or Stressors**	**Degradation Mechanism/Aging Effect**	**Safety Strategy**	**Practice for Inspection or Testing**
Vessels						
Ion exchanger (demineralizer) Shell Nozzles	Containment of Radioactive waste	Carbon steel with elastomer lining	Chemically treated borated water Air, leaking chemically treated borated water (External Surface)	Loss of material/ Pitting and crevice corrosion (only for carbon steel after lining degradation) Loss of material/ Boric acid corrosion	Control Water Chemistry Nondestructive examination to detect, quantify and trend damage	Chapter XI.M2, "Water Chemistry," for PWR primary water in EPRI TR-105714 The AMP is to be augmented by verifying the effectiveness of water chemistry control. See Chapter XI.M32, "One-Time Inspection," for an acceptable verification program. Boric Acid Program
Piping, fittings and miscellaneous items						
Auxiliary and Radwaste Area Ventilation System	Containment of Radioactive waste	Carbon steel	Hot or cold treated water	Loss of material/ General, pitting, crevice corrosion	Nondestructive examination to detect, quantify and trend damage	Chapter XI.M21, "Closed-Cycle Cooling Water System"
Spent Fuel Pool	Safe Storage of fuel that	Stainless Steel	Chemically treated	Loss of material/ Pitting and crevice	Control Water Chemistry	Chapter XI.M2, "Water Chemistry," for

	has completed the burn cycle		Oxygenated water up to 50°C (125°F)	corrosion	Nondestructive examination to detect, quantify and trend damage	PWR primary water in EPRI TR-105714 The AMP is to be augmented by verifying the effectiveness of water chemistry control. See Chapter XI.M32, "One-Time Inspection," for an acceptable verification program.
		Carbon steel, low-alloy steel	Air, leaking chemically Treated borated water	Loss of material/ Boric acid corrosion	Nondestructive examination to detect, quantify and trend damage	Chapter XI.M10, "Boric Acid Corrosion"
Ducts						
Duct fittings, access doors and closure bolts Equipment frames and housing	Containment and filtering of airborne radioactive contamination	Carbon steel (galvanized painted) bolts: plated carbon steel	Warm, moist air	Loss of material/ General, pitting, crevice corrosion, And microbiologically Influenced corrosion (for duct drip-pan] and piping for moisture drainage)	Nondestructive examination to detect, quantify and trend damage	Plant Specific Program to be evaluated
Flexible collars between ducts and fans Seals in dampers and doors	Containment and filtering of airborne radioactive contamination	Elastomer (Neoprene)	Warm, moist air	Hardening and loss of strength/ Elastomer degradation	Nondestructive examination to detect, quantify and trend damage	Plant Specific Program to be evaluated
Filters						

Housing and supports	Containment and filtering of airborne radioactive contamination	Carbon Steel	Warm, moist Air or Air, leaking chemically treated borated water	Loss of material/ General, pitting, crevice corrosion, And microbiologically Influenced corrosion (for duct drip-pan] and piping for moisture drainage)	Nondestructive examination to detect, quantify and trend damage	Plant Specific Program to be evaluated Boric Acid Program
Elastomer seals	Containment and filtering of airborne radioactive contamination	Elastomer (Neoprene)	Warm, moist air	Hardening and loss of strength/ Elastomer degradation	Nondestructive examination to detect, quantify and trend damage	Plant Specific Program to be evaluated
Spent Fuel Pool	Safe Storage of fuel that has completed the burn cycle	Carbon steel with elastomer lining	Chemically treated borated water	Loss of material/ Pitting and crevice corrosion (only for carbon steel after lining degradation)	Control Water Chemistry Nondestructive examination to detect, quantify and trend damage	Chapter XI.M2, "Water Chemistry," for PWR primary water in EPRI TR-105714 The AMP is to be augmented by verifying the effectiveness of water chemistry control. See Chapter XI.M32, "One-Time Inspection," for an acceptable verification program.
Air Handler Heating/Cooling						
	Containment and filtering of airborne radioactive contamination	Copper/nickel	Warm, moist air	Loss of material/ Pitting and crevice corrosion	Nondestructive examination to detect, quantify and trend damage	Plant Specific Program

Heat Exchangers						
Heat exchanger (serviced by closed-cycle cooling water system) Shell and access Cover Channel head and access cover (external surface)	Remove excess heat from spent fuel	Carbon steel, low alloy steel	Air, leaking chemically Treated borated water	Loss of material/Boric acid corrosion	Nondestructive examination to detect, quantify and trend damage	Chapter XI.M10, "Boric Acid Corrosion"
Pumps						
	Circulate water that Removes excess heat from spent fuel – Contain radioactive waste material	Carbon steel, low alloy steel	Air, leaking chemically Treated borated water	Loss of material/Boric acid corrosion	Nondestructive examination to detect, quantify and trend damage	Chapter XI.M10, "Boric Acid Corrosion"
Valves						
Spent Fuel Pool	Circulate and direct the flow of water that Removes excess heat from spent fuel – contain radioactive waster material	Carbon steel with elastomer lining	Chemically treated borated water	Loss of material/ Pitting and crevice corrosion (only for carbon steel after lining degradation)	Control Water Chemistry Nondestructive examination to detect, quantify and trend damage	Chapter XI.M2, "Water Chemistry," for PWR primary water in EPRI TR-105714. The AMP is to be augmented by verifying the effectiveness of water chemistry control. See Chapter XI.M32, "One-Time Inspection," for an acceptable verification

						program.
		Carbon steel with stainless Steel cladding	Chemically treated borated water	Crack initiation and growth/Stress corrosion cracking	Control Water Chemistry Nondestructive examination to detect, quantify and trend damage	Chapter XI.M2, "Water Chemistry," for PWR primary water in EPRI TR-105714
Bolting						
Closure Bolting	Contain radioactive waster material	Carbon steel, low-alloy steel	Air, leaking chemically Treated borated water	Loss of material/ Boric acid corrosion	Nondestructive examination to detect, quantify and trend damage	Chapter XI.M10, "Boric Acid Corrosion"

APPENDIX X.

NON SAFETY SSCS WHOSE FAILURE IMPACTS SAFETY FUNCTION

Working Group 2

System Summary Table for LTO (including Degradation Mechanisms and Current Practice)

Component Group	**Safety Function**	**Materials**	**Environment or Stressors**	**Degradation Mechanism/Aging Effect**	**Practice for Inspection or Testing**
Vessels					
Liquid Radiation Waste Tank					
Underground Tanks for Fuel Oil External Surface Internal Surface		Carbon steel	Fuel oil, water (as contaminant) or Outdoor ambient conditions	Loss of material/ General, pitting, crevice, microbiologically influenced corrosion and biofouling	Chapter XI.M30, "Fuel Oil Chemistry" The AMP is to be augmented by verifying the effectiveness of fuel oil chemistry control. See Chapter XI.M32, "One-Time Inspection," for an acceptable verification program. Chapter XI.M29, "Aboveground Carbon Steel Tanks"
Piping, fittings and miscellaneous items					
Piping and fittings		Carbon steel (for fresh water only) aluminumbronze, brass, copper-nickel, stainless steel	Raw water	Loss of material/ General, galvanic, pitting, crevice, microbiologically influenced corrosion and Biofouling, selective leaching	Chapter XI.M27, "Fire Water System" Chapter XI.M20, "Open-Cycle Cooling Water System" and Chapter XI.M33, Selective Leaching of Materials"

			Saturated air	Loss of material/ General and pitting corrosion	Chapter XI.M24, "Compressed Air Monitoring"
Underground piping and fittings (external surface, with or without organic coating or wrapping)		Carbon steel Cast iron	**Soil**	Loss of material/ General, pitting, crevice, and microbiologically influenced Corrosion; Selective leaching	Chapter XI.M28, "Buried Piping and Tanks Surveillance," Chapter XI.M33, "Selective Leaching of Materials"
Hangers and Piping Supports		Stainless steel and Carbon Steel	Air with metal temperature up to 288°C 550°F)	Loss of material/ Wear Structural Distress	Chapter XI.M1, "ASME Section XI Inservice Inspection, Subsections IWB, IWC, and IWD," for Class 1 components
Heat Exchangers					
Heat exchanger Tubing Shell Case/cover		Carbon steel, stainless steel	Chemically treated borated water on one side and opencycle Cooling water (raw water) on the other side	Loss of material/ General and microbiologically Influenced corrosion and biofouling	Chapter XI.M20, "Open-Cycle Cooling Water System" or Chapter XI.M20, "Closed-Cycle Cooling Water System"
Pumps					
Pump Bowl/casing Internal Surface		Stainless Steel; Carbon Steel	Chemically treated borated water at Temperature < 93°C (200°F) Cooling water (raw water)	Crack initiation and growth/Stress corrosion cracking Loss of material/ Erosion	Chapter XI.M2, "Water Chemistry," for PWR primary water in EPRI TR-105714 ASME Section XI Inservice Inspection Chapter XI.M20, "Open-Cycle Cooling Water System" or Chapter XI.M20, "Closed-Cycle Cooling

					Water System”
Bowl/casing External Surface		Casing: carbon steel with stainless steel cladding	Air, leaking chemically Treated borated water	Loss of material/Boric acid corrosion	Chapter XI.M10, **“**Boric Acid Corrosion**”**
				Cumulative fatigue damage/Fatigue	Fatigue is a time-limited aging analysis (TLAA) to be evaluated for the period extended operation.
				Loss of fracture toughness/Thermal aging embrittlement	Chapter XI.M12, “Thermal Aging Embrittlement of Cast Austenitic Stainless Steel (CASS)”
Valves					
Valves Body and bonnet		Carbon steel, stainless steel	Inside surface: treated or raw water, liquid waste; outside surface: ambient air	Loss of material/ General and microbiologically Influenced corrosion and biofouling	Chapter XI.M2, “Water Chemistry,” for PWR primary water in EPRI TR-105714 ASME Section XI Inservice Inspection
Bolting					
Bolting at Flanges		Carbon steel, low-alloy steel	Air, leaking chemically Treated borated water Outdoor/Indoor Ambient conditions	Loss of material/ Boric acid corrosion	Chapter XI.M10, **“**Boric Acid Corrosion**”** ASME Section XI Inservice Inspection A plant-specific aging management program is to be evaluated.
Bolting at Pumps		Carbon steel, low-alloy steel	Air, leaking chemically Treated borated water Outdoor/Indoor Ambient conditions	Loss of material/ Boric acid corrosion	Chapter XI.M10, **“**Boric Acid Corrosion**”**

Bolting at Valves		Carbon steel, low-alloy steel	Air, leaking chemically Treated borated water Outdoor/Indoor Ambient conditions	Loss of material/ Boric acid corrosion	Chapter XI.M10, "Boric Acid Corrosion"