Comparison of Degradation Scenarios in the Proactive Materials Degradation Assessment (PMDA) and the Generic Aging Lessons Learned (GALL) Report

Technical Letter Report

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December 5, 2011

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Executive Summary

As part of license renewal for nuclear power plants in the United States (U.S.), licensees are required to implement aging management programs (AMPs) to address the potential effects of materials degradation in the extended operating period. The AMPs cover a broad range of passive structures, systems, and components including reactor internals, the reactor pressure vessel, primary and secondary piping, electrical cables and components, and concrete structures. Based on plant operating experience and experimental investigations, the U.S. Nuclear Regulatory Commission (NRC) evaluated potential aging-related materials degradation scenarios and developed a set of generic AMPs that were published in NUREG-1801, "Generic Aging Lessons Learned (GALL) Report," Revision 1. Licensees may incorporate by reference the GALL Report AMPs with or without modification into the license renewal application.

To prepare for future updates to the GALL Report, NRC in 2006-2007 convened a panel of subject matter experts to assess the current state of knowledge concerning aging-related degradation of reactor components. It was intended that the panel would provide information to allow NRC to proactively identify degradation scenarios that may arise as plants age, such that steps could be taken before plant safety is compromised. The results of the expert panel assessment were published in 2007 in NUREG/CR-6923 "Expert Panel Report on Proactive Materials Degradation Assessment," commonly referred to as the PMDA report.

The purpose of this letter report is to compare the degradation scenarios in the GALL report and the PMDA report, respectively. In particular, the comparison is intended to determine whether all degradation scenarios identified in the PMDA report were addressed by AMPs in the GALL report. The comparison focused on three categories of degradation scenarios that were identified in the PMDA report: scenarios for which there is high susceptibility and low knowledge (pink category), scenarios for which there is high susceptibility and intermediate-to-high knowledge (red category), and scenarios for which there is intermediate susceptibility and low-to-intermediate knowledge (yellow category).

In total, 384 degradation scenarios identified in the PMDA report were reviewed to determine if they were fully addressed by AMPs in the GALL report. Generally, good correlation was found between the PMDA and GALL reports. A total of 91 differences between the PMDA and GALL report degradation scenarios were noted, where a difference indicates an omission or discrepancy in the description of the component, material, environment, or degradation phenomenon. Only 1 discrepancy was identified for the most significant pink category scenarios, 21 for the red category, and 69 for the yellow category. The results of this comparison may be used to support the development of future revisions to the GALL report or to determine whether interim staff action is warranted.

Acknowledgements

This technical letter report is primarily based on the Pacific Northwest National Laboratories report, “Assessment of PMDA Degradation Scenarios with Respect to the Current GALL Report,” by E.P Simonen and S.M. Bruemmer, provided to NRC under contract JCN6957, Gene Carpenter, Project Manager.

The author also gratefully acknowledges the review and suggestions provided by Kenneth Karwoski, Allen Hiser, and Robert Tregoning.

1.0 Introduction

License renewal for nuclear power plants requires programs or activities to manage the effects of aging on reactor components. Nuclear Regulatory Commission (NRC) guidance on aging management programs (AMPs) is found in NUREG-1801, "Generic Aging Lessons Learned (GALL) Report, Revision 1" (NRC, 2005). The GALL report identified degradation scenarios and AMPs for light-water reactor (LWR) plant systems and components mainly based on plant experience. These AMPs have been evaluated and determined to be acceptable.

In an independent study of plant aging mechanisms, an expert panel similarly reviewed the nuclear plant systems and components for degradation scenarios. The review was based on research and laboratory studies in addition to plant experience and produced NUREG/CR-6923, "Expert Panel Report on Proactive Materials Degradation Assessment" (NRC, 2007). Also referred to as the PMDA report, NUREG/CR-6923 addressed degradation issues differently and may have identified degradation scenarios that may not be addressed in the GALL report. The identification of new degradation scenarios is important for future updates to the GALL report. In addition, the results will allow the NRC staff to determine whether additional research (confirming adequacy of industry programs) or regulatory action is needed to address these degradation scenarios.

The GALL report and subsequent revisions describe surveys of LWR plant component aging mechanisms dependent on material condition, environmental exposure and mechanical history. The plant aging information originates from laboratory testing, NRC reports, industry reports for license renewal, licensee event reports and other generic communications. The GALL report approach emphasizes plant experience with components to identify issues, but does not rank their relative importance. The GALL report is organized in two volumes: an overall summary report (Vol. 1) and a detailed tabulation of results (Vol. 2). The evaluation in the present work is based on Revision 1 of the GALL report. Revision 2 of the GALL report (NRC, 2010) was issued in 2010 but was not completed at the time this report was being prepared.

The PMDA report followed the same general approach used in the GALL report and organized plant aging issues along the lines of components and degradation mechanisms as affected by environment and mechanical histories. In addition to plant operating experience, the PMDA report considered data and information from laboratory studies. A scoring system was devised to rank issues for LWR components according to degradation susceptibility, level of knowledge and perceived reviewer confidence. The scores were accompanied by comments from each of the experts, giving insights into the final ratings.

The objective for this report is to directly compare degradation scenarios identified in the PMDA report to those identified in Revision 1 of the GALL report, and to identify those PMDA scenarios not addressed in the GALL report.

2.0 Assessment Approach for GALL and PMDA Comparisons

2.1 GALL and PMDA Approach Philosophies

The GALL and PMDA reports assessed the potential degradation scenarios for a similar set of LWR systems and components. Four principle systems were examined in each report: (1) reactor coolant systems including internals, (2) engineered safety systems, (3) auxiliary systems including support systems and (4) steam and power conversion systems. The GALL analysis focused on AMPs intended for guidance in the license renewal process. Representatives from the NRC Offices of Nuclear Reactor Regulation and Nuclear Regulatory Research, and Parallax, Inc contributed to the GALL report. The evaluation included systems, structures and components as required by 10 CFR Part 54. Tables of issues were established that identified systems, components, material type, environment, aging mechanism, AMP and need for future evaluation.

PMDA emphasized a more comprehensive and proactive approach to assess component degradation and to rank their importance. The PMDA report authors consisted of a panel of eight technical experts that reviewed information on components, material type, and degradation mechanisms. The panel reviewed and evaluated an extensive list of reactor parts. A scoring system was used to provide a ranking of degradation scenarios in terms of susceptibility, knowledge, and degree of confidence in the susceptibility and knowledge scores. For the current task comparing PMDA to GALL, the three most potentially significant areas were evaluated: (1) high susceptibility and low knowledge degradation scenarios, (2) high susceptibility and intermediate-to-high knowledge degradation scenarios, and (3) intermediate susceptibility and low-to-intermediate knowledge degradation scenarios. These categories were assigned colors in the PMDA analysis as (1) pink, (2) red and (3) yellow as illustrated in Figure 1. The confidence score was not explicitly considered in this analysis. The goal of a proactive materials degradation program is to move degradation scenarios from the higher susceptibility and lower knowledge (pink) regime to that of lower susceptibility and higher knowledge (dark green) as indicated by the arrow. The goal of an AMP is to manage a degradation scenario such that component integrity in the extended operating period is maintained.

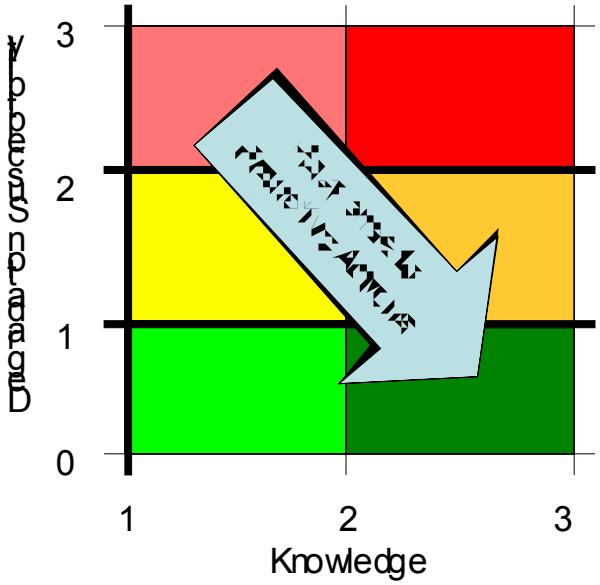

Figure 1. Graphical representation of the PMDA Rating Scheme and the Goal of Proactive Actions to Reduce Degradation Susceptibility and Increase Knowledge

2.2 Spreadsheet Descriptions for Cataloging and Comparing Information

Spreadsheets were used to compare the GALL and PMDA reports. The spreadsheets were set up in Excel software to enable broad-based access, simplicity of use and for the ability to include "comments" within individual cells. The master spreadsheet originated from the PMMD information tool developed at Pacific Northwest National Laboratory for the NRC. The tool's flag view delineated the list of issues to include as rows of information such as the engineering system, component and the degradation mechanism. Specific information concerning the material condition and environment was obtained from the PMMD expert view and was added to the spreadsheet. Similarly, the numerical scores for material susceptibility and knowledge of degradation from the PMMD report were included in the spreadsheet.

A total of five Excel spreadsheets were created covering the three most significant PMDA categories: (1) high susceptibility and low knowledge (pink), (2) high susceptibility and intermediate-to-high knowledge (red) and (3) intermediate susceptibility and low-to-intermediate knowledge (yellow). The spreadsheet for the pink category includes both the pressurized water reactor (PWR) issues and the single boiling water reactor (BWR) issue. Because the number of degradation scenarios was greater, the other categories had separate spreadsheets for the PWR and BWR assessments, respectively. For each degradation scenario, a line-by-line review of the PMDA issues was conducted to identify the corresponding item or items in the GALL report Tabulation of Results.

Spreadsheets were organized by LWR system and specific component with degradation scenarios described below individual components. For each degradation scenario, the first and second columns indicate the PMDA reference number and material condition, respectively. Subsequent columns identify the PMDA degradation mechanism for that

component-material condition and the PMDA expert numerical ratings for susceptibility and knowledge. The next column entitled "GALL Reference (Aging Management Plan)" is of primary importance to the current assessment. It directly links the PMDA degradation scenario to the corresponding line item(s) in the GALL report aging management review (AMR) tables and provides a comment if there is a discrepancy between PMDA and the GALL report. The final column includes a more detailed description of the PMDA expert comments concerning the degradation scenario.

The purpose of the present assessment was not to evaluate the AMPs, but rather to identify PMDA degradation scenarios that do not appear to be identified in Revison 1 of the GALL report. As noted above, comments embedded in the GALL Reference column describe discrepancies between PMDA and the GALL report. The ease of displaying these comments in an Excel spreadsheet simplifies the data review. A more detailed description of each column in the spreadsheets is given below along with important abbreviations that are used.

2.2.1 Subgroup Description: Material and Condition

LWR subsystems are listed along with more detailed information for the metallic alloy, material condition and the service environment. Alloys are mainly stainless steels, carbon steels or nickel-base alloys. Material condition or processing information is noted if deemed important, for example to indicate a weld, a heat-affected zone or if the material has been cold worked or given a special heat treatment. Since many of the degradation mechanisms are environmentally induced, selected information on the environment, irradiation exposure and temperature is provided as needed.

2.2.2 Degradation Mechanism

Fourteen degradation mechanisms were identified in the PMDA report. These are listed in Table 1 along with their corresponding abbreviations used in the spreadsheet. The GALL report identified similar degradation mechanisms, however the specific definitions differ in some cases. Thermal creep is described in GALL as "loss of preload/stress relaxation" and does not include irradiation creep explicitly. Similarly, fatigue can be described in the GALL report as "cyclic loading" or as fatigue. Corrosion fatigue is not included as a separate form of fatigue. Since irradiation assisted stress-corrosion cracking (SCC) is listed as an aging effect or mechanism, irradiation is not included as an environmental issue in the GALL report. Therefore, irradiation is not called out as an environmental parameter when considering damage in the GALL report as it is within the PMDA report.

Table 1. Degradation Mechanisms in the PMDA Report

Degradation Mechanism	Abbreviation or Acronym
Boric acid corrosion	BAC
Thermal creep	CREEP
Crevice corrosion (including denting)	CREV
Erosion corrosion (including steam cutting and cavitation)	EC
Flow-accelerated corrosion	FAC
Fatigue (thermal, mechanical and corrosion)	FAT
Reduction of fracture resistance	FR
Galvanic corrosion	GALV
Irradiation creep	IC
Microbial induced corrosion	MIC
Pitting corrosion	PIT
Stress corrosion cracking (intergranular, transgranular, irradiation assisted, strain induced, hydrogen embrittlement) and intergranular attack	SCC
Swelling	SW
Fretting and wear	WEAR

2.2.3 Susceptibility and Knowledge

The PMDA scores for degradation susceptibility and knowledge, respectively, dictated the category (pink, red, or yellow) to which each degradation scenario was assigned. To obtain the score for degradation susceptibility, the PMDA experts evaluated the scenario using the following numerical scale:

> **Susceptibility factor** - can significant material degradation develop given plausible conditions?
>
> 0 = not considered to be an issue
> 1 = conceptual basis for concern from data, or potential occurrences under unusual operating conditions
> 2 = strong basis for concern or known but limited plant occurrence
> 3 = demonstrated, compelling evidence for occurrence, or multiple plant observations.

Degradation scenarios with average expert score less than 1 were considered low susceptibility, those between 1 and 2 were considered intermediate susceptibility, and those greater than 2 were considered high susceptibility. Some degradation scenarios where the average expert score was less than 2 were nevertheless categorized as high susceptibility if one or more expert gave it a high susceptibility score.

To obtain the score for degradation scenario knowledge, the PMDA experts evaluated the scenario using the following numerical scale:

> **Knowledge factor** - extent to which the relevant dependencies have been quantified
>
> 1 = poor understanding, little and/or low-confidence data
> 2 = some reasonable basis to know dependencies qualitatively or semi-quantitatively from data or extrapolation in similar "systems"
> 3 = extensive, consistent data covering all dependencies relevant to the component, perhaps with models; should provide clear insights into mitigation or management of problem

Degradation scenarios with average expert score of 2 or less were considered low knowledge, those greater than 2 but less than 2.5 were considered intermediate knowledge, and those greater than 2.5 were considered high knowledge.

2.2.4 GALL Reference (Aging Management Program)

The GALL Reference column identifies the specific GALL chapter, section and item number within the section that best matches the PMDA degradation scenario. Titles of these GALL chapters and the major system sections are listed in Table 2. The AMPs typically referred to Section XI of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel code, time limited aging analyses (TLAA), and/or the need for a licensee commitment.

Table 2. GALL Report Chapter and Major Systems Sections

Chapter IV. Reactor Vessel, Internals, and Reactor Coolant System
Section A1. Reactor Vessel (Boiling Water Reactor)
Section A2. Reactor Vessel (Pressurized Water Reactor)
Section B1. Reactor Vessel Internals (Boiling Water Reactor)
Section B2. Reactor Vessel Internals (PWR) - Westinghouse
Section B3. Reactor Vessel Internals (PWR) - Combustion Engineering
Section B4. Reactor Vessel Internals (PWR) - Babcock and Wilcox
Section C1. Reactor Coolant Pressure Boundary (Boiling Water Reactor)
Section C2. Reactor Coolant System and Connected Lines (Pressurized Water Reactor)
Section D1. Steam Generator (Recirculating)
Section D2. Steam Generator (Once-Through)
Section E. Common Miscellaneous Material/Environment Combinations
Chapter V. Engineered Safety Features
Section A. Containment Spray System (Pressurized Water Reactors)
Section B. Standby Gas Treatment System (Boiling Water Reactors)
Section C. Containment Isolation Components
Section D1. Emergency Core Cooling System (Pressurized Water Reactors)
Section D2. Emergency Core Cooling System (Boiling Water Reactors)
Section E. External Surfaces of Components and Miscellaneous Bolting
Section F. Common Miscellaneous Material/Environment Combinations
Chapter VII. Auxiliary Systems
Section A1. New Fuel Storage
Section A2. Spent Fuel Storage
Section A3. Spent Fuel Pool Cooling and Cleanup (PWR)
Section A4. Spent Fuel Pool Cooling and Cleanup (BWR)
Section A5. Suppression Pool Cleanup System (BWR)
Section B. Overhead Heavy Load and Light Load (Refueling) Handling Systems
Section C1. Open-Cycle Cooling Water System (Service Water System)
Section C2. Closed-Cycle Cooling Water System
Section C3. Ultimate Heat Sink
Section D. Compressed Air System
Section E1. Chemical and Volume Control System (PWR)
Section E2. Standby Liquid Control System (BWR)
Section E3. Reactor Water Cleanup System (BWR)
Section E4. Shutdown Cooling System (Older BWR)
Section F1. Control Room Area Ventilation System
Section F2. Auxiliary and Radwaste Area Ventilation System
Section F3. Primary Containment Heating and Ventilation System
Section F4. Diesel Generator Building Ventilation System
Section G. Fire Protection
Section H1. Diesel Fuel Oil System
Section H2. Emergency Diesel Generator System
Section I. External Surfaces of Components and Miscellaneous Bolting
Section J. Common Miscellaneous Material/Environment Combinations
Chapter VIII. Steam and Power Conversion System
Section A. Steam Turbine System
Section B1. Main Steam System (PWR)
Section B2. Main Steam System (BWR)
Section C. Extraction Steam System
Section D1. Feedwater System (PWR)
Section D2. Feedwater System (BWR)
Section E. Condensate System
Section F. Steam Generator Blowdown System (PWR)
Section G. Auxiliary Feedwater System (PWR)
Section H. External Surfaces of Components and Miscellaneous Bolting
Section I. Common Miscellaneous Material/Environment Combinations

The notations for the AMPs are shown in Table 3. Additional notations are used for TLAA and for cases where confirmation of plant-specific AMPs need to be confirmed.

Table 3. AMPs Referenced in the Spreadsheets

AMP Title	AMP Designation
ASME Section XI Inservice Inspection, Sections IWB (class 1), IWC (class 2) and IWD (class 3)	XI.M1
Water Chemistry	XI.M2
Reactor Head Closure Studs	XI.M3
BWR Vessel ID Attachment Welds	XI.M4
BWR Stress Corrosion Cracking	XI.M7
BWR Penetrations	XI.M8
BWR Vessel Internals	XI.M9
Thermal Aging and Neutron Irradiation Embrittlement of Cast Austenitic Stainless Steel (CASS)	XI.M13
Flow-Accelerated Corrosion	XI.M17
Bolting Integrity	XI.M18
Steam Generator Tube Integrity	XI.M19
Open-Cycle Cooling Water System	XI.M20
Closed-Cycle Cooling Water System	XI.M21
Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components	XI.M38

Most spreadsheet cells in the “GALL Reference” column contain embedded comments that relate to the comparison between the GALL report and the PMDA report. These comments call out differences between the two reports. A cell that contains no comments indicates that the two reports were in good agreement. The cell comments that indicate “None” describe the case where the degradation scenario identified in the PMDA report was entirely missing in the GALL report. Other comments refer to a lack of one or more specific details in the GALL report. For example, the general material description may be mentioned in the GALL report (e.g., stainless steel), whereas the PMDA report has a more thorough description of the material condition (e.g., cold-worked stainless steel). Because the material condition may have a significant effect on the potential for degradation, such differences were included in the comments for the “GALL Reference” column.

2.2.5 PMDA Comments

Lastly, the column identified as “PMDA Expert Comments” is included as a blank spreadsheet cell but with an embedded comment that summarizes the expert comments found in the PMDA report. The embedded comment includes the PMDA reference number, the material condition, degradation mode and each expert’s score and a brief statement of rationale. The rationale provides more detail as to the expert’s assessment basis and degree of concern for specific issues.

3.0 Comparison of PMDA and GALL Degradation Scenarios

3.1 General Comments

This comprehensive review indicates that both the GALL and PMDA reports identify common degradation scenarios for LWR component degradation issues. The parallel organization of the two reports facilitates the detailed comparison of the results expressed in the spreadsheets. As a general observation, the PMDA report is more specific as to the degradation process both in terms of alloy fabricated condition and the chemical-irradiation environment in service. Most degradation scenarios required a comment embedded in the "GALL Reference" column of the spreadsheets to describe the challenges in comparing the two reports. A detailed discussion of the comparison between PMDA and the GALL report is found in the following sections.

3.2 PMDA High Susceptibility and Low Knowledge (Pink) Degradation Scenarios

There were a limited number of degradation scenarios that the PMDA report placed in the pink category of high susceptibility and low knowledge, 23 for PWRs and only 1 for BWRs. The PWR degradation scenarios in this category are mainly fatigue for socket welds, SCC for dissimilar metal welds, and radiation effects for stainless steels. These degradation scenarios are referenced in the GALL report tables, though the PMDA gives more specific identification of materials and material conditions (e.g., PMDA refers to SCC of Alloy 82/182 dissimilar metal welds whereas GALL report refers to SCC of nickel alloy materials). The only PMDA degradation scenario identified as pink for BWRs, SCC of the low-alloy steel T-quencher, does not have a directly corresponding line item in the AMR tables of the GALL report. The component is, however, mentioned in GALL AMP XI.M18 Bolting Integrity, which calls for periodic inspection of bolting for indications of degradation.

3.3 PMDA High Susceptibility and Intermediate-to-High Knowledge (Red) Degradation Scenarios

There were a greater number of degradation scenarios that the PMDA report placed in the in the red category for high susceptibility and intermediate-to-high knowledge, 42 for PWRs and 96 for BWRs. The largest number of red category degradation scenarios for PWRs pertain to SCC of stainless steel and nickel alloy components. Although there are some differences between PMDA and the GALL report concerning the level of detail in the description of materials conditions and the environment, only six of these degradation scenarios for PWRs do not appear to be completely addressed in the GALL report. These include a PMDA reference to the effect of saturated water on fatigue of carbon steel steam generator components, two references to the SCC of high strength pump parts and three references to SCC of stainless steel pipe welds from the external environment. Of the 96 degradation scenarios categorized as red for BWRs in PMDA, the most numerous pertain to SCC of austenitic alloys with an emphasis on welds and heat-affected zones. A total of 15 red BWR degradation scenarios did not appear to be fully addressed in the GALL report. Among these are microbially-influenced corrosion of

carbon steel and certain material types (e.g., high-strength nickel alloys or titanium), erosion corrosion of titanium, and pitting of the T-quencher.

3.4 PMDA Intermediate Susceptibility and Low-to-Intermediate Knowledge (Yellow) Degradation Scenarios

The PMDA report placed 192 degradation scenarios for PWRs into the yellow category for *intermediate susceptibility and low-to-intermediate knowledge*. The most numerous of these scenarios pertain to fatigue and SCC of austenitic alloys. A total of 41 out of these 192 degradation scenarios were not completely addressed in the GALL report. Most of the discrepancies concerned loss of fracture resistance for austenitic alloys, and SCC or fatigue of CASS. Others related to boric acid corrosion of stainless steel clad ferritic piping, fatigue of reactor coolant pump parts, fatigue of the divider plate, and SCC of high-strength fasteners and springs. Of 30 degradation scenarios that PMDA placed into the yellow category for BWR components, 28 were not fully addressed in the GALL report. These mainly concerned the loss of fracture resistance in austenitic alloys.

4.0 Summary

A total of 384 degradation scenarios in the pink, red, and yellow PMDA categories were evaluated. Comparison with the GALL report revealed potential discrepancies for 91 of these 384 scenarios. The distribution of these findings is shown in Table 4. The findings show good agreement between PMDA and GALL for the high susceptibility and low knowledge pink category, where only one potential difference between PMDA and the GALL report was identified. For the high susceptibility and intermediate-to-high knowledge red, there were 21 potential differences between PMDA and the GALL report. For the intermediate susceptibility and low-to-intermediate knowledge yellow category, there were 69 potential differences between PMDA and the GALL report. PWR degradation scenarios of intermediate susceptibility and knowledge, particularly fracture resistance of austenitic alloys, contributed significantly to the number of potential discrepancies with the GALL report. This is consistent with the fact the PMDA review included degradation issues that have emerged in more recent laboratory studies and have not been identified as a significant issue in operating plants.

Table 4. Discrepancies between PMDA and GALL Report Degradation Scenarios

Category	Mechanism	Component	Environment	Alloy	Total
PWR-Pink					
BWR-Pink		1			1
PWR-Red	2	1	3		6
BWR-Red	6	5	2	2	15
PWR-Yellow	40			1	41
BWR-Yellow	26		2		28

5.0 References

Nuclear Regulatory Commission, “Generic Aging Lessons Learned (GALL) Report,” NUREG-1801, Rev. 1, September 2005.

Nuclear Regulatory Commission, “Generic Aging Lessons Learned (GALL) Report,” NUREG-1801, Rev. 2, December 2010.

Nuclear Regulatory Commission, “Expert Panel Report on Proactive Materials Degradation Assessment,” NUREG/CR-6923, February 2007.

Appendix A:
PMDA–GALL Comparison Spreadsheet –
Pressurized Water Reactor Pink Category

Subgroup Description:	Material and Condition	Degradation Mechanism				PMDA Expert Ratings		GALL Reference	PMDA
		FAT	IC	SCC	SW	Susceptibility	Knowledge	(Aging Management Plan)	Comments
Accumulator Piping to RCS Cold Leg									
18.13	308/309, 82/182 Dissimilar Metal Weld; PWR Primary Water; CE/B&W					2.50	1.75	IVC2-1,2,13, 27 (XI.MI,IWB,IWB.XI.M2,XI.M35)	
SI/RHR Piping to RCS Hot Leg									
19.10	308/309, 82/182 Dissimilar Metal Weld; PWR Primary Water; CE/B&W					2.75	1.88	IVC2-1,2,13, 27 (XI.MI,IWB,IWB.XI.M2,XI.M35)	
CVCS Piping to RCS Cold Leg									
22.8	308/309, 82/182 Dissimilar Metal Weld; PWR Primary Water; CE/B&W					2.88	1.88	IVC2-1,2,13, 27 (XI.MI, IWB, IWB.XI.M2, XI.M35)	
Cold Leg Piping									
1.7	304/308/316SS Socket Welds; 556-559F; PWR Primary Water					2.38	1.75	IVC2-25,26 (TLAA - XI.MI, IWB, IWC.IWD, XI.M2)	
Crossover Leg Piping									
2.7	304/308/316SS Socket Welds; 556-559F; PWR Primary Water					2.38	1.75	IVC2-25,26 (TLAA - XI.MI, IWB, IWC.IWD, XI.M2)	
Hot Leg Piping									
3.7	304/308/316SS Socket Welds; 610-620F; PWR Primary Water					2.38	1.75	IVC2-25,26 (TLAA - XI.MI, IWB, IWC.IWD, XI.M2)	
Pressurizer									
4.6	Alloy 82/182 Dissimilar Metal Welds; PWR Primary Water					2.88	1.88	IVC2-17,24 (TLAA - XI.M2, XI.M32XI.MI, IWB, IWC.IWD)	
4.7	Forged Alloy 600 Nozzles; PWR Primary Water					3.00	2.00	IVC2-24 (TLAA - XI.MI, IWB, IWC.IWD, XI.M2)	
Pressurizer Spray Piping									
5.6	304/308/316SS Socket Welds; 556-559F; PWR Primary Water					2.38	1.75	IVC2-18,25,26 (TLAA - XI.MI, IWB, IWC.IWD, XI.M2)	
Pressurizer Surge Piping									
6.6	304/308/316SS Socket Welds; 620-653F; PWR Primary Water					2.38	1.75	IVC2-18,25,26 (TLAA - XI.MI, IWB, IWC.IWD, XI.M2)	

(Continued on next page)

Subgroup Description:	Material and Condition	Degradation Mechanism				PMDA Expert Ratings		GALL Reference	PMDA
		FAT	IC	SCC	SW	Susceptibility	Knowledge	(Aging Management Plan)	Comments
Pressurizer Piping to PORVs									
7.6	304/308SS Socket Welds (Stagnant); 653F; PWR Primary Water					2.25	1.75	IVC2-18,25,26 (TLAA - XI.MI, IWB, IWC.IWD, XI.M2)	
Reactor Pressure Vessel									
10.8	Alloy 82/182 Dissimilar Metal Welds; PWR Primary Water					2.13	2.00	IVA2-21 (TLAA)	
Reactor Vessel Internals									
12.9	Type 304 SS HAZ (>0.5 dpa); PWR Primary Water					1.88	1.75	(CE) IVB3-9,11 (XI.M2)	
12.10	308 SS Weld Metal (>0.5 dpa); PWR Primary Water					1.88	1.75	IV.B2-2,8,10,12,20,24,30, 36,42, B3-2,11,15,21,28, B4-2,10,22,29,34,40,44 (XI.M2)	
12.11	316 CW SS (>0.5 dpa); 556-620F					2.88	1.75	IV.B2-5,14,25,33,38, B3-6,7, B4-6,9,14,19,26,33 (XI.M2)	
12.11	316 CW SS (>0.5 dpa); PWR Primary Water					3.00	2.00	IVB2-2,8,10,12,16,20,24, 28,30,36,40,42,B3-2,5,9, 11,15,21,23,28, B4-2,5,7, 10,13,18,20,22,25,29,32,3 4,36,40,43,44 (XI.M2)	
12.11	316 CW SS (>0.5 dpa); 556-620F					2.14	1.88	(CE) IV.B3-4,8,10,12,13, 14,16,19,20,27 (XI.M2)	
12.12	High Strength Bolts (>0.5 dpa); A286/X750; 556-620F; B&W					2.57	1.88	(B&W) IVB4-9 (Commitment confirm)	
12.12	High Strength Bolts (>0.5 dpa); A286/X750; PWR Primary Water					2.57	1.88	(B&W) IVB4-7 (XI.M2)	
12.12	High Strength Bolts (>0.5 dpa); A286/X750; 556-620F; B&W					2.14	1.88	(B&W) IVB4-1,8 (Commitment confirm)	
CVCS Pump Piping to Crossover Leg Injection									
31.11	304SS Socket Welds; 557F; PWR Primary Water					2.13	2.00	IVC2-25,26 (TLAA - XI.MI, IWB, IWC.IWD, XI.M2)	

Appendix B:
PMDA–GALL Comparison Spreadsheet –
Boiling Water Reactor Pink Category

Subgroup Description		Degradation Mechanism				PMDA Expert Ratings		GALL Reference	PMDA
		FAT	IC	SCC	SW	Susceptibility	Knowledge	(Aging Management Plan)	Comments
Main Steam									
17.5	LAS Bolt (A540) for T-Quencher; <90F Suppression Pool					2.75	2.00	None (XI.M18)	

Appendix C:
PMDA–GALL Comparison Spreadsheet –
Pressurized Water Reactor Red Category

Subgroup Description: Material and Condition		Degradation Mechanism									PMDA Expert Ratings		GALL Reference	PMDA
		BAC	CREV	FAC	FAT	IC	MIC	PIT	SCC	WEAR	Susceptibility	Knowledge	(Aging Management Plan Ref)	Comments
Main Steam														
24.2	CS Components/Weldments; saturated steam; 445-530F			■							2.25	3.00	VIIIB1-9 (XI.M17 FAC)	
Main Feedwater System													VIIIB1-10	
25.4	CS Components/Weld/HAZ; 450F Water			■							2.50	2.88	VIIID1-9 (XI.M17 FAC)	
25.4	CS Components/Weld/HAZ; 450F Water				*						2.00	2.63	VIIID1-7 (TLAA)	
Steam Generator Blowdown														
27.2	CS Comp/Weld/HAZ (Sat. Water); 550F			■							2.38	2.75	VIIIF-26 (XI.M17 FAC)	
27.2	CS Comp/Weld/HAZ (Sat. Water); 550F				*						1.88	2.75	None	
Cold Leg Piping														
1.9	308/309SS Dissimilar Weld - External								■		1.86	2.14	None (XI.M1, IWB, IWC, IWD, XI.M2)	
Crossover Leg Piping														
2.9	308/309SS Dissimilar Weld - External								■		1.86	2.14	None (XI.M1, IWB, IWC, IWD, XI.M2)	
Hot Leg Piping														
3.9	308/309SS Dissimilar Weld - External								■		1.71	2.14	None (XI.M1, IWB, IWC, IWD, XI.M2)	
Pressurizer														
4.14	Alloy 600 (CW) Heater Clad/Welds; >653F Primary Water; CE								■		2.75	2.13	IVC2-17,21,24 (XI.M2, IWB, IWC, IWD, XI.M32)	
Reactor Coolant Pump														
9.3	High Strength Parts; A286, 17-4PH, 403, X750; 558F Primary								■		2.38	2.13	None (IVC2-7 closure bolting)	
Reactor Pressure Vessel														
10.2	Shell/Plates, Forgings, Welds; 558F Primary Water	■									2.13	2.13	IVA2-13 (XI.M10)	
10.8	Alloy 82/182 Dissim. Welds; 653F Primary Water								■		2.88	2.13	IVA2-9,11,12,15,18,19 (XI.M1, IWB, IWC, IWD, XI.M2)	
10.9	Forged Alloy 600 Nozzles; 653F Primary Water								■		2.75	2.25	IVA2-9,15 (XI.M1, IWB, IWC, IWD, XI.M2)	
10.10	304/308SS CRDM Housing; 200-600F Primary Water (Stagnant)								■		1.88	2.13	IVA2-11 (XI.M1, IWB, IWC, IWD, XI.M2)	

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Subgroup Description:	Material and Condition	Degradation Mechanism									PMDA Expert Ratings		GALL Reference	PMDA
		BAC	CREV	FAC	FAT	IC	MIC	PIT	SCC	WEAR	Susceptibility	Knowledge	(Aging Management Plan Ref)	Comments
Steam Generator														
11.5	Alloy 600 MA SG Tubes; 556-620F Primary Water								■		2.50	2.50	IVD1-20 (XI.M19, XI.M2)	
11.6	Alloy 600 MA SG Tubes; 544-620F Secondary Water								■		3.00	2.38	IVD1-23,IVD2-17 (XI.M19, XI.M2)	
11.6	Alloy 600 MA SG Tubes; 544-620F Secondary Water									■	2.13	2.25	IVD1-24,D2-18 (XI.M19, XI.M2)	
11.9	Alloy 600 Divider Plate; 556-620F Primary Water								■		2.25	2.13	IVD1-6 (XI.M2)	
11.12	Alloy 600 TT SG Tubes; 556-620F Primary Water								■		2.25	2.68	IVD1-20 (XI.M19, XI.M2)	
11.14	Alloy 600 TT SG Tubes; 544-620F Secondary Water								■		2.25	2.25	IVD1-23,IVD2-17 (XI.M19, XI.M2)	
11.14	Alloy 600 TT SG Tubes; 544-620F Secondary Water									■	2.13	2.38	IVD1-24,D2-18 (XI.M19, XI.M2)	
11.16	Alloy 82/182 Dissim. Welds; 556-620F Primary Water								■		2.88	2.13	IVD1-4,6,18,20, IVD2-2,4,12,14 (XI,M1,M2,M19)	
11.20	Secondary Water			■							2.25	2.38	XI.M2)	
11.22	Alloy 600, Sensitized SG Tubes; 556-620F Primary Water								■		2.13	2.75	IVD1-20 (XI.M19, XI.M2)	
11.23.1	Alloy 600, Sensitized SG Tube; 544-620F Secondary Water								■		2.88	2.75	IVD2-17 (XI.M19, XI.M2)	
11.23.2	Alloy 600, Sensitized SG Tubes; 544-620F Secondary Water									■	1.88	2.50	IVD2-18 (XI.M19, XI.M2)	
Reactor Vessel Internals														
12.4	316SS CW (~0.5 dpa); 556-620F Primary Water								■		1.71	2.29	IVB2-2,8,10,12,16,20,24,28,30,36,40,42,B3-2,5,9,11,15,21,23,28, B4-2,5,7,10,13,18, 20,22,25,29,32,34,36,40,43,44 (XI.M2)	
12.7	High Strength Fasteners/Springs; X750, 718;					■					1.88	2.13	IV.B2-14,25,38, B3-6,7, B4-14,19,26,33	
12.8	304SS Plates/Tubes (>0.5 dpa); 556-620F Primary Water								■		1.71	2.38	IV.B2-2,8,10,12,20,24,30,36,42, B3-2,11, 15,21,28, B4-2,10,22,29,34,40,44 (XI.M2)	
Service Water Suction Piping from Pond														
28.3	CS Comp/Weld/HAZ (Pond);						■				2.00	2.75	VIIC1-5,19 (XI.M20)	
28.3	CS Comp/Weld/HAZ (Pond);							■			1.88	2.75	VIIC1-5,19 (XI.M20)	
28.4	CS Comp/Weld/HAZ (Lake/Sea, Salt Water); 100F		■								2.29	2.71	VIIC1-5,19 (XI.M20)	

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Subgroup Description: Material and Condition		Degradation Mechanism									PMDA Expert Ratings		GALL Reference	PMDA
		BAC	CREV	FAC	FAT	IC	MIC	PIT	SCC	WEAR	Susceptibility	Knowledge	(Aging Management Plan Ref)	Comments
28.4	CS Comp/Weld/HAZ (Lake/Sea, Salt Water); 100F						■				2.13	2.63	VIIC1-5,19 (XI.M20)	
28.4	CS Comp/Weld/HAZ (Lake/Sea, Salt Water); 100F							■			2.43	2.71	VIIC1-5,19 (XI.M20)	
Service Water Pump Discharge Piping														
29.2	CS Comp/Weld/HAZ (Pond);						■				2.00	2.75	VIIC1-5,19 (XI.M20)	
29.2	CS Comp/Weld/HAZ (Pond);							■			1.88	2.75	VIIC1-5,19 (XI.M20)	
29.3	CCW HX Cu-Zn tubes (Pond or CCW); 100F							■			2.13	2.75	VIIC1-3,9 (XI.M20)	
29.3	CCW HX Cu-Zn tubes (Pond or CCW); 100F								■		1.88	2.63	None	
29.4	CS CCW HX Shell/Tubesheets/Fittings (Pond); 100F						■				2.00	2.88	VIIC1-5 (XI.M20)	
29.4	CS CCW HX Shell/Tubesheets/Fittings (Pond); 100F							■			1.88	2.88	VIIC1-5 (XI.M20)	
Service Water Piping Inside Containment														
30.2	CS Comp/Weld/HAZ (Pond);						■				1.88	2.75	VIIC1-5,19 (XI.M20)	
30.2	CS Comp/Weld/HAZ (Pond);							■			1.88	2.75	VIIC1-5,19 (XI.M20)	

Appendix D:
PMDA–GALL Comparison Spreadsheet –
Boiling Water Reactor Red Category

Subgroup Description:	Material and Condition	Degradation Mechanism							Susceptibility	Knowledge	GALL Reference	PMDA
		CREV	EC	FAT	GALV	MIC	PIT	SCC			(Aging Manage Plan)	Comments
Reactor Core Isolation Cooling												
12.3	547F			■					2.00	2.25	IVC1-5,15 (TLAA, XI.M1)	
12.15	CS SA216; Suppression Pool Water; <100F	■							2.00	2.88	VD2-8 (XI.M21)	
Low Pressure Core Spray												
10.5	CS + Higher Strength Bolts; Suppression Pool Water; <100F	■							2.13	2.88	VD2-7,8 see 12.15 (XI.M21)	
HPCS - CST Water (Other Plant)												
11A.1	CS SA105,106,216,234; Condensate Storage Water; <100F	■							2.00	2.71	VD2-17 (XI.M38)	
11A.1	CS SA105,106,216,234; Condensate Storage Water; <100F					■			1.86	2.71	None	
11A.1	CS SA105,106,216,234; Condensate Storage Water; <100F						■		2.00	2.71	VD2-17 (XI.M38)	
11A.2	CS SA105,106,216,234 - Weld/HAZ; Condensate Storage Water; <100F	■							2.00	2.71	VD2-17 (XI.M38)	
11A.2	CS SA105,106,216,234 - Weld/HAZ; Condensate Storage Water; <100F					■			1.86	2.71	None	
11A.2	CS SA105,106,216,234 - Weld/HAZ; Condensate Storage Water; <100F						■		2.00	2.71	VD2-17 (XI.M38)	
11A.4	CS SA105,106,216,234 - Valves; Condensate Storage Water; <100F	■							2.00	2.71	VD2-17 (XI.M38)	
11A.7	CS/LAS A106,A516; Cond. Storage Water; <100F	■							2.00	2.71	VD2-17 (XI.M38)	
11A.7	A106,A516 Carbon & Low Alloy Steels; Condensate Storage Water; <100F					■			1.71	2.71	None	
11A.7	A106,A516 Carbon & Low Alloy Steels; Condensate Storage Water; <100F						■		1.86	2.71	VD2-17 (XI.M38)	
RHR Suction Line Piping to RHR Pumps												
13.3	304SS HAZ; Normally Stagnant Water, 549F							■	2.13	3.00	IVC1-1,4,9 (XI.M1, XI.M2, XI.M7)	
RHR Pump Discharge Piping to RHR HX												
14.8	CS HX Fittings; Suppression Pool Water; 125-334F; flowing						■		2.00	2.63	VD2-8 (XI.M20)	
RHR Spray Piping												
16.10	CS - Brass joint (Drywell); Suppression Pool; 100F	■							2.13	2.88	VD2-8 (XI.M20)	
16.10	CS - Brass joint (Drywell); Suppression Pool; 100F				■				2.50	2.88	VD2-8 (XI.M20)	
16.14	CS - Brass joint (Drywell); Suppression Pool; 100F				■				2.50	2.88	VD2-8 (XI.M20)	

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Subgroup Description:	Material and Condition	Degradation Mechanism							Susceptibility	Knowledge	GALL Reference	PMDA
		CREV	EC	FAT	GALV	MIC	PIT	SCC			(Aging Manage Plan)	Comments
Main Steam												
17.5	A540 B21 (Hatch 2) T-Quencher; Suppression Pool; Normally <90F								2.13	2.88	None	
Main Condenser												
21.6	Titanium tubes, outside of tube; Wet Steam								1.88	2.88	None	
Reactor Pressure Vessel Closure Head												
1.7	A508 Nozzle to 304 SS Flange 182 Weld; Reactor Coolant Steam; 547F								2.25	2.75	IVA1-12 (XI.M7, XI.M2, XI.M8, XI.M4)	
1.8	304SS Flange HAZ; Reactor Coolant Steam; 547F								2.00	2.88	None	
1.12	Dryer Hold Down Bracket 182 Weld; Reactor Coolant Steam; 547F								2.25	2.63	None	
Pressure Vessel Shell												
2.8	Alloy 600 Feedwater Safe End; Reactor Water; 427F								2.13	3.00	IVA1-1, 12 (XI.M7, XI.M2, XI.M4)	
2.9	Alloy 600 Feedwater Thermal Sleeve; Reactor Water; 427F								2.13	3.00	None	
2.10	Feedwater Thermal Sleeve/A508 Nozzle 182 Weld; Reactor Water; 427F								2.25	2.88	IVA1-12 (XI.M4, XI.M2)	
2.11	316SS Safe Ends and Thermal Sleeves; Reactor Water; 427F								2.13	2.88	IVA1-1, 12 (XI.M4, XI.M2)	
2.12	82/182 Weld Between CS and Alloy 600; Reactor Water; 427F								2.25	3.00	IVA1-12 (XI.M4, XI.M2)	
2.13	82/182 Weld Pad Bet. A508 and Alloy 600; Reactor Water; 533F								2.25	2.75	IVA1-12 (XI.M4, XI.M2)	
2.17	Alloy 182 Attachment Pads; Reactor Water or Steam; 575F								2.25	2.75	IVA1-12 (XI.M4, XI.M2)	
2.19	304SS HAZ Jet Pump Riser Bracket; Reactor Water; 533F								2.25	2.75	IVA1-12 (XI.M4, XI.M2)	
Reactor Pressure Vessel Bottom Head												
3.4	Dissimilar Metal Nozzle Weld 182/82; Reactor Water; 533-547F								2.25	3.00	IVA1-1,12 (XI.M7, XI.M2, XI.M8, XI.M4)	
3.5	Dissimilar Metal J-Weld 182/82; Reactor Water; 533-547F								2.25	3.00	IVA1-5 (XI.M2, XI.M8, XI.M4)	
3.6	316NG or 316L SS HAZ; Reactor Water; 533-547F								2.00	2.75	IVA1-1,5,12 (XI.M7, XI.M2, XI.M8, XI.M4)	
3.7	304SS HAZ Safe End; Reactor Water; 533-547F								2.25	2.88	IVA1-1 (XI.M7, XI.M2, XI.M8)	
3.9	82/182 Weld Pad, Thermal Sleeve/Nozzle; Reactor Water; 533-547F								2.38	3.00	IVA1-1 (XI.M7, XI.M2, XI.M4)	

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Subgroup Description:	Material and Condition	Degradation Mechanism							Susceptibility	Knowledge	GALL Reference	PMDA
		CREV	EC	FAT	GALV	MIC	PIT	SCC			(Aging Manage Plan)	Comments
3.10	Alloy 600 HAZ CRD Stub Tube; Reactor Water; 533-547F								2.13	3.00	IVA1-5 (XI.M2, XI.M8)	
3.11	Dissimilar 82/182 Welds; Reactor Water; 533-547F								2.25	3.00	IVA1-1,5,12 (XI.M7, XI.M2, XI.M8, XI.M4)	
3.12	Alloy 600 HAZ; Reactor Water; 533-547F								2.25	3.00	IVA1-1,5,12 (XI.M7, XI.M2, XI.M8, XI.M4)	
3.13	182 Weldments of Inconel to Inconel; Reactor Water; 533-547F								2.63	3.00	IVA1-1,5,12 (XI.M7, XI.M2, XI.M8, XI.M4)	
Core Shroud												
4.2	304SS Vertical HAZ; Reactor Water; 533F								2.38	2.88	IVB1-1,3,6 (XI.M9, XI.M2)	
4.4	304SS Circumferential HAZ; Reactor Water; 533F								2.38	2.88	IVB1-1,3,6 (XI.M9, XI.M2)	
4.6	304SS Vertical HAZ (low dose); Reactor Water; 533F								2.50	2.88	IVB1-1,3,6 (XI.M9, XI.M2)	
4.8	304SS HAZ (mod. dose); Reactor Water; 533F								2.50	2.63	IVB1-1,3,6 (XI.M9, XI.M2)	
4.8	304SS HAZ (mod. dose); Reactor Water; 533F							HWC	1.75	2.50	IVB1-1,3,6 (XI.M9, XI.M2)	
4.9	Alloy 182 Shroud Weld Metal; Reactor Water; 533F								2.25	2.63	IVB1-2,4,5 (XI.M9, XI.M1, XI.M2)	
4.10	304SS Shroud HAZ; Reactor Water; 533F								2.25	2.88	IVB1-1,3,6 (XI.M9, XI.M2)	
4.14	304SS (with 308L welds); Reactor Water; 533F								2.13	2.88	IVB1-1,3,6 (XI.M9, XI.M2)	
4.15	304SS Guide Structure (mod. To high dose); Reactor Water; 533F								2.50	2.75	IVB1-1,3,6 (XI.M9, XI.M2)	
4.17	304SS Core Plate Structure; Reactor Water; 533F								1.75	2.88	IVB1-1,3,6 (XI.M9, XI.M2)	
4.20	X750 Flow Plug Spring; Reactor Water; 533F								2.38	3.00	None	
4.20	X750 Flow Plug Spring; Reactor Water; 533F							HWC	1.88	2.75	None	
Core Controls												
5.2	304/316SS Control Rod Blade (4-6 dpa); Reactor Water; 525F								2.29	2.71	None	
5.8	Alloy 182 RPV Stub Weld Metal; Reactor Water; 525F								2.38	2.75	IVA1-5 (XI.M8, XI.M2)	
5.9	304SS RPV Stub HAZ; Reactor Water; 525F								2.38	2.88	IVA1-5 (XI.M8, XI.M2)	
5.10	Alloy 600 RPV Stub HAZ; Reactor Water; 525F								2.13	2.88	IVA1-5 (XI.M8, XI.M2)	
5.12	304SS In-Core Guide (high dose); Reactor Water; 525-550F								2.13	2.88	None	

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Subgroup Description:	Material and Condition	Degradation Mechanism							Susceptibility	Knowledge	GALL Reference	PMDA
		CREV	EC	FAT	GALV	MIC	PIT	SCC			(Aging Manage Plan)	Comments
5.16	182 Weld Metal In-Vessel Structures; Reactor Water; 525F								2.25	2.50	None	
5.17	304SS In-Vessel HAZ; Reactor Water; 525F								2.25	2.75	IVB1-8,9,10 (XI.M9, XI.M2, XI.M13)	
Jet Pump Assembly (all with low irradiation dose)												
6.3	304SS Component HAZ; Reactor Water; 525F								2.38	2.75	IVB1-13 (XI.M9, XI.M2)	
6.5	X750 (mostly HTH) Holddown Beam; Reactor Water; 525F								2.38	2.88	IVB1-13 (XI.M9, XI.M2)	
6.5	X750 (mostly HTH) Holddown Beam; Reactor Water; 525F							HWC	2.13	2.75	IVB1-13 (XI.M9, XI.M2)	
6.6	Alloy 600 Access Hole Cover; Reactor Water; 525F								1.88	2.88	IVB1-5 (XI.M1, XI.M2)	
6.7	Alloy 182 Weld Metal Access Hole Cover; Reactor Water; 525F								2.38	2.50	IVB1-5 (XI.M1, XI.M2)	
6.10	304 SS Riser Brace HAZ; Reactor Water; 525F								2.38	2.75	IVB1-13 (XI.M9, XI.M2)	
6.11	SS Adapter HAZ; Reactor Water; 525F								2.38	2.88	IVB1-13 (XI.M9, XI.M2)	
6.12	Alloy 182 Adapter Weld Metal; Reactor Water; 525F								2.38	2.63	IVB1-13 (XI.M9, XI.M2)	
6.13	SS HAZ on Adapter and Diffuser; Reactor Water; 525F								2.38	2.88	IVB1-13 (XI.M9, XI.M2)	
ECCS Connections												
7.2	304SS Feedwater HAZ; Reactor Water; 427F								2.25	2.88	VD2-26, VD2-29 (XI.M2, XI.M21, XI.M7)	
7.5	304SS Feedwater Sparger HAZ; Reactor Water; 427F								2.25	3.00	IVB1-7 (XI.M9, XI.M2)	
7.8	304SS Core Spray HAZ; Reactor Water; 533F								2.38	2.88	IVB1-7 (XI.M9, XI.M2)	
7.11	304SS LPCI Component HAZ; Reactor Water; 533F								2.38	3.00	VD2-26 (XI.M21)	
Steam Separator & Dryer												
8.1	304SS Steam Seaparator and Dryer; Reactor Water, Wet Steam; 550F								1.88	2.25	IVB1-16 (AMP plant specific)	
8.2	308/L SS Steam Dryer Weld Metal; Reactor Water, Wet Steam; 550F								1.88	2.50	IVB1-16 (AMP plant specific)	
8.3	304SS Steam Dryer HAZ; Reactor Water, Wet Steam; 550F								2.00	2.38	IVB1-16 (AMP plant specific)	
8.3	304SS Steam Dryer HAZ; Reactor Water, Wet Steam; 550F								2.38	2.88	None	
Reactor Recirculation System												
9.6	316SS Component HAZ; Reactor Water; 550F								2.38	2.88	IVC1-1, IVC1-9 (XI.M2, XI.M1, XI.M7)	

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Subgroup Description:	Material and Condition	Degradation Mechanism							Susceptibility	Knowledge	GALL Reference	PMDA
		CREV	EC	FAT	GALV	MIC	PIT	SCC			(Aging Manage Plan)	Comments
9.9	304SS Component HAZ; Reactor Water; 550F								2.50	3.00	IVC1-1, IVC1-9 (XI.M2, XI.M1, XI.M7)	
9.13	Socket Welds 308 on 304/316SS; Reactor Water; 550F								2.50	2.50	IVC1-15 (TLAA)	
9.13	Socket Welds 308 on 304/316SS; Reactor Water; 550F			HWC					2.25	2.50	IVC1-15 (TLAA)	
9.13	Socket Welds 308 on 304/316SS; Reactor Water; 550F								2.13	2.88	IVC1-1,9 (XI.M2, XI.M1)	
Reactor Water Cleanup Piping to Pumps + Elbows, Reducers												
25.5	304SS HAZ; BWR Water; 535F								2.25	2.75	VII.E3-13 (XI.M21)	
25.7	304SS Base Metal, Weld & HAZ; BWR Water; 535F								2.38	2.83	VII.E3-13 (XI.M21)	
Service Water Suction Piping from Pond												
28.3	CS Comp/Weld/HAZ; Pond Water, 100F								2.00	2.75	VIIC1-19 (XI.M20)	
28.3	CS Comp/Weld/HAZ; Pond Water, 100F								1.88	2.75	VIIC1-19 (XI.M20)	
28.4	Coated CS Comp/Weld/HAZ (Lake/Sea); Salt Water, 100F								2.29	2.71	VIIC1-19 (XI.M20)	
28.4	Coated CS Comp/Weld/HAZ (Lake/Sea); Salt Water, 100F								2.13	2.63	VIIC1-19 (XI.M20)	
28.4	Coated CS Comp/Weld/HAZ (Lake/Sea); Salt Water, 100F								2.43	2.71	VIIC1-19 (XI.M20)	
Service Water Pump Discharge Piping												
29.2	CS Comp/Weld/HAZ; Pond Water, 100F								2.00	2.75	VIIC1-19 (XI.M20)	
29.2	CS Comp/Weld/HAZ; Pond Water, 100F								1.88	2.75	VIIC1-19 (XI.M20)	
29.3	CCW HX Cu-Zn tubes; Internal CCW and external pond water; ≤100F								2.13	2.75	VIIC1-3, VIIC1-9 (XI.M20)	
29.3	CCW HX Cu-Zn tubes; Internal CCW and external pond water; ≤100F								1.88	2.63	None	
29.4	CS CCW HX Shell and Tubesheets; Pond Water, ≤100F								2.00	2.88	VIIC1-19 (XI.M20)	
29.4	CS CCW HX Shell and Tubesheets; Pond Water, ≤100F								1.88	2.88	VIIC1-19 (XI.M20)	
Service Water Piping Inside Containment												
30.2	CS Comp/Weld/HAZ; Pond Water, <100F								1.88	2.75	VIIC1-19 (XI.M20)	
30.2	CS Comp/Weld/HAZ; Pond Water, <100F								1.88	2.75	VIIC1-19 (XI.M20)	

Appendix E:
PMDA–GALL Comparison Spreadsheet –
Pressurized Water Reactor Yellow Category

Subgroup Description: Material Condition		Degradation Mechanism							PMDA Expert Ratings		GALL Reference	PMDA
		BAC	CREEP	EC	FAT	FR	SCC	SW	Susceptibility	Knowledge	(Aging Manage Plan)	Comments
RWST Header Piping												
14.6	Type 304SS Socket Welds; 100F Borated Demineralized Water								2.000	2.000	VD1-27 (TLAA)	
CVCS Pump Suction Piping												
15.6	Type 304SS Socket Welds; 100-200F Borated Demineralized Water								2.000	2.000	VII.E1-16 (TLAA)	
SI Pump Suction Piping												
16.6	304SS Socket Welds; Ambient Temperature Borated Demineralized Water (Stagnant)								2.000	2.000	VII.E1-16 (TLAA)	
RHR Pump Suction Piping												
17.5	CASS Components;100-350F Borated Demineralized Water (Stagnant)								0.857	2.000	None	
17.7	304SS Socket Welds; Ambient Temperature Borated Demineralized Water (Stagnant) Ambient								2.000	2.000	V.D1-27 (TLAA)	
Accumulator Piping to RCS Cold Leg												
18.5	308/309, 82/182 Disimilar Weld - Internal;100-150F Borated Demineralized Water (Stagnant)								1.000	2.000	None	
18.5	308/309, 82/182 Disimilar Weld - Internal; 100-150F Borated Demineralized Water (Stagnant)								1.143	1.750	None	
18.7	Type 304SS Socket Welds; 100-150F Borated Demineralized Water (Stagnant)								2.000	2.000	V.D1-27 (TLAA)	
18.10.1	Type 304SS HAZ (High T/P); 600F Primary Water								1.375	2.000	IV.C2-25 (TLAA)	
18.10.2	Type 316SS HAZ (High T/P); 600F Primary Water								1.375	2.000	IV.C2-25 (TLAA)	
18.11	Type 308SS Weld (High T/P); 600F Primary Water								1.500	2.000	IV.C2-25 (TLAA)	

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Subgroup Description: Material Condition		Degradation Mechanism							PMDA Expert Ratings		GALL Reference	PMDA
		BAC	CREEP	EC	FAT	FR	SCC	SW	Susceptibility	Knowledge	(Aging Manage Plan)	Comments
18.11	Type 308SS Weld (High T/P); 600F Primary Water								1.000	1.875	None	
18.12	Forged 304/316SS Nozzles (Hi T/P); 600F Primary Water								1.625	1.875	IV.C2-25 (TLAA)	
18.13	308/309, 82/182 Dissimilar Weld; 600F Primary Water (CE and B&W)								1.750	1.875	IV.C2-25 (TLAA)	
SI/RHR Piping to RCS Hot Leg												
19.6	Type 304SS Socket Welds; 100-350F Borated Demineralized Water (Stagnant)								1.750	2.000	V.D1-27 (TLAA)	
19.8.1	Type 304SS HAZ (High T/P); 600F Primary Water								1.370	2.000	IV.C2-25 (TLAA)	
19.8.2	Type 316SS HAZ (High T/P); 600F Primary Water								1.375	2.000	IV.C2-25 (TLAA)	
19.9	Type 308SS Weld (High T/P); 600F Primary Water								1.500	2.000	IV.C2-25 (TLAA)	
19.9	Type 308SS Weld (High T/P); 600F Primary Water								1.143	1.875	None	
19.10	308/309, Alloy 82/182 Dissimilar Weld; 600F Primary Water (CE and B&W)								2.000	2.000	IV.C2-25 (TLAA)	
19.11	Forged 304/316SS Nozzles (High T/P); 600F Primary Water								1.625	1.875	IV.C2-25 (TLAA)	
RHR Pump Discharge Piping												
20.6	Type 304SS Socket Welds; 100-350F Borated Demineralized Water								2.000	2.000	V.D1-27 (TLAA)	
RHR Piping to RCS Cold Leg												
21.6	Type 304SS Socket Welds; 100-350F Borated Demineralized Water								2.000	2.000	V.D1-27 (TLAA)	
CVCS Piping to RCS Cold Leg												
22.5	Type 308SS Weld (High Temp.); 560F Primary Water								1.125	2.000	IV.C2-25 (TLAA)	
22.7	Type 304SS Socket Welds; 200F Borated Demineralized Water								2.000	2.000	V.D1-27 (TLAA)	

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Subgroup Description: Material Condition		Degradation Mechanism							PMDA Expert Ratings		GALL Reference	PMDA
		BAC	CREEP	EC	FAT	FR	SCC	SW	Susceptibility	Knowledge	(Aging Manage Plan)	Comments
22.8	308/309, 82/182 Dissimilar Weld; 600F Primary Water								2.000	2.000	V.D1-27 (TLAA)	
Cold Leg Piping												
1.3.1	Type 304SS Piping HAZ; 556-559F Primary Water								1.250	1.750	IV.C2-26 (XI.M1)	
1.3.2	Type 316SS Piping HAZ; 556-559F Primary Water								1.250	1.750	IV.C2-26 (XI.M1)	
1.4	Type 308SS Weld; 556-559F Primary Water								1.500	1.750	IV.C2-26 (XI.M1)	
1.4	Type 308 SS Weld; 556-559F Primary Water								1.125	2.000	IV.C2-1,2,27 (XI.M1, IWB,IWD.XI.M2)	
1.5	308/309 Dissimilar Weld - Internal; 556-559F Primary Water								1.250	1.875	IVC2-25,26 (TLAA cyclic load, fatigue XI.M1,IWB,IWC,IWD)	
1.5	308/309 Dissimilar Weld - Internal; 556-559F Primary Water								1.250	1.500	None	
1.5	308/309 Dissimilar Weld - Internal; 556-559F Primary Water								1.500	1.625	IV.C2-1,2,27 (XI.M1,IWB,IWD.XI.M2)	
1.6	CASS CF8/CF8M Components; 556-559F Primary Water								1.125	1.875	None	
1.6	CASS CF8/CF8M Components; 556-559F Primary Water								1.250	1.250	IV.C2-3 (Plant specific)	
1.8	Forged 304/316 SS Nozzles; 556-559F Primary Water								1.375	1.875	IVC2-25,26 (TLAA cyclic load, fatigue XI.M1,IWB,IWC,IWD)	
1.10	CASS CF8/CF8M Piping; 556-559F Primary Water (Westinghouse)								1.125	1.875	None	
1.10	CASS CF8/CF8M Piping; 556-559F Primary Water (Westinghouse)								1.250	1.500	IV.C2-3 (Plant specific)	
1.11	SS Clad Ferritic Piping; 559F Primary Water (CE and B&W)								1.250	1.875	None	

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Subgroup Description: Material Condition		Degradation Mechanism							PMDA Expert Ratings		GALL Reference	PMDA
		BAC	CREEP	EC	FAT	FR	SCC	SW	Susceptibility	Knowledge	(Aging Manage Plan)	Comments
Crossover Leg Piping												
2.3.1	Type 304SS Piping HAZ 556-559F Primary Water								1.250	1.750	IV.C2-26 (XI.M1)	
2.3.1	Type 304SS Piping HAZ; 556-559F Primary Water								1.250	2.000	IV.C2-1,2,27 (XI.M1,IWB,IWD.XI.M2)	
2.3.2	Type 316SS Piping HAZ; 556-559F Primary Water								1.250	1.750	IV.C2-26 (XI.M1)	
2.3.2	Type 316SS Piping HAZ; 556-559F Primary Water								1.125	2.000	IV.C2-1,2,27 (XI.M1, IWB,IWD.XI.M2)	
2.4	Type 308SS Weld; 556-559F Primary Water								1.125	1.750	IV.C2-26 (XI.M1)	
2.4	Type 308SS Weld; 556-559F Primary Water								1.143	2.000	None	
2.4	Type 308SS Weld; 556-559F Primary Water								1.125	2.000	IV.C2-1,2,27 (XI.M1,IWB,IWD.XI.M2)	
2.5	308/309 Dissimilar Weld - Internal; 556-559F Primary Water								1.125	1.875	IV.C2-25 (TLAA)	
2.5	308/309 Dissimilar Weld - Internal; 556-559F Primary Water								1.200	1.600	None	
2.5	308/309 Dissimilar Weld - Internal; 556-559F Primary Water								1.500	1.750	IV.C2-1,2,27 (XI.M1,IWB,IWD.XI.M2)	
2.6	CASS CF8/CF8M Components; 556-559F Primary Water								1.125	1.875	None	
2.6	CASS CF8/CF8M Components; 556-559F Primary Water								1.250	1.250	IV.C2-3 (Plant specific)	
2.8	Forged 304/316 SS Nozzles; 556-559F Primary Water								1.375	1.875	IVC2-26 (IX.M1)	
2.10	CASS CF8/CF8M Piping; 556-559F Primary Water (Westinghouse)								1.143	2.000	None	
2.10	CASS CF8/CF8M Piping; 556-559F Primary Water (Westinghouse)								1.250	1.500	IV.C2-3 (Plant specific)	

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Subgroup Description: Material Condition		Degradation Mechanism							PMDA Expert Ratings		GALL Reference	PMDA
		BAC	CREEP	EC	FAT	FR	SCC	SW	Susceptibility	Knowledge	(Aging Manage Plan)	Comments
Hot Leg Piping												
3.2	Wrought 304/316SS Piping; 610-620F Primary Water								1.625	2.000	IV.C2-26 (XI.M1)	
3.2	Wrought 304/316SS Piping; 610-620F Primary Water								1.625	2.000	IV.C2-1,2,27 (XI.M1,IWB,IWD.XI.M2)	
3.3.1	Type 304SS Piping HAZ; 610-620F Primary Water								1.750	1.750	IV.C2-26 (XI.M1)	
3.3.1	Type 304SS Piping HAZ; 610-620F Primary Water								1.250	2.000	IV.C2-1,2,27 (XI.M1,IWB,IWD.XI.M2)	
3.3.2	Type 316SS Piping HAZ; 610-620F Primary Water								1.750	1.750	IV.C2-26 (XI.M1)	
3.3.2	Type 316SS Piping HAZ; 610-620F Primary Water								1.125	2.000	IV.C2-1,2,27 (XI.M1)	
3.4	Type 308SS Weld; 610-620F Primary Water								1.750	1.750	IV.C2-26 (XI.M1)	
3.4	Type 308SS Weld; 610-620F Primary Water								1.143	2.000	None	
3.4	Type 308SS Weld; 610-620F Primary Water								1.250	2.000	IV.C2-1,2,27 (XI.M1, IWB,IWD.XI.M2)	
3.5	308/309 Dissimilar Weld - Internal; 610-620F Primary Water								1.500	1.875	IV.C2-26 (XI.M1)	
3.5	308/309 Dissimilar Weld - Internal; 610-620F Primary Water								1.200	1.600	None	
3.5	308/309 Dissimilar Weld - Internal; 610-620F Primary Water								1.500	1.750	IV.C2-1,2,27 (XI.M1,IWB,IWD.XI.M2)	
3.6	CASS CF8/CF8M Components; 610-620F Primary Water								1.125	1.875	None	
3.6	CASS CF8/CF8M Components; 610-620F Primary Water								1.250	1.250	IV.C2-3 (Plant specific)	
3.8	Forged 304/316 SS Nozzles; 556-559F Primary Water								1.500	1.875	IVC2-26 (IX.M1)	

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Subgroup Description: Material Condition		Degradation Mechanism							PMDA Expert Ratings		GALL Reference	PMDA
		BAC	CREEP	EC	FAT	FR	SCC	SW	Susceptibility	Knowledge	(Aging Manage Plan)	Comments
3.10	CASS CF8/CF8M Piping; 610-620F Primary Water (Westinghouse)								1.250	1.875	None	
3.10	CASS CF8/CF8M Piping; 610-620F Primary Water (Westinghouse)								1.375	1.500	IV.C2-3 (Plant specific)	
Pressurizer												
4.4	Wrought 304/316SS - Internal; 653F Primary Water								1.500	1.625	IV.C2-25 (TLAA)	
4.5	308/309 Dissimilar Welds - Internal;653F Primary Water								1.750	1.875	IV.C2-25 (TLAA)	
4.5	308/309 Dissimilar Welds - Internal;653F Primary Water								1.500	1.750	IV.C2-19,20 (XI.M1, IWB,IWC,IWD.XI.M2)	
4.6	Alloy 82/182 Dissim. Welds - Internal;653F Primary Water								2.000	2.000	IV.C2-25 (TLAA)	
4.6	Alloy 82/182 Dissim. Welds - Internal;653F Primary Water								1.429	1.875	None	
4.7	Forged Alloy 600 Nozzles;653F Primary Water								1.750	1.875	IV.C2-25 (TLAA)	
4.8	308/316 (CW) Heater Clad/Welds; >653F Primary Water								1.625	1.750	IV.C2-18 (XI.M1,IWB, IWC,IWD.XI.M2)	
4.8	308/316 (CW) Heater Clad/Welds;>653F Primary Water								1.875	1.125	IV.C2-19 (XI.M1,IWB, IWC,IWD.XI.M2)	
4.9	SA-193 Gr B7 Manway Bolts;653F Primary Water (Flange Leak)								1.000	1.750	IV.C2-19 (XI.M1,IWB, IWC,IWD.XI.M2)	
4.10.1	Type 304SS HAZ;653F Primary Water								1.625	1.750	IV.C2-18 (XI.M1,IWB, IWC,IWD.XI.M2)	
4.10.2	Type 316SS HAZ;653F Primary Water								1.625	1.750	IV.C2-18 (XI.M1,IWB IWC,IWD.XI.M2)	
4.13	Forged 304/316SS Nozzles;653F Primary Water								1.375	1.875	IV.C2-18 (XI.M1,IWB, IWC,IWD.XI.M2)	

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Subgroup Description: Material Condition		Degradation Mechanism							PMDA Expert Ratings		GALL Reference	PMDA
		BAC	CREEP	EC	FAT	FR	SCC	SW	Susceptibility	Knowledge	(Aging Manage Plan)	Comments
4.14	Alloy 600 (CW) Heater Clad/Welds;>653F Primary Water								1.625	1.875	IV.C2-18 (XI.M1,IWB, IWC,IWD.XI.M2)	
Pressurizer Spray Piping												
5.3.1	Type 304SS Piping HAZ; 556-559 Primary Water								1.125	1.750	IV.C2-18 (XI.M1,IWB, IWC,IWD.XI.M2)	
5.3.2	Type 316SS Piping HAZ; 556-559 Primary Water								1.125	1.750	IV.C2-18 (XI.M1,IWB, IWC,IWD.XI.M2)	
5.4	Type 308SS Weld; 556-559 Primary Water								1.125	1.750	IV.C2-18 (XI.M1,IWB, IWC,IWD.XI.M2)	
5.4	Type 308SS Weld; 556-559 Primary Water								1.200	2.000	None	
5.4	Type 308SS Weld; 556-559 Primary Water								1.250	2.000	IV.C2-19 (XI.M1,IWB, IWC,IWD.XI.M2)	
5.5	Forged 304/316SS Nozzles; 556-559 Primary Water								1.375	1.875	IV.C2-18 (XI.M1,IWB, IWC,IWD.XI.M2)	
Pressurizer Surge Piping												
6.3.1	Type 304SS Piping HAZ; 620-653F Primary Water								1.750	1.750	IV.C2-18 (XI.M1,IWB, IWC,IWD.XI.M2)	
6.3.1	Type 304SS Piping HAZ; 620-653F Primary Water								1.375	2.000	IV.C2-19 (XI.M1,IWB, IWC,IWD.XI.M2)	
6.3.2	Type 316SS Piping HAZ; 620-653F Primary Water								1.750	1.750	IV.C2-18 (XI.M1,IWB, IWC,IWD.XI.M2)	
6.3.2	Type 316SS Piping HAZ; 620-653F Primary Water								1.250	2.000	IV.C2-19 (XI.M1,IWB, IWC,IWD.XI.M2)	
6.4	Type 308SS Weld; 620-653F Primary Water								1.625	1.750	IV.C2-18 (XI.M1,IWB, IWC,IWD.XI.M2)	
6.4	Type 308SS Weld; 620-653F Primary Water								1.200	2.000	None	

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Subgroup Description: Material Condition		Degradation Mechanism							PMDA Expert Ratings		GALL Reference	PMDA
		BAC	CREEP	EC	FAT	FR	SCC	SW	Susceptibility	Knowledge	(Aging Manage Plan)	Comments
6.4	Type 308SS Weld ; 620-653F Primary Water								1.200	2.000	IV.C2-19 (XI.M1,IWB, IWC,IWD.XI.M2)	
6.5	Forged 304/316SS Nozzles; 620-653F Primary Water								1.625	1.875	IV.C2-18 (XI.M1,IWB, IWC,IWD.XI.M2)	
Pressurizer Piping to PORVs												
7.2	Type 304SS Piping; 653F Stagnant Steam Primary Water								1.125	1.750	IV.C2-18 (XI.M1,IWB, IWC,IWD.XI.M2)	
7.3.1	Type 304SS Piping HAZ; 653F Stagnant Steam Primary Water								1.375	1.625	IV.C2-18 (XI.M1,IWB, IWC,IWD.XI.M2)	
7.3.1	Type 304SS Piping HAZ; 653F Stagnant Steam Primary Water								1.500	2.000	IV.C2-19 (XI.M1,IWB, IWC,IWD.XI.M2)	
7.3.2	Type 316SS Piping HAZ; 653F Stagnant Steam Primary Water								1.375	1.625	IV.C2-18 (XI.M1,IWB, IWC,IWD.XI.M2)	
7.3.2	Type 316SS Piping HAZ; 653F Stagnant Steam Primary Water								1.375	2.000	IV.C2-19 (XI.M1,IWB, IWC,IWD.XI.M2)	
7.4	Type 308SS Weld; 653F Stagnant Steam Primary Water								1.250	1.750	IV.C2-18 (XI.M1,IWB, IWC,IWD.XI.M2)	
7.4	Type 308SS Weld; 653F Stagnant Steam Primary Water								1.200	2.000	None	
7.4	Type 308SS Weld; 653F Stagnant Steam Primary Water								1.250	2.000	IV.C2-19 (XI.M1,IWB, IWC,IWD.XI.M2)	
7.5	Forged 304/316SS Nozzles; 653F Stagnant Steam Primary Water								1.375	1.875	IV.C2-18 (XI.M1,IWB, IWC,IWD.XI.M2)	

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Subgroup Description: Material Condition		Degradation Mechanism							PMDA Expert Ratings		GALL Reference	PMDA
		BAC	CREEP	EC	FAT	FR	SCC	SW	Susceptibility	Knowledge	(Aging Manage Plan)	Comments
Pressurizer Piping to SRVs												
8.2	304/316SS Piping; 653F Stagnant Steam Primary Water								1.250	2.000	IV.C2-18 (XI.M1,IWB, IWC,IWD.XI.M2)	
8.3.1	Type 304SS Piping HAZ; 653F Stagnant Steam Primary Water								1.250	1.625	IV.C2-18 (XI.M1,IWB, IWC,IWD.XI.M2)	
8.3.2	Type 316SS Piping HAZ; 653F Stagnant Steam Primary Water								1.250	1.625	IV.C2-18 (XI.M1,IWB, IWC,IWD.XI.M2)	
8.4	Type 308SS Weld; 653F Stagnant Steam Primary Water								1.375	1.750	IV.C2-18 (XI.M1,IWB, IWC,IWD.XI.M2)	
8.4	Type 308SS Weld; 653F Stagnant Steam Primary Water								1.200	2.000	None	
8.4	Type 308SS Weld; 653F Stagnant Steam Primary Water								1.250	2.000	IV.C2-19 (XI.M1,IWB,IWC,IWD.XI .M2)	
8.5	Forged 304/316SS Nozzles; 653F Stagnant Steam Primary Water								1.250	1.875	IV.C2-18 (XI.M1,IWB,IWC,IWD.XI .M2)	
Reactor Coolant Pump												
9.2	304/308/316SS Components - Welds; 556-559F Primary Water								1.875	1.750	None	
9.3	High Strength Parts A-286, 17-4PH, X750, 403; 556-559F Primary Water								1.875	2.000	None	
9.3	High Strength Parts A-286, 17-4PH, X750, 403 ; 556-559F Primary Water								2.000	1.625	None	
9.5	CASS CF8 Components; 556-559F Primary Water								1.250	1.250	IV.C2-3 (Plant specific)	
9.6	SA-540 Gr. B24 Bolts;Air Hot from Primary Water								1.000	1.625	IV.C2-7 (XI.M18)	
Reactor Pressure Vessel												
10.4	308/309 Dissimilar Welds- Internal; 653F Primary Water								1.750	1.875	IV.A2-21 (TLAA)	

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Subgroup Description: Material Condition		Degradation Mechanism							PMDA Expert Ratings		GALL Reference	PMDA
		BAC	CREEP	EC	FAT	FR	SCC	SW	Susceptibility	Knowledge	(Aging Manage Plan)	Comments
10.4	308/309 Dissimilar Welds- Internal; 653F Primary Water								1.500	1.500	IV.A2-5,11	
10.5	Forged 304/316SS Nozzles; 653F Primary Water								1.250	1.875	IV.A2-21 (TLAA)	
10.5	Forged 304/316SS Nozzles; 653F Primary Water								1.400	2.000	IV.A2-15 (XI.M1,IWB ,IWC,IWD.XI.M2)	
10.6	SA-540 Gr B23 Closure Studs; 556-559F Primary Water (Flange Leak)								1.750	2.000	IV.A2-3 (XI.M3)	
10.7	CASS CF8 Components; 556-559F Primary Water								1.250	2.000	None	
10.7	CASS CF8 Components; 556-559F Primary Water								1.125	1.125	None	
10.8	Alloy 82/182 Dissimilar Welds - Internal; 653F Primary Water								1.286	1.875	None	
Steam Generator												
11.5	Alloy 600 MA SG Tubes etc.; 556-620F Primary Water								1.750	1.875	IV.D1-21, IV.D2-3 (TLAA)	
11.7	308/309 Dissimilar Welds - Internal; 556-620F Primary Water								1.750	1.875	IV.D1-8,D2-3 (TLAA)	
11.7	308/309 Dissimilar Welds - Internal; 556-620F Primary Water								1.286	1.750	None	
11.7	308/309 Dissimilar Welds - Internal; 556-620F Primary Water								1.500	1.750	IV.D1-1 (XI.M1,IWB, IWC,IWD.XI.M2)	
11.8	Forged 316 SS Nozzles; 556-620F Primary Water								1.250	2.000	IV.D1-8,D2-3 (TLAA)	
11.9	Alloy 600 Divider Plate; 556-620F Primary Water								1.250	1.875	None	
11.11	Alloy 52/82 Channel Head Clad; 610-620F Primary Water								1.000	1.875	None	
11.16	Alloy 82/182 Dissim. Welds - Internal; 556-620F Primary Water								1.429	1.750	None	
11.17	Type 308/309 Dissim. Welds - External Environment (Cl)								1.500	2.000	IV.D1-14 (XI.M19,M2)	

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Subgroup Description: Material Condition		Degradation Mechanism							PMDA Expert Ratings		GALL Reference	PMDA
		BAC	CREEP	EC	FAT	FR	SCC	SW	Susceptibility	Knowledge	(Aging Manage Plan)	Comments
11.19	Alloy 690 Divider Plate; 556-559F Primary Water								1.125	2.000	None	
Reactor Vessel Internals												
12.3	Type 308SS Weld (~0.5 dpa); 556-620F Primary Water								1.375	2.000	IV.B3-24 (TLAA)	
12.4	CW Type 316SS Comps (~0.5 dpa); 556-620F Primary Water								1.625	1.625	IV.B2-31,B3-24,B4-37 (TLAA)	
12.5	CASS Components; 556-620F Primary Water								1.143	1.750	None	
12.5	CASS Comps 556-620F Primary Water								1.125	1.125	None	
12.6	SA Type 304SS Holdown Spring; 600F Primary Water								2.000	2.000	IV.B2-33 (Commit confirmed)	
12.6	SA Type 304SS Holdown Spring; 600F Primary Water								1.167	1.857	IV.B2-31,B3-24,B4-37 (TLAA)	
12.7	High Strength Fasteners/Springs Alloys X750, 718; 556-620F Primary Water								1.500	1.714	IV.B2-31,B3-24,B4-37 (TLAA)	
12.7	High Strength Fasteners/Springs Alloys X750, 718 556-620F Primary Water								2.000	2.000	None	
12.8.1	304SS Plates/Tubes (>0.5 dpa); 556-620F Primary Water								2.000	2.000	IV.B2-1,B4-3,B4-11, B4-12 (Commit confirmed)	
12.9	Type 304SS HAZ (>0.5 dpa); 556-620F Primary Water								1.286	1.750	IV.B2-31,B3-24,B4-37 (Commit confirmed)	
12.9.1	Type 304SS HAZ (>0.5 dpa); 556-620F Primary Water								2.000	2.000	IV.B3-4,8,10,12,13, 14,16,19,20,27 (Commit confirmed)	
12.10	308SS Weld Metal (>0.5 dpa); 556-620F Primary Water								1.571	1.625	IV.B2-31,B3-24,B4-37 (Commit confirmed)	
12.10	308SS Weld Metal (>0.5 dpa); 556-620 F Primary water								2.000	2.000	IV.B3-4,8,10,12,13, 14,16,19,20,27 (Commit confirmed)	
12.11	CW 316SS Comps. (>0.5 dpa); 556-620F Primary Water								1.714	1.500	IV.B2-31,B3-24,B4-37 (Commit confirmed)	

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Subgroup Description: Material Condition		Degradation Mechanism							PMDA Expert Ratings		GALL Reference	PMDA
		BAC	CREEP	EC	FAT	FR	SCC	SW	Susceptibility	Knowledge	(Aging Manage Plan)	Comments
12.12	High Strength Bolts Type A286, Alloy X750 (>0.5 dpa); 556-620F Primary Water (B&W)								1.571	1.750	IV.B2-31,B3-24,B4-37 (Commit confirmed)	
12.12	High Strength Bolts Type A286, Alloy X750 (>0.5 dpa)556-620F Primary Water (B&W)								1.714	1.625	IV.B4-1,B4-16,B4-31 (Commit confirmed)	
Stop Valve Loop Bypass Piping												
13.3.1	304SS Piping HAZ; 600F Primary Water								1.125	1.875	IV.C2-10, C2-25 (TLAA)	
13.3.2	316SS Piping HAZ; 600F Primary Water								1.125	1.875	IV.C2-10, C2-25 (TLAA)	
13.4	Type 308SS Weld; 600F Primary Water								1.375	1.875	IV.C2-10, C2-25 (TLAA)	
13.4	Type 308SS Weld; 600F Primary Water								1.143	1.875	None	
13.5	CASS components; 600F Primary Water								1.143	1.875	None	
13.5	CASS components; 600F Primary Water								1.125	1.125	IV.C2-3 (Plant specific)	
13.6	Forged 304/316SS Nozzles; 600F Primary Water								1.375	1.750	IV.C2-10 (TLAA)	
CVCS Pump Piping to Crossover Leg Injection												
31.4	Type 308SS Weld; 130F Primary Water								1.125	2.000	IV.C2-25 (TLAA)	
31.6	Type 304SS Socket Welds; 130 F Primary Water								2.000	2.000	IV.C2-25 (TLAA)	
31.8	304/316SS Piping HAZ (High T); 557F Primary Water								1.375	1.875	IV.C2-25 (TLAA)	
31.8	304/316SS Piping HAZ (High T); 557F Primary Water								1.200	1.600	None	
31.9	308SS Weld (High T); 557F Primary Water								1.250	1.875	IV.C2-25 (TLAA)	
31.10	Forged 304/316Comp (High T); 557F Primary Water								1.375	2.000	IV.C2-25 (TLAA)	
31.12	Flange Retaining Bolts; Building Air Low Temperature								1.125	2.000	VII.E1-8 (XI.M18) inspect if not replace	

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Subgroup Description: Material Condition		Degradation Mechanism							PMDA Expert Ratings		GALL Reference	PMDA
		BAC	CREEP	EC	FAT	FR	SCC	SW	Susceptibility	Knowledge	(Aging Manage Plan)	Comments
CVCS Normal Letdown Piping												
32.3	Type 304/316SS HAZ 115-560F Primary Water								1.250	1.875	IV.C2-25 (TLAA)	
32.3	Type 304/316SS HAZ 115-560F Primary Water								1.167	1.667	None	
32.5	Forged 304/316SS Components; 115-560F Primary Water								1.125	2.000	IV.C2-25 (TLAA)	
CVCS Regenerative HX Piping to Letdown HX												
33.3	Type 304/316SS HAZ;115-290F Primary Water								1.125	2.000	IV.C2-25 (TLAA)	
33.4	Type 308SS Weld;115-290F Primary Water								1.125	2.000	IV.C2-25 (TLAA)	
33.6	Type 304SS Socket Welds;115-290F Primary Water								2.000	2.000	IV.C2-25 (TLAA)	
CVCS Letdown HX Piping to VCT												
34.3	Type 304/316SS HAZ; 115F Primary Water								1.125	2.000	IV.C2-25 (TLAA)	
34.4	Type 308SS Weld; 115F Primary Water								1.125	2.000	IV.C2-25 (TLAA)	
34.6	Type 304SS Socket Welds; 115F Primary Water								2.000	2.000	IV.C2-25 (TLAA)	
CVCS Mixed Bed Piping to Filter												
35.3	Type 304/316SS HAZ; 115F Primary Water								1.125	2.000	IV.C2-25 (TLAA)	
35.4	Type 308SS Weld; 115F Primary Water								1.125	2.000	IV.C2-25 (TLAA)	
35.6	Type 304SS Socket Welds; 115F Primary Water								2.000	2.000	IV.C2-25 (TLAA)	
CVCS VCT Piping to Charging Pump Suction												
36.3	Type 304/316SS HAZ; 160 or 115F Primary Water								1.125	2.000	IV.C2-25 (TLAA)	
36.4	Type 308SS Weld; 160 or 115F Primary Water								1.125	2.000	IV.C2-25 (TLAA)	
CVCS Charging Pump Piping to Regenerative HX												
37.3	Type 304/316SS HAZ; 130F Primary Water								1.125	2.000	IV.C2-25 (TLAA)	

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Subgroup Description: Material Condition		Degradation Mechanism							PMDA Expert Ratings		GALL Reference	PMDA
		BAC	CREEP	EC	FAT	FR	SCC	SW	Susceptibility	Knowledge	(Aging Manage Plan)	Comments
37.4	Type 308SS Weld; 130F Primary Water								1.125	2.000	IV.C2-25 (TLAA)	
37.6	Type 304SS Socket Welds; 130F Primary Water								2.000	2.000	IV.C2-25 (TLAA)	
CVCS Regenerative HX Piping to Cold Leg												
38.3	Type 304/316SS HAZ; 517F Primary Water								1.375	1.875	IV.C2-25 (TLAA)	
38.3	Type 304/316SS HAZ; 517F Primary Water								1.167	1.667	None	
38.4	Type 308SS Weld; 517F Primary Water								1.250	1.875	IV.C2-25 (TLAA)	
38.5	Forged 304/316SS Components; 517F Primary Water								1.375	2.000	IV.C2-25 (TLAA)	
CVCS Injection Filter Piping to RCP Seals												
39.3	Type 304/316SS HAZ; 130F Primary Water								1.125	2.000	IV.C2-25 (TLAA)	
39.4	Type 308SS Weld; 130F Primary Water								1.125	2.000	IV.C2-25 (TLAA)	
39.6	Type 304SS Socket Welds; 130F Primary Water								2.000	2.000	IV.C2-25 (TLAA)	
CVCS RCP Seal Return Piping to Filter												
40.3	Type 304/316SS HAZ; 250-150F Primary Water								1.125	2.000	IV.C2-25 (TLAA)	

Appendix F:
PMDA–GALL Comparison Spreadsheet –
Boiling Water Reactor Yellow Category

Subgroup Description: Material Condition		Degradation Mechanism			PMDA Expert Ratings		GALL Reference	PMDA
		FAT	FR	SCC	Susceptiblity	Knowledge	(Aging Manage Plan)	Comments
Reactor Core Isolation Cooling								
12.1	SA105,106,234 - Carbon Steel;547F Primary and Secondary Water				1.750	2.000	IV.C1-5,11,15 (XI.M1, TLAA)	
12.9	SA105,106,234 - Carbon Steel Base & Weld; <100F Stagnant Storage Water				1.500	2.000	None	
Main Steam								
17.4	A234, A106, A105 Weldolet; 547F Saturated Steam				2.000	2.000	VIII.B2-5 (TLAA)	
17.7	CASS, A351 Type 304SS, Venturi; 547F Saturated Steam				1.125	2.000	None	
Reactor Pressure Vessel Shell								
2.12	Alloy 82/182 Weld Between CS and Alloy 600; 427F Reactor Water				1.375	2.000	None	
2.13	Alloy 82/182 Weld Pad Between A508 and Alloy 600; 427F Reactor Water				1.250	2.000	None	
2.18	CF8M Brackets and Guide Rods; 427F Reactor Water				1.500	1.875	None	
2.18	CF8M Bracketsfor Steam Driyer and Guide Rods; 547F Reactor Water or Coolant Steam			HWC	1.250	1.875	None	
Reactor Pressure Vessel Bottom Head								
3.4	Dissimilar Metal Nozzle Weld Alloy 182/82; 533-547F Reactor Water				1.375	2.000	None	
3.5	Dissimilar Metal J-Weld Alloy 182/82; 533-547F Reactor Water				1.375	2.000	None	
3.8	308 Weldments; 533-547F Reactor Water				1.125	2.000	None	
3.9	Alloy 82/182 Weld Pad Bet.Thermal Sleeve and Nozzle; 533-547F Reactor Water				1.375	2.000	None	
3.11	Dissimilar Alloy 82/182 Welds; 533-547F Reactor Water				1.375	2.000	None	
3.13	Alloy 182 Weldments of Inconel to Inconel; 533-547F Reactor Water				1.375	2.000	None	
Core Shroud								
4.1	308/308L Vertical Weld; 533F Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)				1.125	2.000	None	

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Subgroup Description: Material Condition		Degradation Mechanism			PMDA Expert Ratings		GALL Reference	PMDA
		FAT	FR	SCC	Susceptiblity	Knowledge	(Aging Manage Plan)	Comments
4.2	Type 304SS Vertical HAZ; 533F Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)				1.250	2.000	None	
4.3	308/308L Circumferential Weld; 533F Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)				1.125	2.000	None	
4.4	Type 304SS Circumferential HAZ ; 533F Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)				1.250	2.000	None	
4.5	Type 308/308L Weld Metal (low flu); 533F Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)				1.125	2.000	None	
4.6	Type 304SS Vertical HAZ (low flu); 533F Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)				1.250	2.000	None	
4.7	Type 308/308L Weld Metal (moderate fluence); 533F Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)				1.125	2.000	None	
4.8	Type 304SS HAZ (moderate fluence); 533F Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)				1.250	2.000	None	
4.9	Alloy 182 Shroud Weld Metal; 533F Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)				1.375	2.000	None	
4.14	Type 304SS (with 308L welds); 533F Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)				1.250	2.000	None	
Core Controls								
5.3	CF3 A351 Control Rod Guide (low to moderate				1.625	2.000	None	
5.8	Alloy 182 RPV Stub Weld Metal				1.500	2.000	None	
5.9	Type 304 SS RPV Stub HAZ				1.375	2.000	None	
Jet Pump Assembly								
6.5	Alloy X750 (mostly HTH) Holddown Beam (low fluence); 533F Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)				1.500	2.000	None	
6.7	Alloy 182 Weld Metal (AHC) (low fluence); 533F Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)				1.500	2.000	None	

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Subgroup Description: Material Condition		Degradation Mechanism			PMDA Expert Ratings		GALL Reference	PMDA
		FAT	FR	SCC	Susceptiblity	Knowledge	(Aging Manage Plan)	Comments
6.10	304SS Riser Brace HAZ (low fluence); 533F Reactor Water (<0.15 uS/cm, <5 ppb SO4/Cl)				1.375	2.000	None	