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August 27, 2012

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Chief, Rules, Announcements, and Directives Branch (RADB)  
Office of Administration  
Mail Stop: TWB-05-B01M  
U.S. Nuclear Regulatory Commission  
Washington, DC 20555-0001

*7/13/2012  
77FR 41457  
①*

**Subject:** Industry Comments on Draft License Renewal Interim Staff Guidance, LR-ISG-2012-01, "Wall Thinning Due to Erosion Mechanisms," Docket ID: NRC-2012-0170

**Project Code: 689**

Dear Ms. Bladey:

The U.S. Nuclear Regulatory Commission (NRC) requested public comment on Draft License Renewal Interim Staff Guidance (LR-ISG), LR-ISG-2012-01, "Wall Thinning Due to Erosion Mechanisms." The draft LR-ISG proposes to revise an NRC staff-recommended aging management program (AMP) in NUREG-1801, Revision 2, "Generic Aging Lessons Learned (GALL) Report," and the NRC staff's aging management review procedure and acceptance criteria contained in NUREG-1800, Revision 2, "Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants" (SRP-LR) to address wall thinning due to various erosion mechanisms for piping and components within the scope of 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants." This LR-ISG provides changes to the recommendations in GALL Report, Revision 2, AMP XI.M17, "Flow-Accelerated Corrosion," based on the staff's review of several license renewal applications' flow-accelerated corrosion AMPs and stakeholder input. The purpose of this letter is to provide integrated industry comments on the subject ISG.

The industry believes that inclusion or addition of mechanical erosion mechanisms into the FAC AMP (XI.M17) would be confusing and possibly detrimental to the currently well bounded and structured industry FAC programs. The susceptibility bases of industry FAC programs are clearly defined and the inclusion of erosion mechanisms would cross many of those boundaries. This would result in the FAC program having two separate sets of susceptibility criteria for FAC and erosion, as well as

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separate methods for selecting inspections and strategies. Therefore, the industry recommends that the NRC create a separate erosion AMP rather than mixing it into the current program.

Additional comments are contained in the attachment.

We appreciate the opportunity to comment on the ISG and respectfully request that you incorporate industry comments as stated in the attachment. If you have any questions or require additional information, please contact me.

Sincerely,

A handwritten signature in black ink, appearing to read "Jason Remer", written in a cursive style.

Jason Remer

Attachment

c: Ms. Melanie A. Galloway, NRR/DLR, NRC  
Mr. James A. Gavula, NRR/DLR/RAPB, NRC  
NRC Document Control Desk

## Industry Comment Collection Form

LR-ISG-2012-01, Wall Thinning Due to Erosion Mechanisms

Submitted by NEI

Ref #	Section in Document	Comment	Proposed Resolution
1	General	<p>The inclusion or addition of mechanical erosion mechanisms into the FAC AMP (XLM17) would be confusing and possibly detrimental to the currently well bounded and structured industry FAC programs. The susceptibility bases of industry FAC programs are clearly defined and the inclusion of erosion mechanisms would cross many of those boundaries. This would result in the FAC program having two separate sets of susceptibility criteria for FAC and erosion, as well as separate methods for selecting inspections and strategies; therefore, it makes sense to respond by creating a separate erosion program rather than mixing it into the current program.</p> <p>The inclusion or addition of mechanical erosion mechanisms into the FAC AMP (XLM17) would significantly detract from the effectiveness of the current industry FAC programs in that the scope of the current programs would require expansion away from the focused "FAC susceptible" systems and</p>	<p>Create a separate AMP for mechanical erosion mechanisms.</p> <p>If a separate AMP is not created, consider revising XLM38 - Inspection of Internal Surfaces in Miscellaneous Piping and Ducting Components instead.</p> <p>Create plant specific program AMR lines or create a separate AMP for mechanical erosion mechanisms in ESF and Steam &amp; Power Conversion Systems. Consider management of erosion in safety related cooling water systems with AMP XLM20 Open-Cycle Cooling Water System.</p>

		<p>components to the incorporation of virtually all piping systems into the program regardless of their susceptibility to FAC. Additionally significant changes to the current FAC program structures along with new guidance would be needed to facilitate new methodologies required for ranking of susceptible locations, new or updated “fitness for services” methodologies for determination of remaining service life (i.e. – linear vs. non-linear wear) and guidance for recommended mitigation strategies.</p>	
2	General	<p>LR-ISG-2012-01 does not address a key consideration of operating experience associated with many of the erosion related phenomena such as damaging cavitation, or solid particle impingement. Many plants have chosen to “manage” or address erosion phenomena with a design modification or in some cases with a periodic replacement program. Both of these “management” techniques are example of operating experience that does require an aging management program.</p>	<p>Create plant specific program AMR lines or create a separate AMP for mechanical erosion mechanisms in ESF and Steam &amp; Power Conversion Systems. Consider management of erosion in safety related cooling water systems with AMP XI.M20 Open-Cycle Cooling Water System.</p>
3	General	<p>The inclusion or addition of mechanical erosion mechanisms into the clearly defined and bounded FAC AMP (XI.M17) would require significant program changes and conflicts with NSAC 202L-R3 and associated predictive codes such as CHECKWORKS. During aging management program reviews</p>	<p>Create plant specific program AMR lines or create a separate AMP for mechanical erosion mechanisms in ESF and Steam &amp; Power Conversion Systems. Consider management of erosion in safety related cooling water systems with AMP XI.M20 Open-Cycle Cooling Water System.</p>

		<p>several exceptions would be required to incorporate management of erosion into the FAC program. For example management of erosion in cooling water systems and several ESF systems would require an exception to the FAC program exemptions for fluid temperatures less than 200F, systems with high levels of dissolved oxygen, and system with stainless steel (chrome content) piping. In addition NSAC 202L-R3 states that if wall thinning is being developed by mechanism other than FAC, an appropriate inspection program should be developed.</p>	
4	General	<p>LR-ISG-2012-01 clearly defines FAC and erosion as two different aging mechanisms that cause loss of material. Detection, analysis, and corrective action associated with erosion related phenomena such as damaging cavitation, and solid particle impingement are beyond the predictive tools of the FAC program. GALL includes specialized aging management program such as XI.M33 Selective Leaching and XI.M35 OTI of ASME Code Class 1 Small-Bore Piping for unique aging mechanisms and/or component considerations.</p>	<p>Create plant specific program AMR lines or create a separate AMP for mechanical erosion mechanisms in ESF and Steam &amp; Power Conversion Systems. Consider management of erosion in safety related cooling water systems with AMP XI.M20 Open-Cycle Cooling Water System.</p>
5	General	<p>Erosion → Erosion-corrosion → Corrosion is a continuum, moving from a purely mechanical effect to a purely electrochemical effect. FAC is a</p>	<p>Add one or more paragraphs that state what is discussed in the comment, noting that FAC programs have been shown to effectively address FAC,</p>

		special case of erosion-corrosion since it only afflicts carbon steel under very specific environmental conditions (i.e., temperature, pH, dissolved oxygen, all of which control the solubility of magnetite and its susceptibility to removal by turbulence)	however, solutions for FAC will not necessarily be effective for erosion or for erosion-corrosion phenomena of other materials
6	General	Where treated water is monitored for particulates, erosion would only be due to cavitation in a single phase environment or only be due to droplet impingement or flashing in a two phase environment.	Consider adding this kind of guidance/information.
7	Page 2, First full Paragraph, 3 <sup>rd</sup> Sentence	The CHECWORKS™ software does not specifically “identify locations susceptible to wall thinning” or “predict susceptible locations related to erosion”. Susceptibility is defined and documented by programs engineers based on specific criteria and the software evaluates or predicts a relative rate of FAC wear for each component in the susceptible lines.	Reword:  For example, the “monitoring and trending” program element of GALL Report AMP XI.M17 includes the use of software to identify locations <b><u>most</u></b> susceptible to wall thinning due to FAC, but the software does not <b><u>identify locations most susceptible to erosion.</u></b>
8	Page 2, Clarifications to Definitions, first paragraph	The statement “FAC is a pure corrosion process that does not have an erosion component” is not correct. While electrochemical conditions make the “window” where FAC will be operative very small, if there is no turbulence, there is no FAC and there is only minimal dissolution.	1. Revise the incorrect statement. 2. Define the (purely mechanical) erosion to the (purely electrochemical) corrosion continuum discussed above. Properly note where FAC lies in that continuum and why FAC only occurs for a single material class under special environmental conditions
9	Changes to	The end of the second paragraph in	Consider comments by EPRI,

	the FAC AMP, second paragraph  Page 3	the "Changes to FAC AMP" section, there is a reference to Callaway 1999; this is obviously a reference to the failure OE from Callaway. This OE event was attributed in part by both FAC and Erosion mechanisms. There is still a disagreement in the industry between the site, and EPRI, as to whether the report on this issue performed by an outside vendor is accurate.	which have been communicated between the current Callaway site FAC Program Engineer, and EPRI experts on FAC and Wall Thinning mechanisms. They have extensively reviewed this OE, and are revisiting the incident to support the comments to this ISG.
10	Page 3, Clarifications to Definitions, last paragraph	This paragraph is completely correct, however, it does not offer a solution.	<ol style="list-style-type: none"> <li>1. Clearly define erosion, erosion-corrosion, corrosion (and FAC) as noted above.</li> <li>2. Note that erosion, in various forms (cavitation, particles, et al.) will cause metal loss</li> <li>3. Licensees must demonstrate that their programs address areas of "pure" erosion in terms of prediction, inspection, and resolution.</li> </ol>
11	Page 3, Changes to the FAC AMP, third paragraph	"Lines that are being monitored for wall thinning due to erosion mechanisms may be included with these other non-modeled (per the FAC program) lines and treated in a comparable fashion."	Add a clearly worded sentence or paragraph that states that solutions to (pure) erosion conditions will be different than solutions to FAC, so the two degradation mechanisms must be addressed separately, but that the existing and well established FAC program and methodology provides a useful way to plan inspections, record and trend data, etc.
12	Page 3, 3 <sup>rd</sup> Full Paragraph, Last Sentence	The operating experience at Callaway (in 1999) and Dresden (in 2007) are cited as examples of combined FAC and erosion. Callaway may have been an example but it is not clear from the lab analysis that it was. The Dresden	Reword:  The staff's review of operating experience has shown that, in some cases, wall thinning is <b>may be</b> caused by a combination of mechanisms, which includes FAC and some

		operating experience could not have contained an FAC element since the material was FAC-resistant P11 chrome-moly steel.	type of erosion ( <del>Callawy 1999, Dresden 2007</del> ).
13	Page 3, 3 <sup>rd</sup> Paragraph in section "Changes to FAC AMP"	While many FAC susceptible locations are modeled and wear predicted using software such as CHECWORKS, a very large portion of the program scope is included in the SNM (Non-modeled) evaluation. The value added by the new CHECWORKS erosion module which is soon to be released will be minimal and only useful in the SSE (modeled) scope. EPRI TR 1011231 and 112657 are discussed and compared as being used together for erosion monitoring.	Don't count on the use of any modifications to currently used program software, such as CHECWORKS, to greatly improve the industry's ability to predict or inspect for potential mechanical erosion induced wall thinning. Components which will be monitored for erosion thinning should not be treated similarly to SNM, as suggested in the ISG. SNM components inspections are strategically chosen at known likely problem areas based upon component geometry, and then generalities are made for the wall thinning of the components and lines. Choosing locations which are more likely to experience erosion and actually finding anything of value would be very unlikely.
14	Page 3, Fourth paragraph, Last sentence	This sentence discusses lines being monitored for erosion damage. Most erosion mechanisms are caused by localized conditions. As such, they are component issues and not line issues. For example, cavitation may occur downstream of a flow control valve but it will not be a concern throughout the entire line.	Reword: Lines <u>or locations</u> that are being monitored for wall thinning due to erosion mechanisms may be included with these other non-modeled lines and treated in a comparable fashion.

15	Page 4, First Paragraph, Last Sentence	Although this sentence does not specifically imply that mechanical erosion mechanisms should be covered in the FAC program it may lead to some expectations and these concerns have been noted in the general comments above.	Reword:  Although every plant site may not encounter erosion mechanisms, if ongoing monitoring <b>activities</b> of wall thinning due to erosion <b>are occurring, they should be included in an AMP.</b> <del>is not included as part of any other AMP, then these monitoring activities should be included in the FAC program.</del>
16	Page 4, ACTION, Bullet #2	The revised definition does not clarify the differences between FAC and (pure) erosion. The revised definition and continued ties to the FAC program, may actually add confusion.	See initial comment on clearly defining erosion through erosion-corrosion to corrosion and defining where FAC fits.
17	Page 4, ACTION, Bullets #1 & #2	These bullets basically come out and say that erosion should be a separate AMP, but that industry and NRC don't want to make a separate AMP.	See Proposed Resolution for "Changes to the FAC AMP, third paragraph"
18	A-2, SRP Table 3.0-1	ISG states, "Where applicable, the program also manages wall thinning...." This change is unnecessary. The text does not define the mechanism except through reference to NSAC-202L, so stating that it also includes erosion mechanisms is unnecessary. NSAC-202L includes identifying loss of material based on OE regardless of whether due to erosion mechanisms or FAC. Managing loss of material due to erosion mechanisms is not precluded by the existing wording.	Delete the added phrase.

19	App B/D General	The FAC program implementation at PWRs addresses systems with carbon steel components. These are present in the secondary systems, and FAC is not used to manage primary (borated) systems. If site-specific OE indicates the need to manage additional aging effects in these systems, a different (or new) program would be chosen to provide that management.	Replace recommendations for assignment of FAC in tables IV.C2, V.D1, VII.C1, and VII.E1 with a plant-specific program for management of wall thinning due to erosion in these systems.
20	App B/D General X1.M17 Scope	As above, the program implemented by NSAC-202L-R2 or R3 generally addresses systems with FAC-susceptible carbon steel components (less than 1.25% chromium) in single phase systems at or above 200F, or in two-phase systems. Allowance is provided to include additional non-modeled components that may have unknown or widely varying operating conditions that may prevent development of reasonably accurate analytical models. The inclusion of this allowance for scope expansion in NSAC-202L-R2/R3 was not intended to extend to additional systems and significantly different materials. If site-specific OE indicates the need to manage additional aging effects in these systems, a different (or new) program would be chosen to provide that management.	Revise last two sentences of Element 1. Scope of Program: to read: "The program may also include piping and components that are susceptible to erosion wall-thinning mechanisms such as cavitation, flashing, droplet impingement, or solid particle impingement in various water systems <u>that may be susceptible to FAC</u> . Since there are no known materials that are immune to wall thinning due to erosion, piping and components of any material may be included in the non-FAC portion of the program."

21	Page B-5 (& D-5), Table IX.F	In the entry under Erosion, in the sentence that states, "Erosion is the progressive loss of material due to the mechanical interaction between a surface and a high-velocity fluid." This statement is incorrect. High-velocities are not required, especially for solid particle erosion as velocities ~ 5 feet per second have been shown to cause damage in raw water systems (e.g., Service Water Systems).	Reword:  Erosion is the progressive loss of material due to the mechanical interaction between a surface and a <del>high-velocity</del> fluid.
22	Page B-5, GALL Table IX.F	The definition of erosion is correct and clear. The initial portion of the definition of FAC is also correct (and implies although not stated) that FAC is a special case of erosion-corrosion that only applies to carbon steel under very specific environmental conditions). The added items in brackets are not correct, as noted above in comments on Clarification and Definitions.	<ol style="list-style-type: none"> <li>1. Remove the added items in brackets.</li> <li>2. Add additional definitions of erosion-corrosion (an interaction between mechanical effects and electrochemical effects) and corrosion (a purely electrochemical process) and note that FAC is a special case of erosion-corrosion.</li> <li>3. FAC Program. Note that FAC programs provide a useful and proven method for planning, executing, and recording inspections, and trending those results.</li> </ol>
23	Page B-6, XLM17 FAC, Program Description – General	Stating that the FAC program "may be used to manage wall thinning due to various erosion mechanisms" is good but also potentially asks for trouble (i.e., blindly using the FAC program will have licensees wonder why higher Cr carbon steel erodes (e.g., as shown in some of the OE).	Clearly state that the FAC program provides a useful format and methodology, however, the differences in the source, rates, solutions to degradation, etc. must be properly understood.

24	Page B-6 (& D-6), item (#2)	The noted conditions are effective in reducing or eliminating FAC but have minimal impact on erosion mechanisms.	Reword: However, it is noted that monitoring of water chemistry to control pH and dissolved oxygen content, and selection of appropriate piping material, geometry, and hydrodynamic conditions, are effective in reducing FAC <del>and</del> <b>but not</b> erosion mechanisms.
25	Page B-6 (& D-6), item (#1)	Recommend revising “piping and components” to read “piping, piping components, and piping elements” since these are the only components listed in the marked up pages of the GALL included in the ISG. This would improve the clarity of the scope.	Reword: Revise “piping and components” to read “piping, piping components, and piping elements” to be consistent with other GALL component types.
26	Page B-7 (& D-7), item (#5) Line 5	The sentence that begins, “It is recognized ...” misrepresents the design and usage of CHECWORKS. CHECWORKS™ is a “best estimate” program and as such its predictions are adjusted by inspection data to pass through the center of the inspection data.	Reword:  <del>It is recognized that CHECWORKS™ is not always conservative in predicting component thickness; therefore, when measurements show the predictions to be non-conservative, the model must be re-calibrated using the latest field data.</del>  <b><u>Inspection data from every refueling outage is input into CHECWORKS™ to ensure that the predictive model is properly re-calibrated.</u></b>
27	Page B-7 (& D-7), item	It is uncertain at what level of wall thinning an extent of review is	Include criteria to define when an extent of review is required.

	(#4)	<p>required.</p> <p>Element 4 states “If wall thinning due to an erosion mechanism (e.g., cavitation, flashing, droplet impingement, or solid particle impingement) is identified, then the applicant performs an extent-of-condition review to identify other components that are comparably susceptible to the same mechanism”</p>	
28	Page B-7 (& D-7), item#5, Second Paragraph, first sentence	Element 5 does not identify a preferred methodology to be used to “predict the remaining service life of the component”	Identify the methodology preferred by the NRC to “predict the remaining service life to the component”.
29	Page B-7, XIM17 FAC, 5. Monitoring and Trending, second paragraph.	Predictive tools are absent.	Identify the lack of predictive tools, meaning that the licensee must have some understanding of where susceptibilities could exist in the system and must act accordingly.
30	Page B-8 (& D-8), item (#7), second sentence	The paragraph is accurate, but it would be clearer to modify the second sentence.	<p>Reword:</p> <p><b><u>For FAC, long-term corrective actions could include adjusting operating parameters or selecting resistant materials.</u></b></p>
31	Page B-8, XIM17 FAC, 7. Corrective Actions	No guidance is given for evaluating the effectiveness of corrective actions for erosion mechanisms or “as part an AMP”, presumably, a different AMP.	As noted above, clearly state (and reiterate) that the FAC program (merely) provides a useful format and methodology, however, the differences in the sources, rates, solutions to

			degradation, etc. must be properly understood. That is, in the absence of a separate AMP to cover erosion mechanisms, the AMP format, etc. can be used; however, the differences between FAC and erosion must be clearly understood in terms of drivers and solutions.
32	Page B-8 (& D-8), item (#10), second sentence	<p>Five examples of operating experience are cited as "... other than FAC or a combination of mechanisms." Looking at the five:</p> <ul style="list-style-type: none"> <li>• Point Beach – FWH shell was due to FAC alone according to EPRI review.</li> <li>• Callaway - may have been an example but it is not clear from the lab analysis.</li> <li>• Peach Bottom – cavitation erosion, abrasive erosion (i.e., solid particle erosion), and water jet cutting</li> <li>• Dresden – liquid droplet impingement</li> <li>• Quad Cities – "erosion"</li> </ul> <p>While wall thinning caused by a combination of mechanisms may occur, it is not common.</p>	<p>Reword:</p> <p>Observed wall thinning may be due to mechanisms other than FAC or, <b><u>less commonly</u></b>, due to a combination of mechanisms.</p>
33	Page D-2, GALL IV-C2	<p>It is hard to imagine that wall thinning is an issue in the RCS system of a PWR. Particulates are monitored, the only place two-phase coolant exists is next to the fuel rods and in the pressurizer, and the only place cavitation or flashing would occur is in the RCP or downstream of connecting valves or orifices,</p>	<p>Make line item specific to BWRs. In GALL, Rev 2, FAC is only applied to BWRs. I did not see any examples of wall thinning in the RCS system in the ISG, yet the revisions seem to focus on the RCS system. I know Palo Verde experienced cavitation issues related to the</p>

		<p>which may or may not be the RCS system. Based on review of EPRI 1011231 "Recommendations for Controlling Cavitation, Flashing, Liquid Droplet Impingement, and Solid Particle Erosion in Nuclear Power Plant Piping Systems," we do not understand the NRC concern for erosion in the RCS of PWRs. BWRs are mentioned in EPRI 1011231, but not PWRs.</p>	<p>RCPs during start-up, but these were resolved. Add OE related to erosion to the AMP and provide the cause.</p>
34	Page D-3 line item in VII C1	<p>This line item is not needed as XI. M20 manages erosion in service water systems in accordance with 89-13 commitments. This new item confuses this issue. To do this would be contrary to the 89-13 commitment which is part of M20.</p>	<p>Delete this line item as it is not needed. Revise M20 to include wall thinning due to erosion as an aging effect. Do not credit a program that is not part of the 89-13 commitments.</p>
35	Page D-5, Table IX.F	<p>Says, "Different forms of erosion may include cavitation, flashing, droplet impingement, or solid particle impingement." Forms of erosion DO include the listed items.</p>	<p>Change to read, "Different forms of erosion include cavitation, flashing, droplet impingement, <u>and</u> solid particle impingement.</p>
36	Page D-5, Table IX.F	<p>Definition of FAC contains reference to previous definitions. This is unnecessary. Recommend just sticking with the new definition without apologizing for previous version.</p>	<p>Delete "[In previous versions of the GALL Report and past NRC generic communications, this type of corrosion has been incorrectly called erosion-corrosion, which is misleading since erosion implies a mechanical process instead of chemical dissolution.]</p>
37	Page D-5, GALL Appendix D, Table IX.F,	<p>This section was more correct before the modifications. That is, it did not define FAC as only being operative on piping. It did correctly state that</p>	<ol style="list-style-type: none"> <li>1. Return to the original wording.</li> <li>2. Add discussion as proposed</li> </ol>

	Flow-accelerated corrosion	FAC is a form of erosion-corrosion, and that the mechanism is well understood and well described.	in the comment for Discussion – General
38	Page D-6, GALL XI.M17 Program Description	The qualifier is unnecessary. Should limit the discussion to what the program does; not necessarily when you may choose to use it.	Delete “if the erosion mechanisms are not being managed by another program.”
39	Page D-6, GALL XI.M17 Program Description	Added paragraph indicates that “an appropriate inspection program ... should be developed.” The FAC “program” may be that program and it is already “developed” as described in XI.M17.	Recommend modifying the first sentence to indicate that wall thinning may be caused by the listed mechanisms and reference the EPRI 1011231, and that this M17 program may be used to manage such wall thinning. Perhaps combine the first sentence of the Program Description into this paragraph.
40	Page D-6, XI.M17 Element#1	In added text, don’t need to specify a “non-FAC portion of the program.”	Delete from last sentence, “the non-FAC portion of.”
41	Page D-6, XI.M17 Element#3	In its basic form, wall thinning is still loss of material.	Recommend leaving loss of material as the relevant aging effect.
42	Page D-6, XI.M17 Element#4	The added discussion on performing extent of condition review is unnecessary and redundant. As stated on page 4 extent of condition is part of corrective action element and should remain only there. There is no need to include this review in element 4 as detection of aging effects is used to provide information on how the aging effects will be detected not corrective	Delete the extent of condition review discussion

		actions. It states in this element that the program includes identification of susceptible locations which is the same as an extent of condition review.	
43	Page D-7, GALL Appendix D, Item 5. Monitoring and Trending, first paragraph	The first paragraph is modified to expand and update discussions of CHECWORKS, et al. but does not clearly state that those codes and associated chemistry and materials selection solutions are for FAC and FAC only.	The first paragraph must clearly state whenever possible that CHECWORKS, et al. are for FAC and FAC only. The (added) second paragraph on erosion should note that the methodology for inspection planning, execution of inspections, data recording, data trending, etc. provided in FAC programs can be useful for erosion evaluations, but that predictive methods for FAC or FAC solutions will not be applicable to erosion.
44	Page D-8, XI.M17 Element #6	Acceptance criteria should not refer to inputting data into a predictive code or say you need to include corrective actions. The prediction may be a simple straight line projection from two measured points. Corrective actions are covered by element #7.	Revise the first part of first sentence to read, "Inspection results are used to calculate...". Change last sentence to say, "Calculations indicate that an area will not reach the minimum allowed wall thickness before the next scheduled inspection."

45	Page D-8, XLM17 Element #7	The statement, "The selection of replacement materials requires consideration of a number factors, because a material that is completely erosion resistant is not available." can be shortened. It could just say "A material that is completely erosion resistant is not available." Whenever replacement materials are evaluated a number of factors are normally considered.	Revise the wording to shorten the statement.
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## Comment Collection Form

### LR-ISG-2012-01, Wall Thinning Due to Erosion Mechanisms

Section in Document	Comment	Proposed Resolution
<b>Introduction</b>	Erosion mechanisms are not "Aging Effects."	The erosion mechanisms discussed do result in wall thinning but are not aging effects similar to general corrosion, FAC, MIC, etc. Remove the reference to aging mechanisms and only refer to the wall thinning or wear attributes of the erosion mechanisms.
General	The inclusion or addition of mechanical erosion mechanisms into the FAC AMP (XLM17) would be confusing and possibly detrimental to the currently well bounded and structured industry FAC programs. The susceptibility bases of industry FAC programs are clearly defined and the inclusion of erosion mechanisms would cross many of those boundaries.	Create a separate AMP for mechanical erosion mechanisms.
<b>Discussion</b>	Erosion, similar to FAC, is a wall-thinning phenomenon related to fluid dynamics.	FAC is a true aging mechanism due to corrosion; in this case, the degradation of the normally protective oxide layer of a carbon steel component. Fluid dynamics only accelerates the process. Remove "similar to FAC" from the statement.
<b>Discussion</b>	Erosion mechanism such as cavitation, flashing and droplet impingement are not aging mechanisms but typically associated with improper operation	Remove the reference to aging mechanisms as related to cavitation, flashing and droplet impingement or clarify/reiterate that these are not aging

	and considered to be a design deficiency.	mechanisms.
<b>Discussion</b>	<p>During recent license renewal reviews, the staff found instances where applicants continued to experience loss of material due to cavitation erosion because the design deficiency was not corrected. The industry guidelines also state that this deficiency will be corrected during the current term of operation. In that regard, the Statement of Considerations (60 FR 22461, 22469; May 8, 1995) for 10 CFR Part 54 notes that corrective actions that should be taken to address functional degradation logically include cause determinations, which could involve mechanisms other than aging (e.g., improper operation), but that corrective actions should focus on prevention, elimination, or management of the effects caused by these mechanisms.</p>	<p><b>Revise or Recall LR-ISG-2012-01.</b> Erosion mechanisms are not aging effects and a few instances of improper management of these degradation mechanisms, is not sufficient cause for new industry guidance. Industry guidance has already been established for these degradation effects in the form of prevention and elimination. Industry guidelines also state that these types of deficiencies should be corrected when found, therefore in the current term of operation, and need not be carried into the extended period of operation.</p> <p><b>However if these additional wear mechanisms are to be managed programmatically, then a new AMP should be created.</b></p>
<b>Discussion</b>	<p>GALL Report AMP XI.M17, "Flow-Accelerated Corrosion," manages wall thinning due to FAC and is well established and widely used by industry. However, the existing guidance in this program is not fully applicable to wall thinning due to erosion mechanisms. For example, the "monitoring and trending" program element of GALL Report AMP XI.M17 includes the use of software to identify locations susceptible to wall thinning due to FAC, but the software does not predict susceptible locations</p>	<p>Erosion mechanisms should not be managed by "monitoring and trending". The industry guidelines also state that this <b>deficiency will be corrected during the current term of operation.</b> In that regard, the Statement of Considerations (60 FR 22461, 22469; May 8, 1995) for 10 CFR Part 54 notes that corrective actions that should be taken to address functional degradation logically include cause determinations, which could involve mechanisms other than aging (e.g., improper operation), but that corrective actions should focus on prevention, elimination, or management of the effects caused by these mechanisms.</p>

	<p>related to erosion. Also, the “corrective actions” program element includes the replacement of susceptible components with FAC-resistant material, such as high chromium steel, which does not necessarily prevent wall thinning due to erosion mechanisms. As such, additional consideration is needed to address wall thinning due to erosion mechanisms.</p>	
<p><b>Discussion</b></p>	<p>As noted in SRP-LR Section 2.1.3.2.2, “Long-Lived,” passive components that are not replaced on the basis of a qualified life or specified time period require an aging management review (AMR) under 10 CFR 54.21(a)(1)(ii). SRP-LR Section 2.1.3.2.2 also states that components replaced on the basis of condition are not generically excluded from an AMR, and condition monitoring may be evaluated as a program to ensure functionality during the period of extended operation. If an applicant has implemented a replacement strategy for susceptible items, such as replacement frequency that utilizes actual wall thinning data from past plant-specific operating experience, then the staff recognizes these items do not meet the definition of long-lived, passive components and, therefore, they do not have to be managed for aging within the context of license renewal. However, if other strategies to manage the aging of the susceptible items are utilized, such as replacement based on periodic monitoring for loss of material by wall thickness measurements, then these items</p>	<p>Since most utilities address damaged areas caused by erosion mechanisms when identified and do not treat erosion as “Long-Lived” wear, the comments in this section should be heightened for awareness.</p> <p>Should a new AMP be processed strictly for erosion, this statement addressing AMP exclusion should be forefront in the discussion.</p>

	should be managed for aging, and this ISG is applicable.	
<b>Discussion</b>	<p>GALL Report AMP XI.M17, "Flow-Accelerated Corrosion," manages wall thinning due to FAC and is well established and widely used by industry. However, the existing guidance in this program is not fully applicable to wall thinning due to erosion mechanisms. For example, the "monitoring and trending" program element of GALL Report AMP XI.M17 includes the use of software to identify locations susceptible to wall thinning due to FAC, but the software does not predict susceptible locations related to erosion. Also, the "corrective actions" program element includes the replacement of susceptible components with FAC-resistant material, such as high chromium steel, which does not necessarily prevent wall thinning due to erosion mechanisms.</p> <p><b>As such, additional consideration is needed to address wall thinning due to erosion mechanisms.</b></p>	Additional wall thinning due to erosion mechanisms should be addressed in a new and separate AMP.
<b>Discussion</b>	<p>GALL Report AMP XI.M17, "Flow-Accelerated Corrosion," manages wall thinning due to FAC and is well established and widely used by industry. However, the existing guidance in this program is not fully applicable to wall thinning due to erosion mechanisms. For example, the "monitoring and trending" program element of GALL Report AMP XI.M17 includes the use of software to identify locations susceptible to wall thinning due to FAC, but the software does not</p>	The additional consideration noted should be in the form a new AMP and not incorporated into M17.

	<p>predict susceptible locations related to erosion. Also, the “corrective actions” program element includes the replacement of susceptible components with FAC-resistant material, such as high chromium steel, which does not necessarily prevent wall thinning due to erosion mechanisms. <b>As such, additional consideration is needed to address wall thinning due to erosion mechanisms.</b></p>	
<p><b>Discussion – Clarifications to Definitions</b></p>	<p>Section IX.E, “Aging Effects,” of the GALL Report currently includes “erosion” and “flow accelerated corrosion,” in its definition of “loss of material,” but only includes “cavitation” for concrete structures. Section IX.F, “Significant Aging Mechanisms,” of the GALL Report defines “erosion” as the “loss of material from a solid surface...due to mechanical interaction between that surface and a fluid.” In addition, it defines “flow-accelerated corrosion” as the “co-joint activity involving corrosion and erosion in the presence of a moving corrosive fluid leading to the accelerated loss of material.” Although the GALL Report definition associates flow-accelerated corrosion with erosion, EPRI Report 106611, “Flow-Accelerated Corrosion in Power Plants,” states that FAC is “a pure corrosion process that does not have an erosion component.” Since erosion is not involved in the FAC process, as the GALL Report definition suggests, this may lead to some confusion and inconsistencies in how NRC guidance is applied. In addition,</p>	<p>Erosion is not an aging mechanism in piping systems. Erosion in piping systems is the result of design deficiencies, malfunctioning components or abnormal system operation.</p> <p>The definitions in the GALL report should be revised to disconnect FAC and erosion as similar wear mechanisms.</p>

	<p>Section IX.E of the GALL Report currently defines “wall thinning” as an aging effect that “is a specific type of loss of material attributed to general corrosion or flow-accelerated corrosion.” In light of this discussion, the definitions of these aging effects and their associated mechanisms need to be revised to include additional mechanisms associated with erosion.</p>	
<p><b>Discussion – Clarifications to Definitions</b></p>	<p>Erosion in piping is caused by fluid motion that can involve cavitation, flashing, liquid droplet impingement, and solid particle impingement, which are found in many water systems. Erosion mechanisms are sometimes perceived as being comparable to wall thinning due to FAC; however, these other mechanisms are not addressed in the prediction methodology for FAC programs. Based on staff reviews of industry-wide operating experience, these additional mechanisms require further consideration to ensure that passive components are being maintained consistent with the current licensing basis.</p>	<p>Erosion is not FAC and is not addressed in FAC programs. If required, a new AMP should be created for erosion and not included in M17.</p>
<p><b>Discussion</b></p>	<p>Changes to the FAC Aging Management Program</p>	<p>M17 should not be revised to address erosion mechanisms. If required a new AMP should be developed. All references to FAC programs managing the effects of erosion mechanisms should be removed.</p>
<p><b>General</b></p>	<p>AMP M17</p>	<p>AMP M17 should not be revised to include erosion mechanisms except to reference a new AMP for Erosion Mechanisms. In the ISG’s tables where the Aging Management Program for Wall Thinning due to Erosion is referenced as</p>

		<b>Chapter XI.M17, “Flow-Accelerated Corrosion”</b> , replace with a reference to a new AMP for Erosion.
<b>General</b>	Raw Water, Service Water, Closed Cooling Water and other water systems (<200F) are covered by other AMPS.	Reference/Revise AMP’s M21 and M21A to address erosion in these systems.
<b>Appendix A</b>	The following table in Appendix A all begin to discuss additional scoping for the FAC AMP. Many of these locations, systems, structures, components are monitored by other programs, and should not be duplicated, for example buried piping, or raw water. Scope of this ISG doesn’t limit itself to piping/components.	The current industry programs are set up that the primary focus is piping and pressure retaining components, adding structures such as vessel internals etc. would not be appropriate as there are other more specific and advanced monitoring techniques used.
<b>Appendix A: Table 3.1-1</b>	This section mentions the Amp for Reactor vessel, internals, and RCS. If this table is suggesting adding these locations to the susceptibility, or SNM, portion of the FAC Program. This is just one example of how greatly this ISG could impact the scope of the program, expanding it significantly and necessitating a significant expense to reconsider and re-evaluate all susceptible locations. These areas would otherwise be completely excluded by the program due to materials, system conditions, etc.	Provide more information into what this Table is actually suggesting or implying. If it is implying that Erosion may be possible in these systems and locations, and that it needs to be monitored by the FAC AMP, which could be a problem programmatically.
<b>Appendix A: Table 3.2-1</b>	AMP for Engineered Safety features evaluated in Chapter V of Gall. Including areas in these systems/locations would greatly increase the scope of the program, many areas that would have	This ISG appears to have the potential to have a completely open possibility for scope expansion as it seems to argue that any and all locations are susceptible to erosion.

	otherwise and previously been excluded.	
<b>Appendix A: Table 3.3-1</b>	AMP for Auxiliary Systems evaluated in Chapter VII of Gall. Including areas in these systems/locations would greatly increase the scope of the program, many areas that would have otherwise and previously been excluded.	This ISG appears to have the potential to have a completely open possibility for scope expansion as it seems to argue that any and all locations are susceptible to erosion.
<b>Appendix A: Table 3.4-1</b>	AMP for Steam and Power Conversion System evaluated in Chapter VIII of Gall. Including areas in these systems/locations would greatly increase the scope of the program, many areas that would have otherwise and previously been excluded.	This ISG appears to have the potential to have a completely open possibility for scope expansion as it seems to argue that any and all locations are susceptible to erosion. This seems most appropriate in this area, as many locations in the Steam and Power systems are already part of the FAC Program, and continuing to monitor locations which are known to degrade, even after replacement with more susceptible materials seems more appropriate than significantly increasing program scope as suggested by the 3 sections above.
<b>Appendix B IV-C2, V-D1, VII-C1, VII- E1, VII- E3</b>	This ISG is proposing a number of RCS, ECCS, Open-Cycle Cooling, Service Water, CVCS, and Reactor Water Cleanup systems to be added to the FAC program (wall thinning) SNM, which would greatly increase the scope of the monitoring program.	It would be more appropriate to look at industry OE for problem areas where there are known Erosive mechanisms degrading systems, and components, limit the scope increase.

<b>All</b>	The addition of mechanical erosion mechanisms into the FAC AMP would be detrimental to the well bounded and structured industry FAC programs. The susceptibility bases of industry FAC programs are clearly defined and the inclusion of erosion mechanisms would cross many of those boundaries.	Create a separate AMP for mechanical erosion mechanisms.
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