

**AUDIT WORKSHEET**  
**GALL REPORT AMP**

PLANT: \_\_\_\_\_

LRA AMP: \_\_\_\_\_

REVIEWER: \_\_\_\_\_

GALL AMP: **XI.M15, Neutron Noise Monitoring**

DATE: \_\_\_\_\_

Program Element	Auditable GALL Criteria	Documentation of Audit Finding
Program Description	A. The program relies on monitoring the excore neutron detector signals due to core motion to detect and monitor significant loss of axial preload at the core support barrel's upper support flange in pressurized water reactors (PWRs). This inservice monitoring program is based on the recommendations from the American Society of Mechanical Engineers operation and maintenance standards and guides (ASME OM-S/G)-1997, Part 5, "Inservice Monitoring of Core Support Barrel Axial Preload in Pressurized Water Reactors Power Plants."	Consistent with GALL AMP: <input type="checkbox"/> Yes <input type="checkbox"/> No Document(s) used to confirm Criteria:  Comment:
1. Scope of Program	A. The program includes measures to monitor and detect loss of axial preload (loss of axial restraint) at the core support barrel's upper support flange in PWRs. The loss of axial restraint may arise from long-term changes resulting from abnormal wear at the reactor vessel core barrel mating surface or short-term changes due to improper installation of the reactor internals. The program also includes guidelines for further data acquisition that may be needed to define future plant operation and/or program plans in order to maintain the capability of the structure/components to perform the intended function.	Consistent with GALL AMP: <input type="checkbox"/> Yes <input type="checkbox"/> No Document(s) used to confirm Criteria:  Comment
2. Preventive Actions	A. The program is a monitoring/detection program that provides early indication and detection of the onset of aging degradation of the core support barrel hold-down mechanism prior to a scheduled shutdown, thus reducing outage time and avoiding potential damage to the core support barrel and fuel assemblies. The AMP does not rely on preventive actions.	Consistent with GALL AMP: <input type="checkbox"/> Yes <input type="checkbox"/> No Document(s) used to confirm Criteria:  Comment:

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3. Parameters Monitored/ Inspected	<p>A. The program relies on the use of excore neutron detector signals to provide information on the conditions of the axial preload. The excore neutron flux signal is composed of a steady state, direct current (DC) component that arises from the neutron flux produced by the power operation of the reactor, as well as a fluctuating (noise-like) component. This fluctuating signal arises from the core reactivity changes due to lateral core motion from the loss of axial preload. This core motion is mainly the result of beam mode vibration of the core support barrel. Despite the fact that this beam mode vibration provides only a very weak neutron noise source, it may be reliably detected and identified through Fourier Analysis of the fluctuating signal component of the excore neutron flux signal. This signal component has the characteristics of having 180-degree shifts and a high degree of coherence between signals obtained from pairs of excore neutron detectors that are positioned on diametrically opposite sides of the core. The neutron noise signals are characterized by parameters, which include the auto correlation, cross correlation, coherence, and phase. These parameters are to be monitored and evaluated.</p>	<p>Consistent with GALL AMP: <input type="checkbox"/> Yes <input type="checkbox"/> No  Document(s) used to confirm Criteria:</p> <p>Comment:</p>
4. Detection of Aging Effects	<p>A. Flow-induced vibration of the core support barrel will change the thickness of the downcomer annulus (water gap). This variation in the thickness will give rise to fluctuating changes in the neutron flux, as monitored by the excore neutron detectors. The natural frequencies and the amplitudes of the vibratory motion of the core barrel are related to the effective axial preload at the upper support flange of the core support barrel. Monitoring of the neutron noise signal obtained with the neutron flux detectors located around the external periphery of the reactor vessel provides detection of anomalous vibrational motion of the core support barrel, and hence significant loss of the axial preload. Decrease in the axial preload leads to decreases in the core support barrel beam mode frequency and an increase in the magnitude of the noise signal. The overall</p>	<p>Consistent with GALL AMP: <input type="checkbox"/> Yes <input type="checkbox"/> No  Document(s) used to confirm Criteria:</p> <p>Comment:</p>

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	effect of a decrease in the axial preload is to shift the neutron noise power spectrum toward larger amplitudes for the lower frequency region.	
5. Monitoring and Trending	<p>A. The neutron noise random fluctuation in the signals from the excore detectors are monitored, recorded, and analyzed to identify changes in the beam mode natural frequency of the core support barrel and its direction of motion for the purpose of a timely determination of the need and urgency for a detailed inspection and examination of the reactor vessel internals hold-down mechanism and mating component surfaces. These activities and analytical methodology are performed, and associated personnel are qualified, in accordance with site-controlled procedures and processes as indicated by vendor, industry, or regulatory guidance documents.</p> <p>The neutron noise monitoring program has three separate phases: a baseline phase, a surveillance phase, and a diagnostic phase. The baseline phase establishes the database to be used as a reference for developing limits and trends in the surveillance phase and to support data evaluation and interpretation in the diagnostic phase. During the baseline phase, data on the time history and DC level of each neutron flux detector and each cross-core detector pair are obtained. From this database, the characteristic amplitudes and frequencies of the core barrel motion are extracted. The wide and narrow frequency bands with their associated normalized root mean square (NRMS) values are established. The ASME-OMS/G-1997, Part 5, recommends collecting the baseline data during the first fuel cycle that the neutron noise monitoring program is applied to an already operating plant. Whenever</p>	<p>Consistent with GALL AMP: <input type="checkbox"/> Yes <input type="checkbox"/> No</p> <p>Document(s) used to confirm Criteria:</p> <p>Comment:</p>

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	significant changes takes place for the core, reactor internals, or operating conditions, additional baseline data is obtained.	
“	<p>B. In the surveillance phase, routine neutron noise monitoring of normal plant operations is performed over the life of the plant. The DC level and data for frequency analysis of each detector and two pair of cross-core detectors, may be collected. Comparisons of the measured amplitude and frequency data, with limits established from the baseline data, are made. In using neutron noise monitoring, accounts are taken of the effect of core burn-up, decreasing boron concentration, changes in fuel management, and in-core contact with the reactor vessel mechanical snubbers, which may affect the neutron noise signatures. Proper allowances for these factors during the baseline and surveillance phases will help toward detecting loss of axial preload before the core barrel becomes sufficiently free to wear against the reactor vessel and will also reduce the need to invoke the diagnostic phase.</p>	<p>Consistent with GALL AMP: <input type="checkbox"/> Yes <input type="checkbox"/> No  Document(s) used to confirm Criteria:</p> <p>Comment:</p>
“	<p>C. If the diagnostic phase becomes necessary, then evaluations are carried out to establish whether any deviations from the baseline data detected during the surveillance phase arises from core barrel motion due to loss of axial preload. The need and frequency of additional data collection on the time history and DC level of each neutron flux detector and each cross-core detector pair collection are guided by the results of these evaluations.</p>	<p>Consistent with GALL AMP: <input type="checkbox"/> Yes <input type="checkbox"/> No  Document(s) used to confirm Criteria:</p> <p>Comment:</p>

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6. Acceptance Criteria	A. If evaluation of the baseline data indicates normal operation for the applicable structure/component, the surveillance phase may commence. If evaluation indicates anomalous behavior, the monitoring program enters the diagnostic phase.	Consistent with GALL AMP: <input type="checkbox"/> Yes <input type="checkbox"/> No Document(s) used to confirm Criteria:  Comment:
“	B. During the surveillance phase, if deviations from the baseline fall within predetermined acceptable limits, the surveillance will continue. Otherwise, the diagnostic phase will commence.	Consistent with GALL AMP: <input type="checkbox"/> Yes <input type="checkbox"/> No Document(s) used to confirm Criteria:  Comment:
7. Corrective Actions	A. Initial results from the diagnostic phase of the program may be used to determine whether there is a need to increase the minimum frequency with which the surveillance data are acquired. In addition, if necessary, corrective actions may be taken to change the type of data acquisition and analysis from that previously recommended for the surveillance part of the program. The data trends may be established to guide further data acquisition that may be needed to define future plant operation and/or program plans. As discussed in the appendix to this report, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the corrective actions.	Consistent with GALL AMP: <input type="checkbox"/> Yes <input type="checkbox"/> No Document(s) used to confirm Criteria:  Comment:
8. Confirmation Process	A. Site quality assurance (QA) procedures, review and approval processes, and administrative controls are implemented in accordance with the requirements of 10 CFR Part 50, Appendix B. As discussed in the appendix to this report, the staff finds the requirements of 10 CFR Part 50, Appendix B, acceptable to address the confirmation process and administrative controls.	Consistent with GALL AMP: <input type="checkbox"/> Yes <input type="checkbox"/> No Document(s) used to confirm Criteria:  Comment:
9. Administrative Controls	A. See Item 8, above.	Consistent with GALL AMP: <input type="checkbox"/> Yes <input type="checkbox"/> No Document(s) used to confirm Criteria:

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		Comment:
10. Operating Experience	A. The neutron noise monitoring program and procedures were developed by the industry and published as a guide in ASME OM-S/G-1997, Part 5, an American National Standard. This monitoring program and procedures have been effective in limited industry use for monitoring and detecting loss of core support barrel axial preload in PWR power plants.	Consistent with GALL AMP: <input type="checkbox"/> Yes <input type="checkbox"/> No Document(s) used to confirm Criteria:  Comment:

EXCEPTIONS

Item Number	Program Elements	LRA Exception Description	Basis for Accepting Exception	Documents Reviewed (Identifier, Para.# and/or Page #)
1.				
2.				
...				

ENHANCEMENTS

Item Number	Program Elements	LRA Enhancement Description	Basis for Accepting Enhancement	Documents Reviewed (Identifier, Para.# and/or Page #)
1.				
2.				
...				

DOCUMENT REVIEWED DURING AUDIT

Document Number	Identifier (number)	Title	Revision and/or Date
1.			
2.			
3.			
4.			
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