Public Meeting with Analysis and Measurement Services Corporation (AMS) Regarding AMS-TR-0720R0

Online Monitoring (OLM) Technology to Extend Calibration Intervals of Nuclear Plant Pressure Transmitters

August 20, 2020

No.	Reference	Comment	Significance*
1	Section 1.1 Pg. 1	Section 5, "Related Regulations and Standards," of the topical report (TR) states in the context of demonstrating the compliance of Title 10 of the *Code of Federal Regulations* (10 CFR) 50.36, that "AMS proposes to use its OLM methodology as the technical basis to support plant-specific Technical Specification changes to switch from time-based surveillance frequency for channel calibrations to a condition-based calibration frequency based on OLM results." The U.S. Nuclear Regulatory Commission (NRC) staff currently understand that the goal of this TR is for licensees to employ an OLM methodology for condition-based calibrations and add the methodology to the technical specifications (TSs) as an alternative to periodic calibration requirements (Section 11). The TR could therefore be referenced by licensees in a subsequent license amendment request (LAR) as a technical basis to modify the TSs and demonstrate compliance with applicable regulations. Alternatively, the TR could serve as a methodological framework to support a future site-specific OLM methodology, that is further developed on a site-specific basis and submitted by licensees for NRC approval in TS licensing changes. However, the TR introduction states: "This report is intended to provide the NRC with the information that it needs to produce a [Safety Evaluation (SE)] to outline the regulatory requirements for OLM implementation in nuclear power plants." The NRC does not use TRs in a licensing decision as described in this statement. NRC typically makes findings on the technical adequacy of the framework, designs, analysis, and/or methods in a TR, including the extent to which it supports compliance with regulatory requirements. These findings may include limitations and conditions of use, and/or additional site-specific actions,	Acceptance Review (AR) Sufficiency

** Significance categorization may be subject to change as a result of further review and additional interactions with AMS

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		analyses, or methodologies that a licensee must develop and provide, to employ the TR and demonstrate compliance with applicable regulations in site-specific licensing actions. **The Introduction statement needs to be revised to describe the general intent and expected process for licensees using and referencing the TR. Otherwise, please clarify for NRC's understanding, the intended purpose, and use of the TR.** The TR should propose what is necessary and sufficient for achieving its stated purpose and technical findings for reference by licensees. In key places throughout the document (e.g., see Items 4 and 6 below regarding TS mark-ups) the TR does not provide sufficient detail for the staff to make conclusions regarding the acceptability of crediting OLM in the manner described in the TS as an alternative to periodic calibration checks. The following items further highlight the areas where additional detail is required.	
2	Section 3	Section 3, "Fundamentals of Transmitter Drift Monitoring," of the TR states: "The theoretical basis and details of OLM technology are not covered in this report, because they are available in public domain documents and open literature referenced throughout this report with a summary of each provided in Appendix D." (Note: Appendix D includes 49 references.) The basis and details of the OLM methodology for which approval is being requested should be included within the TR. There are different OLM technologies with different functions and design features. **A roadmap or explanation is needed** in the TR to clarify the technologies for which approval is being sought. That is, based on the 49 references, there are many combinations of approaches, methods, and analyses that could be credited in these references and applied by licensees in the Section 11 OLM methodology. It is not clear which references a licensee should technically apply or evaluate, and the process and criteria for the Section 11 OLM implementation methodology.	AR Sufficiency
3	Section 3.4 Section 3.4.1 Pg.11&12	Section 3.4, "Detecting Transmitter Failure Modes with OLM," of the TR includes a summary of transmitter failure modes and their associated detectability. **The TR should further address:** (1) How OLM detects the particular failure modes described (e.g., algorithm/method and acceptance criteria).	AR Sufficiency

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		(2) How failure modes not detectable by OLM should be addressed or why it is acceptable not to address them. For example, Section 3.4.2, "Failure Modes Detectable by Response Time Testing," of the TR states: "Also, two manufacturing defects were identified as failure modes that could affect sensor response time: low sensor fill fluid and crimped capillary lines. An analysis of these failure modes determined that they could be addressed using either post manufacturing benchtop response time testing or post-installation response time testing prior to normal operation." However, Section 11 does not require this type of testing be performed as part of the OLM implementation methodology. (3) The failure modes described and detected are not all the ones that could affect response time. For example, Section 3.5, "OLM and [Technical Specification Task Force (TSTF)] Options to Extend Transmitter Calibration Intervals," states: "The noise analysis technique has been used since 2005 at the Sizewell B nuclear power plant in the United Kingdom for sensor response time testing and detection of sensing line blockages and was adopted in 2019 by SNOC at its Vogtle nuclear power stations Units 1 and 2 in connection with OLM implementation." However, Section 11 does not require that OLM include noise analysis. (4) The potential adverse impact of any other "devices in the channel required for channel OPERABILITY" that are included in the condition-based monitoring signal. This information is needed to establish a technical basis that OLM will reliably identify failures that are addressed by time-based calibration frequencies in current NRC TS.	
4	Appendix C	Typically, TS controls that uses a program to control frequencies and completion times first get NRC's approval of the methodology, and propose a mark-up to the Standard TS (STS) which includes: (a) mark-ups to the TS, and (b) the addition of "Control Program" to the STS. For example: (1) TSTF Traveler TSTF-425, Rev. 3, "Relocate Surveillance Frequencies to Licensee Control – RITSTF Initiative 5b," is based on NEI 04-10 Rev. 1, "Risk-Informed Technical Specifications Initiative 5b, Risk-Informed Method for Control of Surveillance Frequencies." The insert into the FREQUENCY column of the SURVEILLANCE REQUIREMENTS table generally states	Potential RAI or AR sufficiency

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		“[OR In accordance with the Surveillance Frequency Control Program].” The insert in Section 5 of the STS include a short Surveillance Frequency Control Program which references NEI 04-10 Rev. 1. (2) TSTF Traveler TSTF-505, Revision 2, “Provide Risk-Informed Extended Completion Times – RITSTF Initiative 4b,” is based on NEI 06-09, Rev. 0-A, “Risk-Informed Technical Specifications Initiative 4b, Risk-Managed Technical Specifications (RMTS) Guidelines.” The insert into the COMPLETION TIME column of the ACTIONS table generally states “OR In accordance with the Risk Informed Completion Time Program].” The insert in Section 5 of the STS include a short Risk Informed Completion Time Program which references NEI 06-09, Rev. 0-A. Contrary to this formatting convention of the STS, the AMS-TR-0720R0 generally includes an insert into the FREQUENCY column of the SURVEILLANCE REQUIREMENTS table, which states “[OR In accordance with the ONLINE MONITORING methodology approved by the NRC in TR-xxxx]” and does not include an insert in Section 5 of the STS of a short Control Program. It is generally unclear what parts of the topical report constitute “the ONLINE MONITORING methodology approved by the NRC,” which would become an obligation through this insert. (see item 1)	
5	Section 11	The Section 11 of the TR is not written with a clearly stated convention for normative verb use. That is, some documents use the words “shall” and “must” to denote required or normative material, and “should” to denote a recommendation. Furthermore, some part of the TR use “is” or “are” and these could be interpreted as being normative also. It is preferable to clearly state a convention and follow it. Assuming the TR becomes a requirement to the licensee because it is a program referenced by the TS, it needs to be updated to be clear on what is required and what is not required, and what are optional practices that should be considered or employed.	Potential RAI or AR sufficiency
6	Abstract and Section 11.1 Pg. iii and	The Abstract in the TR states: “This topical report describes how online monitoring technology can be used in nuclear power plants as an analytical tool to measure sensor drift during plant operation and thereby identify the **sensors** whose calibration must be checked physically during an outage.” [**emphasis** added]	Potential RAI

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	80	Furthermore, based on where (in the instrument channel) the sensor information is obtained, addition components, but not necessarily all component in the instrumentation channel, are also included in the comparison. Section 11.1, Step 1 states: “As a first step towards OLM implementation, a list of **<u>transmitters</u>** to be included in the OLM program must be developed.” [**<u>emphasis</u>** added] The proposed TS markups generally include an insert in the “FREQUENCY” column of the “Perform CHANNEL CALIBRATION” surveillance requirements table. Generally, CHANNEL CALIBRATION includes more than just the sensors or transmitters. For example, the STS include definitions for CHANNEL CALIBRATION such as: “A CHANNEL CALIBRATION shall be the adjustment, as necessary, of the channel output such that it responds within the necessary range and accuracy to known values of the parameter that the channel monitors. The CHANNEL CALIBRATION shall **<u>encompass all devices in the channel required for channel OPERABILITY</u>**. Calibration of instrument channels with resistance temperature detector (RTD) or thermocouple sensors may consist of an in-place qualitative assessment of sensor behavior and normal calibration of the remaining adjustable devices in the channel. The CHANNEL CALIBRATION may be performed by means of any series of sequential, overlapping, or total channel steps.” [**<u>emphasis</u>** added] Consider identifying all other “devices in the channel required for channel OPERABILITY” that are subject to OLM in Step 1 in Section 11.1, "Data Acquisition and Analysis to Monitor for Drift,” of the TR or justify why it’s limited to just the ones identified. Consider including an analysis that demonstrates the other devices included in the monitored signal do not invalidate the OLM methodology employed or justify why not. How are the TS markups of the “Perform CHANNEL CALIBRATION” surveillance requirements to be understood? Only the sensors and transmitters are subject to condition-based calibration in accordance with the topical report, and all other “devices in the channel required for channel OPERABILITY” are subject to the other FREQUENCY (e.g., periodic) requirements. That is, the implementation of the TS markups will always include two FREQUENCY criteria, if the condition-based calibration is used.	

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7	Appendix A And Section 3.1	Appendix A, "OLM Implementation Issues with SER of Year 2000 and Proposed AMS Solutions," of the TR addresses the implementation issues with the methodology described in EPRI TR-104965-R1-A. In the SE, the NRC identified fourteen requirements that each licensee must address in any LAR to extend transmitter calibration intervals using OLM. Appendix A of AMS-TR-0720R0 addresses the implementation issues associated with the fourteen requirements. The first of the fourteen requirements include addressing "un-traceability of accuracy to standards" but this is not identified as an implementation issue; therefore, there is no solution provided in Appendix A. Please describe how this "requirement" is addressed. Section 3.1 of AMS-TR-0720R0 describes conventional calibration as a two-step process: (1) comparison of the sensor/transmitter to a traceable standard, and (2) sensor/transmitter adjustment if necessary (about 10% of the time). Effectively, the OLM methodology proposes to replace the comparison to a traceable standard with a comparison to redundant sensors/transmitters for the same process parameter; this replacement is justified in AMS-TR-0720R0 based on the fact that four sensors are unlikely (because it has not been observed to date) to experience common drift. Does this limit the applicability of the methodology to only when there are at least four redundant sensors? If one of the four sensors is declared inoperable†, how is the methodology adjusted? If one of the four sensors drifts so far that it is excluded from the average, why is the methodology still applicable for the remaining three? Would this approach still be valid for a plant application that has only three redundant sensors? NRC staff is aware of an instance at a U.S. nuclear power plant where three (of four) sensors experienced common-mode drift. NRC staff is also aware of the setpoint of 6 differential pressure switches serving as Reactor Water Level Narrow Range function have all shifted from their previously calibrated settings by approximately the same amount in the same direction due to a systematic effect resulting from the design of the instrument (See NRC Bulletin BL 86-02 and Information Notice IN 86-47). However, Section 3.3, "Common Mode Drift," claims that common	Potential RAI

† Typically, TSs include several types of SURVEILLANCE REQUIREMENTS such as CHANNEL CHECK, CHANNEL CALIBRATION, CHANNEL OPERATIONAL TEST (COT), and ACTUATION LOGIC TEST. The AMS-TR-0720R0 only proposes to change the FREQUENCY of the CHANNEL CALIBRATION for certain sensors/transmitters to be condition based. All other surveillances are unaffected and can result in a channel being declared inoperable.

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		mode drift has not been seen. The NRC staff's understanding of the OLM methodology described in the SER of the year 2000 states: "At least one redundant sensor will be calibrated each scheduled fuel cycle. For n redundant sensors, all sensors will be calibrated at least once in every n outage… In addition to calibrating at least one redundant sensor each scheduled fuel cycle, sensors that are identified as out-of-calibration by the on-line monitoring process will also be calibrated as necessary… By proposing to change the TS required instrumentation calibration frequency from the current once-per-refueling-cycle to a maximum of "once every 8 years based on the results of performance monitoring using the on-line monitoring technique," the topical report basically proposes to replace the current "time-directed traditional calibration" with the "on-line monitoring and calibrate-as-required approach," with an interval between the two successive calibrations limited to a maximum duration of eight years." The purpose of NUREG-0800, Branch Technical Position (BTP) 7-13 Rev. 6, "Guidance on Cross-Calibration of Protection System Resistance Temperature Detectors," is to identify the information and methods acceptable to the staff for using cross-calibration techniques for surveying the performance of resistance temperature detectors (RTDs). This BTP contains acceptance criteria similar to the previous SE. Will all proposed implementations of OLM that reference AMS-TR-0720R0 be implemented in accordance with this understanding that at least one of a group of X redundant sensors be calibrated against a known standard at least once per refueling outage? If so, would the calibration of a group of four redundant channel sensors rotate each refueling outage to a different sensor, such that each of the four sensors are calibrated to a known standard at least once every 8 years? The TR needs to clarify this issue and provide a basis for any significant deviations from the OLM methodology in the previous SE approval.	

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8	Section 3.3	An argument is made in Section 3.3, "Common Mode Drift," of the TR that common mode drift is not a credible failure mode. This argument is based on calibration data collected at several plants over a ten-year period. Because this data is based on observations made over a finite period, the results cannot support use of an unlimited calibration intervals. The argument used in the TR is based on data from transmitters that are frequently checked for calibration. This data does not indicate drift levels over extended periods of time (i.e., significantly greater than ten years) and the probability of common mode drift becomes greater over time. If there is no maximum calibration interval, then the probability of common mode transmitter drift is indeterminate. In absence of a maximum calibration interval, an infinite amount of transmitter data would be required to demonstrate that common mode drift is not credible for the entire service life of the transmitters. If a statistical analysis is the basis for eliminating the possibility of common mode transmitter drift, is there a maximum calibration interval for the process group?	Potential RAI
9	Section 3.4	Calibration typically address drift and failure modes, and linearity, responsiveness, pressure offset, and hysteresis. Please describe how the OLM program addresses linearity, responsiveness, pressure offset, and hysteresis.	Potential RAI
10	Section 3.4.1 pg. 12	Section 3.4.1, "Calibration Failure Modes Detectable by OLM," of the TR states: "Force-Balance Transmitters: FMEA analysis of these transmitters identified fourteen possible failure modes; all but one of which are detectable by OLM. Of these, nine can be detected by OLM during **normal plant operation**, one during **transient operation**, and three during either modes of operation. The single failure mode that cannot be detected by OLM is a change in viscosity of the fill fluid; usually caused by changes in environmental conditions (e.g., temperature or radiation)." [**emphasis** added] Furthermore, the sensor range may significantly exceed the process variable range during operation, which may lead to greater uncertainty than can be achieved during calibration. Define or describe normal or transient operation for the various applications (e.g., RWST level) or show that OLM is performed during all the manners or operation that are required to detect the failure modes.	Potential RAI
11		In empirical, model-based OLM, current measurements are applied to an algorithm that uses historical plant data to predict the plant's current operating parameter values. The deviation between the algorithm's predicted parameter values and the measured plant parameters is used to detect any instrument faults, including instrument drift. Many algorithms can be used to	Potential RAI

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		accomplish OLM, for example: auto-associative neural networks (AANN), auto-associative kernel regression (AAKR), and auto-associative multivariate state estimation technique (AAMSET). However, the AMS TR on OLM does not mention that OLM is model-based or what particular algorithm is used to predict plant parameter values. This TR implies that only the two "averaging" techniques explicitly discussed can be used to determine the plant parameter value used for determining sensor/transmitter drift and that noise from individual sensors/transmitters is used to determine associated instrument tube fouling. Please clarify.	
12	Section 1.1 pg. 1	EPRI TR-103436, "Instrument Calibration and Monitoring Program," Volume 1, "Basis for the Method," pages 4-9 state: "The only instrument property that is not verified with the ICMP methodology is response time. This compares favorably with current field calibration practices which do not verify response time and deadband, and depending on the procedure used, may not verify repeatability." However, in the NRC SE for WCAP-13632 P-A Rev. 2, "Elimination of Pressure Sensor Response Time Testing Requirements," the NRC stated: "Based on its review of the information presented in WCAP-13632, Revision 2, the staff has concluded that any sensor failure that significantly degrades sensor response time can be detected during the performance of other surveillance tests, principally calibration. Accordingly, the staff concludes that the performance of periodic RTT for the selected pressure and differential pressure sensors identified in the topical report can be eliminated from Technical Specifications (TS) and that allocated sensor response times may be used to verify acceptable RTS and ESFAS channel response times. Therefore, the staff accepts WCAP-13632, Revision 2, for reference in license amendment applications for all Westinghouse pressurized water reactors with the conditions discussed below." The AMS OLM TR states: "Online monitoring (OLM) technologies have been developed and validated for condition monitoring applications in a variety of process and power industries. These applications include: 1) optimized maintenance of instrumentation and control (I&C) systems including online drift monitoring and in-situ response time testing of sensors, 2) detection of blockages, voids, leaks, and flow anomalies in operating processes, and 3) identification of excessive vibration, overheating, and equipment or process deviations from normal behavior [1-7]. However, this	Potential RAI

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		report is focused on the application of OLM for monitoring drift of pressure, level, and flow transmitters in nuclear power plants." However, Section 3 describes which failure modes are detectable with response time testing and/or OLM. So, even though OLM does not support response time testing, it detects most of the failure mode that would be detectable by response time testing. Clarify if this is the correct intent. Some process parameters may be steady or change very slowly (when compared to expected instrument response times). For these process parameters, how does OLM detect the failures that are detectable by response time testing?	
13	Appendix A pg. A-1	Appendix A of the TR states: "...the methodology described in the [SE] of the year 2000 contains several issues identified by the industry... In this section, the fourteen requirements from the [SE] are listed in Table A.1 along with the implementation issue[(s)] with each requirement, and the proposed solution from the OLM methodology implementation described in this report." This quotation implies that the OLM Implementation proposed by a licensee will be in accordance with ERPI TR-104965-R1-A as augmented and supplemented with the solutions of the "implementation issues" provided in AMS-TR-0720R0; however, this is not explicitly stated in AMS-TR-0720R0. Is this correct? Are there any aspects of ERPI TR-104965-R1-A which are not going to be implemented?	Potential RAI
14	Appendix A pg. A-1	Appendix A of the TR states: "A [Safety Evaluation (SE)] on the EPRI OLM implementation methodology was published in July 2000 [A1]. In the SER, the NRC identified fourteen requirements that each licensee must address in any license amendment request (LAR) to extend transmitter calibration intervals using OLM. In 2006, a nuclear power plant submitted an LAR for extending transmitter calibration intervals that addressed the fourteen requirements. The NRC responded with questions on how the licensee addressed some of the requirements, and the LAR was subsequently withdrawn in mid-2006 after meetings between the NRC and the licensee [A2 - A4]."	Potential RAI

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		This quotation implies that industry and NRC staff had different expectations about the material to be included in a LAR. Please identify what information is expected to be included within a LAR. A model LAR could be included as an Appendix to support this request.	
15		This TR should list (or clearly characterize) the sensors/transmitters to which the OLM described in the TR could be applied. Alternatively, if a new type of sensor/transmitter is to be added, there is no description of the process to do so. For example, if a sensor/transmitter in the program is replaced with a different type (i.e., one not on the approved list), please clarify how the program deals with this?	Potential RAI
16	Appendix C	An NRC approval of this TR can serve as a generic basis for site-specific LARs. STS mark-ups are included in the TR to provide an example of changes, which should be supported justifications in the TR. These TS changes are however not proposed changes as formal changes to the STSs. The current position of NRC staff is not to approve the specific mark-ups as absolutely allowable TS for licensee's referencing this TR (e.g. in a similar manner of a TSTF traveler to the STS). Each licensee will need to perform a site-specific evaluation of both its licensing basis and site-specific TS, and can propose changes using, in part, the generic technical basis in the TR and considering the generalized TS examples in the TR to the extent applicable.	Likely Audit discussion