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DRAFT SAFETY EVALUATION BY THE U.S. NUCLEAR REGULATORY COMMISSION FOR

ANALYSIS AND MEASUREMENT SERVICES CORPORATION TOPICAL REPORT

AMS-TR-0720R1, "ONLINE MONITORING TECHNOLOGY TO EXTEND CALIBRATION

INTERVALS OF NUCLEAR PLANT PRESSURE TRANSMITTERS"

BY THE OFFICE OF NUCLEAR REACTOR REGULATION

(EPID NO. L-2020-TOP-0037)

1.0 INTRODUCTION

By letter dated July 10, 2020 (Ref. 1), as supplemented by letter dated October 9, 2020 (Ref. 2), Analysis and Measurement Services Corporation (AMS) submitted the Topical Report (TR) AMS-TR-0720R1, "Online Monitoring [(OLM)] Technology to Extend Calibration Intervals of Nuclear Plant Pressure Transmitters." AMS requested a formal review of the AMS OLM TR in accordance with the U.S. Nuclear Regulatory Commission (NRC) TR program.

The NRC staff performed an audit (Refs. 5, 6, and 7) of the documentation materials which support AMS positions and statements regarding the efficacy of OLM methodologies. The NRC staff issued request for additional information (RAI) questions (Ref. 3) to obtain information needed to complete this safety evaluation (SE). AMS provided the responses to these RAI questions and described revisions to the AMS OLM TR in Reference 4 to address the NRC staff's RAI questions.

2.0 REGULATORY EVALUATION

The NRC staff considered the following regulatory requirements and guidance in reviewing the concepts presented in AMS OLM TR:

- Title 10 of the *Code of Federal Regulations* (10 CFR) 50.36(c)(1)(ii)(A) states that limiting safety system settings are settings for automatic protective devices related to those variables having significant safety functions. This clause requires that where a limiting safety system setting (LSSS) is specified for a variable on which a safety limit has been placed, the setting must be chosen so that automatic protective action will correct the abnormal situation before a safety limit is exceeded. It also requires that the licensee notify the NRC if the licensee determines that an automatic safety system does not "function as required." The licensee is then required to review the matter and record the results of the review.

- 10 CFR 50.36(c)(3) states, "Surveillance requirements are requirements relating to test, calibration, or inspection to assure that the necessary quality of systems and components is maintained, that facility operation will be within safety limits, and that the limiting conditions for operation will be met."

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- 10 CFR 50.55a(h), "Protection and safety systems," states the following "Protection Systems. For nuclear power plants with construction permits issued after January 1, 1971, but before May 13, 1999, protection systems must meet the requirements in IEEE Std 279-1968, "Proposed IEEE Criteria for Nuclear Power Plant Protection Systems," or the requirements in IEEE Std 279–1971, "Criteria for Protection Systems for Nuclear Power Generating Stations," or the requirements in IEEE Std 603-1991, "Criteria for Safety Systems for Nuclear Power Generating Stations, and the correction sheet dated January 30, 1995. For nuclear power plants with construction permits issued before January 1, 1971, protection systems must be consistent with their licensing basis or may meet the requirements of IEEE Std. 603-1991 and the correction sheet dated January 30, 1995.

  Safety systems. Applications filed on or after May 13, 1999, for construction permits and operating licenses under this part, and for design approvals, design certifications, and combined licenses under Part 52 of this chapter, must meet the requirements for safety systems in IEEE Std. 603-1991 and the correction sheet dated January 30, 1995.

  Clause 4.3, "Quality of Components and Modules," of IEEE 279-1971 states that components and modules shall be of a quality that is consistent with minimum maintenance requirements and low failure rates. Quality levels shall be achieved through the specification of requirements known to promote high quality, such as requirements for design, for the derating of components, for manufacturing, quality control, inspection, calibration, and test.

  Clause 6.5.1 of IEEE 603-1991 states that means shall be provided for checking, with a high degree of confidence, the operational availability of each sense and command feature input sensor required for a safety function during reactor operation. This may be accomplished in various ways, for example:

  a) By perturbing the monitored variable,

  b) Within the constraints of 6.6, by introducing and varying, as appropriate, a substitute input to the sensor of the same nature as the measured variable, or

  c) By cross-checking between channels that bear a known relationship to each other and that have readouts available.

  Clause 6.5.2 of IEEE 603-1991 states that one of the following means shall be provided for assuring the operational availability of each sense and command feature required during the post-accident period:

  a) Checking the operational availability of sensors by use of the methods described in 6.5.1.

  b) Specifying equipment that is stable and the period of time it retains its calibration during the post-accident time period.

- Appendix A to 10 CFR Part 50, General Design Criterion (GDC) 13, "Instrumentation and control," requires that instrumentation be provided to monitor variables and systems over their anticipated ranges for normal operation, for anticipated operational occurrences, and for accident conditions, as appropriate, to assure adequate safety, including those variables and systems that can affect the fission process, the integrity of the reactor core, the reactor coolant pressure boundary, and the containment and its associated systems. Appropriate controls shall be provided to maintain these variables and systems within prescribed operating ranges.

- Appendix A to 10 CFR Part 50, GDC 20, "Protection system functions," states that the protection system shall be designed a) to initiate automatically the operation of appropriate systems including the reactivity control systems, to assure that specified acceptable fuel design limits are not exceeded as a result of anticipated operational occurrences and b) to sense accident conditions and to initiate the operation of systems and components important to safety.

The following are the specific NRC guidance documents applicable to the NRC staff's evaluation of the AMS OLM TR:

- NUREG-0800, Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR [Light Water Reactor] Edition, Branch Technical Position (BTP) 7-12, "Guidance on Establishing and Maintaining Instrument Setpoints"

- Regulatory Guide (RG) 1.105 Revision 4, "Setpoints for Safety-Related Instrumentation." This RG describes an approach that is acceptable to the NRC staff to meet regulatory requirements to ensure that: a) setpoints for safety-related instrumentation are established to protect nuclear power plant safety and analytical limits, and b) the maintenance of instrument channels implementing these setpoints ensures they are functioning as required, consistent with the plant technical specifications (TS).

  This RG endorses American National Standards Institute (ANSI)/International Society of Automation (ISA) Standard 67.04.01-2018, "Setpoints for Nuclear Safety-Related Instrumentation." Among other things, the ANSI/ISA 67.04.01 standard provides criteria for assessing the performance of safety related instrument channels to ensure they remain capable of achieving their required safety functions in a reliable manner. This performance monitoring process requires the establishment of acceptable "As-Found" tolerance limits used to check whether an instrument channel is functioning as required, and the establishment of acceptable "As-Left" tolerance limits used to establish the maximum allowed deviation from the desired setpoint of the instrument channel and still be considered as "within calibration."

The following other guidance documents provide information associated with the periodic calibration of safety related instrument channels that was considered by the NRC staff during its evaluation of the AMS OLM Topical Report:

- Generic Letter 91-04, "Changes in Technical Specification Surveillance Intervals To Accommodate a 24-Month Fuel Cycle," dated April 2, 1991, provides guidance on acceptable methods for licensees to justify an increase in calibration surveillance intervals using as-found and as-left calibration data from past calibration surveillances.

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- Regulatory Issue Summary (RIS) 2006-017, "NRC Staff Position on the Requirements of 10 CFR 50.36, 'Technical Specifications,' regarding Limiting Safety System Settings during Periodic Testing and Calibration of Instrument Channels," dated August 24, 2006 provides regulatory clarification on NRC staff positions in terms of the appropriate determination of TS-related instrument channel operability. The RIS clarifies NRC staff positions about the appropriate establishment of as-found and as-left acceptance tolerances.

- Technical Specification Task Force (TSTF) Traveler TSTF-493, Revision 4, "Clarify Application of Setpoint Methodology for LSSS Functions," dated May 11, 2010, provides guidance about the maintenance of instrument setpoints during periodic surveillances.

3.0 TECHNICAL EVALUATION

The NRC staff reviewed the AMS OLM TR to determine if the proposed condition based methods for performing OLM can be used as an acceptable alternative means to identify whether a transmitter needs to be surveilled at the next frequency-based calibration surveillance opportunity as specified in plant TS surveillance requirements. Specifically, the NRC staff evaluated materials referenced in the AMS OLM TR to verify that adequate evidence exists for using OLM methods to determine when a calibration check, or a full calibration if necessary, is required for plant pressure and differential pressure type transmitter instruments (e.g., incorporated as a programmatic alternative to using a surveillance frequency as specified in the plant TS). Such pressure and differential pressure transmitter type devices are typically used in nuclear power plant safety applications to monitor key reactor and containment systems pressure, level, and flow parameters.

3.1. Overview of the AMS OLM TR Methods

The AMS OLM TR provides a methodology for performing OLM of the output signals of pressure and differential pressure transmitters. This methodology was developed to be used in nuclear power plants as an analytical tool to measure sensor calibration performance during plant operation between scheduled refueling outages, which are typically the times when plant TS surveillance requirements for transmitters are fulfilled. The use of OLM technology enables licensees to identify pressure sensors that have potential calibration performance issues during plant operation rather than relying upon information gained during periodic calibration tests that are performed infrequently (i.e., during refueling outages).

If a pressure or differential pressure transmitter output signal appears to deviate beyond a predetermined allowable range from an average of output signals from a group of transmitters measuring the same parameter, the transmitter is flagged to the analyst as needing a calibration check. Calibration checks could then be scheduled and performed on those identified sensors using traditional calibration procedures during a subsequent plant outage. Alternatively, careful analysis of OLM data may be used to determine there is adequate evidence that a transmitter is performing acceptably and does not need to be re-calibrated at the next scheduled TS surveillance opportunity.

The methodology described in the AMS OLM TR includes processes for performing the following activities:

- Establishing an OLM program and determining which plant sensors may be included in the program.

- Establishing the maximum time period that a group of redundant sensors can operate without at least one being calibrated as a defense against the possibility of common mode drift.

- Establishing criteria for performing data acquisition during plant operation for each sensor group.

- Retrieving redundant sensor measurements using the process plant computer or other data acquisition system.

- Calculating the average of these process measurements and the deviation of each sensor from the average.

- Establishing acceptance limits (monitoring limits) for identifying those transmitters exhibiting excessive deviation from average.

- Identifying sensors that have deviated beyond predetermined monitoring limits.

- Initiating calibration activities to be performed for sensors that have exceeded OLM calibration limits.

- Establishing a noise analysis methodology to enable licensees to assess the occurrence of dynamic failure modes of transmitters that are not covered by the OLM process for transmitter drift monitoring.

The AMS OLM TR is intended to be used by licensees to support plant-specific TS changes to allow transition from time-based periodic calibration surveillance programs for pressure, level, and flow transmitters to condition-based calibration programs based on OLM results. The TR also provides licensees with guidance on how to develop procedures to detect sensing line blockages (as well as other dynamic failure modes) using ~~a~~ the OLM-N~~n~~oise A~~a~~nalysis technique.

3.2. Applicability of the AMS OLM TR Methods

The condition monitoring methodology described in AMS OLM TR focuses on the application of OLM for monitoring calibration performance of pressure, level, and flow transmitters using pressure and differential pressure type sensing devices in nuclear power plants. Therefore, the applicability of this SE is limited to applications involving nuclear plant pressure, level, and flow transmitters using pressure and differential pressure type sensors. The use of OLM technologies for other types of sensors is not approved by the NRC in this SE and must therefore be evaluated separately.

AMS OLM TR, Section 11, “OLM Implementation Methodology,” includes specific steps to determine which pressure, level, and flow transmitters can be included in a plant-specific OLM program. This determination is based, in part, on which transmitters (i.e., make and model – refers to Chapter 12) were included in prior drift studies, or a transmitter’s similarity to the studied

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transmitters. Other considerations relating to the applicability of the AMS OLM TR to a plant specific application are discussed in the sections below.

3.3. Failure Mode Detection using OLM

Section 3.4 of the AMS OLM TR describes transmitter failure modes that have been experienced and explains how OLM techniques can be used to identify these failures. The TR refers to two failure modes and effects analyses (FMEA) that were performed by EPRI and provides summaries of the main conclusions of these reports. These summaries explain that transmitter failures manifest themselves by affecting transmitter calibration or response time. Both effects are detectable to an extent by applying the OLM methods described in Section 11 of the AMS OLM TR.

The failure modes of the following types of transmitters were considered in the referenced FMEAs:

- Force Balance Transmitters
- Strain Gage Transmitters
- Capacitance Transmitters

A total of 35 different failure modes were identified and 31 of these failure modes were determined to be identifiable by applying OLM-Drift Monitoring techniques. The failure modes that are not detectable by OLM-Drift Monitoring were further analyzed as follows:

- **Change in viscosity of the fill fluid (Common to all three transmitter types) –** The TR explains this failure mode is usually caused by changes in environmental conditions to which the transmitter is subjected. The TR also explains that normal variations in the conditions that could produce this failure mode are considered in the “design-basis” of the transmitters. The TR states that “beyond-design-basis” conditions are unlikely because equipment qualification (EQ) performed on safety-related transmitters would reveal such failures.

  The NRC staff notes that requirements for instruments to remain functional under normal operation, maintenance, testing, and postulated accident conditions, including loss-of-coolant accidents are provided within GDC 4, “Environmental and dynamic effects design basis,” which is applied to structures, systems, and components important to safety. It is therefore reasonable to assume that environmental conditions beyond those specified in GDC 4 would not be experienced for the transmitters for which OLM techniques would be applied. Therefore, the failure modes associated with those conditions would not need to be considered. The NRC staff also notes that current periodic calibration programs do not include verification of transmitter functionality under environmental conditions that would cause these failure modes.

- **Blockage of holes in the ceramic inserts used in capacitance transmitters –** This failure mode is unique to Capacitance type transmitters. The AMS OLM TR explains that the ceramic insert holes serve the purpose of transporting fill fluid between the isolation diaphragm and the sensing diaphragm. If the flow of fluid through these holes becomes restricted, then transmitter response time can degrade.

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The NRC staff notes that current periodic calibration programs do not include verification of transmitter response time functionality that would be affected by this failure mode. Though an OLM-Drift Monitoring program would not increase the ability to identify this failure mode during surveillance testing, it would not reduce the ability to detect the failure mode. However, Section 11.3 of the AMS OLM TR described how to assess dynamic failure modes of transmitters using the OLM-~~n~~Noise ~~A~~Aanalysis technique in addition to ~~monitoring for drift~~OLM-Drift Monitoring.

3.4. Response Time Testing using OLM

The OLM-Drift Monitoring processes described in the AMS OLM TR have a limited ability to identify transmitter response time degradation. The degree to which such degradation can be identified is dependent on several factors including the rate of data collection used for OLM and the dynamic characteristics of the process being measured by the transmitters.

For more dynamic processes that have a higher degrees of signal variation, OLM ~~dynamic~~ Noise ~~analysis~~ Analysis techniques can be an effective way to assess whether a transmitter response has degraded. These ~~dynamic analysis~~OLM-Noise Analysis techniques include comparing transmitter responses to process signal variations of other transmitters which are measuring the same process (see AMS OLM TR, Section 11.3). The NRC staff believes that such capability to detect whether a transmitter's response time is degrading is a useful indication for monitoring transmitter performance between scheduled surveillance opportunities to determine whether a transmitter is "functioning as required."

3.5. Response Time Safety Related Test Elimination

Many operating nuclear power plants have eliminated safety related requirements to perform periodic response time (RT) testing. The justification for eliminating RT test requirements often refers to the performance of periodic calibration safety related tests. Licensee's implementing OLM programs should review the basis for eliminating RT tests as applicable to determine if the OLM program can become a suitable substitute for the periodic calibration test programs that are credited in the plant TS. The basis for RT elimination may need to be modified to credit the AMS OLM-Noise Analysis technique ~~TR program~~ in Section 11.3 in lieu of a periodic calibration program.

The AMS OLM TR does not provide guidance for re-evaluating the basis for RT test elimination or TS mark-ups for making changes to the basis for elimination of RT testing. Therefore, an application specific action item is included to ensure that a licensee considers the effects of an OLM program would have on the basis for RT testing elimination. This is applicant specific action item (ASAI) 3 in Section 4.0 of this SE.

3.6. Addressing Common Mode Drift Hazards

The NRC staff recognized that OLM methods could work well to identify whether the output signals of one or more transmitters out of a group of transmitters monitoring the same plant process has deviated from the average of the outputs of all the transmitters in the same group. However, the NRC staff was concerned that it was possible for a common mode instrument performance effect to adversely impact all the transmitters within the group simultaneously, and that OLM data analysis would not detect the fact that all transmitters were simultaneously being affected.

Therefore, the NRC staff requested AMS to provide an evaluation of nuclear power plant industry transmitter performance data that was analyzed using OLM methods to determine if there was historical evidence indicating the likelihood that common mode drift effects could occur but not be subsequently detected. AMS provided several examples of evaluations of OLM data collections that compared the results of OLM data evaluations determining whether a transmitter appears to be performing satisfactorily while in operations, against evaluations of calibration performance data taken from the next scheduled calibration surveillance for those same transmitters (Refs. 4 and 11).

The evaluations indicated there was a very strong agreement between the two sets of data. Out of hundreds of transmitter calibration performance data evaluated, only a very small number of cases indicated a disagreement as to whether a transmitter remained within acceptable performance requirements. None of these cases indicated that a common mode drift effect was occurring among a group of transmitters monitoring the same parameter. The few cases where a disagreement between OLM data analysis and traditional calibration methods existed had plausible explanations as to why the disagreement occurred, and usually these were associated with potential errors (e.g., imprecise calibration method or inappropriate measurement and test equipment performance) in the traditional calibration method.

Further, AMS provided a summary of data analysis they performed for the Sizewell B nuclear power plant located on the eastern coast of Great Britain. The Sizewell B plant has been using OLM methods for identifying transmitters that need calibration checks for many fuel cycles. Throughout the duration of this OLM data evaluation process there has been no evidence of occurrence of common mode drift.

However, should an undetected common mode drift effect could occur, the AMS OLM TR Implementation methodology includes a process for addressing the potential for mitigating the effects of common mode drift among process transmitter groups. This mitigation is accomplished using a calibration surveillance interval "backstop." By using this methodology, licensees will analyze calibration data for common mode drift hazards and will assign shorter calibration backstop intervals for process groups that appear to have greater risk of exhibiting common mode drift characteristics.

Chapter ~~12~~ 13 of the TR describes the method used for establishing backstop calibration intervals. The NRC staff concludes that the use of this extension interval backstop approach will serve to ensure that the possibility for undetectable common mode drift effects will be mitigated. This is addressed as ASAI 4 in Section 4.0 below.

3.7. Maintaining Prime Standard Traceability

Instrument groups to be included in a licensee's OLM calibration program are assigned initial maximum calibration intervals called backstop intervals based on available performance data for the transmitters in the process group. At least one transmitter in each process group is then calibrated at this interval. These maximum calibration backstop intervals can be subsequently adjusted as supported by OLM performance data collected.

Chapter ~~12~~ 13 of the TR describes a method for establishing backstop calibration intervals for each process group of transmitters. By performing a standard calibration of one transmitter in each process group at the pre-determined interval, traceability to calibration prime standards is established and maintained for the instrument group.

3.8. Process dynamics and their effects on OLM methods

The effectiveness of OLM methods in determining transmitter responsiveness is dependent on the dynamic characteristics of the process being measured. Highly stable processes may therefore require higher sample rates and greater data collection requirements to establish an equivalent level of confidence in transmitter responsiveness and performance when compared with transmitters measuring more dynamic processes. The OLM process described in the TR includes performance of an assessment of each process monitored by a group of transmitters to be considered for OLM. This assessment characterizes the measured process to determine the necessary sample rate and duration criteria for OLM to be applied to the group.

The OLM process states that data must be collected during startup, normal operation, and shutdown periods at the highest sampling rate by which the plant computer takes data. The OLM program also includes a method for determining the minimum sample rate for data collection during operation that is based on the dynamic characteristics of the process being measured by the instrument group. In cases where the minimum data collection rate cannot be achieved by the plant computer, an alternative data acquisition system can be used. The actions for performing this method are included in Chapter 11 and a description of the process for determining required sample rates and durations is included in Chapter ~~12~~ 15 of the TR.

3.9. Comparison of OLM Program to Periodic Calibration Program

Section 3.1, “CONVENTIONAL CALIBRATIONS VERSUS OLM,” of the AMS OLM TR provides a comparison between an OLM program and a conventional periodic calibration program. This includes an analysis of calibration data collected from the McGuire Nuclear Power Plant over two complete refueling cycles. The results of this analysis are documented in NUREG/CR-5903 (1993) and NUREG/CR-6343 (1995). The AMS OLM TR states that about 90 percent of plant pressure, level and flow transmitters maintain their calibration for longer than a typical fuel cycle. This statement is derived from calibration data showing that approximately 10 percent of the transmitters that were calibrated required calibration adjustments to restore calibration to within as-left tolerances.

Three calibration drift studies were referenced in the AMS OLM TR as follows:

- 3.3.1 EPRI TR104965 Drift Study – This study used manual calibration data from eighteen nuclear power plants to support extension of calibration intervals for nuclear plant pressure, level, and flow transmitters. The study used data from transmitter calibration records for multiple transmitter manufacturer types.

- 3.3.2 PWROG Drift Study to support Technical Specification Task Force - TSTF-425 – This was a drift analysis performed on Westinghouse PWRs to support extending transmitter calibration intervals one cycle at a time. The analysis was performed using calibration records from forty-one PWR units representing three nuclear steam supply system (NSSS) vendors and five transmitter manufacturers.

- 3.3.3 Sizewell Nuclear Power Plant Drift Studies – Two drift studies were performed which involved statistical analysis of manual calibration records over a seven-year period to establish the drift behavior of its safety-related transmitters. This study used data from five different transmitter models.

Though the objectives and conclusions of each study are unique, all of these studies showed that transmitter calibration drift occurs in a random and non-biased manner and that a large percentage of these transmitters do not drift enough to require calibration adjustments during a single refueling interval. The data used for these studies also demonstrates that when calibration drift does occur to the extent that manual calibrations are needed, the OLM techniques can be used to identify the need for such calibrations.

Section 9, "OLM Implementation in U.S. Plants," of the AMS OLM TR provides an overview of AMS's experience with implementing OLM programs at several operating U.S. nuclear power plants. The AMS OLM TR states that together with OLM implementation at Sizewell B and McGuire, these projects provide the foundation for the development of the generic OLM methodology of the AMS OLM TR. Section 10 of the AMS OLM TR provides a comparison of results between performing manual calibrations and performing OLM. This comparison study uses calibration performance data collected from multiple plants over time period extending back to the mid 1980's. The study also references several other studies conducted by EPRI, AMS, and the NRC during the last 30 years.

The data from Sizewell was used to perform an objective comparative analysis between OLM and manual calibration results. This analysis was possible because both calibration programs were simultaneously in effect when data was obtained. The detailed results of this comparison are provided in Section 10.1.3 of the AMS OLM TR and are summarized as follows:

1. The OLM and manual calibration results were the same for 81.8 percent of the calibrations performed. This means that transmitters requiring calibration adjustments could be identified in advance of the manual calibration procedure by using OLM techniques.

2. For 17.7 percent of the calibrations, OLM identified the transmitters as having drifted beyond their OLM tolerances while manual calibrations of those same transmitters showed no significant drift that would have required calibration adjustment.

3. About 0.5 percent of the calibrations were found to be bad by manual calibrations that were not identified by OLM techniques. The analysis however concluded that such discrepancies are acceptable because they are an improvement over the conventional practices where a higher percentage of human errors and miscalibrations would have typically occurred over the same period.

   The NRC staff reviewed the operational calibration and OLM data provided in the AMS OLM TR and determined that OLM techniques, when implemented correctly, can provide an effective means of identifying transmitter failure modes and of identifying calibration shifts that require calibration adjustments to be performed. When implemented in conjunction with a plant corrective action program, an OLM process can be used to initiate pressure, level, and flow transmitter calibration activities in order to meet the requirements of 10 CFR 50.36(c)(3) for performing tests and calibration to assure that the necessary quality of systems and components is maintained, that facility operation will be within safety limits, and that the limiting conditions for operation will be met.

3.10. Instrument Span Calibration and Setpoint Uncertainties

In some cases, the effective OLM span coverage can be significantly less than the calibrated instrument span depending on the nature of the process being measured. It is also common for the normal exercised process values to never reach or exceed the safety system setpoint value during startup, shutdown, or normal plant operation. It is therefore necessary to identify and address uncertainties associated with the unexercised portions of a transmitter range.

The OLM methodology in Chapter 11 of the AMS OLM TR includes actions to assess transmitter exercised range with respect to the transmitter span and with respect to the safety setpoints associated with the instrument. These defined processes provide a method for addressing uncertainties associated with the portions of transmitter range that are not exercised during plant operation with OLM.

Chapter 14 of the AMS OLM TR, “OLM Coverage of transmitter Setpoints and Range,” describes a process for determining if the OLM span coverage is adequate to provide assurance of transmitter performance over the unexercised portions of a transmitter span. In cases where adequate assurance of instrument performance cannot be demonstrated, the instrument will be excluded from the OLM program and periodic time-based calibrations would continue to be required for these instruments.

The NRC staff determined the processes and methods for addressing unexercised portions of instrument span as outlined in Chapter 14 of the AMS OLM TR provide an acceptable means of assuring safety functionality over the intended ranges of the transmitters within the OLM program.

3.11. Review of Changes to Technical Specification Surveillance Requirements

AMS OLM TR, Section 11.5, and the Example TS changes in Appendix B include a definition of OLM and the Bases associated with the Surveillance Requirements changes.

The proposed TS changes provide instructions for making a condition-based determination of whether a calibration check must be performed for instruments that are included in a plant’s OLM program. The TS change guidance also includes a description of a process for extending calibration intervals for the applicable instruments. The proposed processes involve use of the OLM program to extend transmitter calibration intervals by using the OLM processes described in the AMS OLM TR to determine the condition of the transmitters and thereby to determine when CHANNEL CALIBRATION surveillances should be performed.

These proposed TS changes are examples of how an OLM program could be implemented by a licensee referencing the approved AMS OLM TR with supporting justification. These TS changes are however not approved changes to any TSs and the NRC staff did not review the changes as allowable TS for any licensee referencing the approved AMS OLM TR.

The NRC staff did not make any conclusions regarding the acceptability of these examples, since it was recognized that each licensee adopting OLM methods for flagging whether transmitters need calibration checks would need to perform a plant-specific evaluation of both its existing licensing basis and site-specific TSs. Licensees and applicants may propose TS changes using Appendix B in the TR as a guide for the type of information needed to be addressed for TS as part of its implementation of an OLM program using the 10 CFR 50.90 license amendment process or 10 CFR Part 50 or Part 52 license application process.

The NRC staff examined the AMS OLM TR general processes and descriptions of TS changes needed and agree that they highlight the potential use of OLM methods to justify adjustments to channel calibration intervals. Each licensee will need to perform a site-specific evaluation of both its licensing basis and site-specific TS to demonstrate compliance with 10 CFR 50.36. The NRC staff determined that such TS changes would need to include appropriate markups of the TS Bases section, the TS tables describing limiting conditions for operation and surveillance requirements, and the administrative programs section. This is described in ASAI 1 in Section 4.0 of this SE.

3.12. Identification and Appropriate Allocation of Calibration Uncertainty Source

The OLM methods described in the AMS OLM TR involve collection of instrument loop data using plant computer systems or other data collection instruments. In some cases, these data acquisition systems measure instrument loop output signals instead of direct transmitter signals. For such cases, the measured calibration uncertainties include calibration uncertainties of all instruments in the loop being monitored and not only uncertainties of the transmitter. To account for multiple instruments being used to support the transfer of transmitter signal data from the transmitter to the data collection system, all calibration errors identified using OLM should be initially attributed to the transmitter until testing or analysis can be performed to determine the sources of calibration error and reallocate errors to the individual loop components. The requirement to perform error allocation in this manner is captured as ASAI 2 in Section 4.0 of this SE.

3.13. Establishing Appropriate Criteria for Flagging Potential Excessive Drift Performance

The NRC staff notes that the licensing basis for most operating plants includes the development of design basis instrument setpoint calculations. These calculations address applicable criteria and guidance for establishing performance monitoring acceptance limits for "As-Found" and "As-Left" Tolerance Limits. The "As-Found" tolerance limits serve as the basis for determining whether a transmitter is performing appropriately (i.e., as predicted or expected) when tested during instrument calibration surveillance test intervals under normal calibration conditions. These setpoint calculation documents establish the design and licensing basis for maintaining acceptable performance of safety related instrument channels serving as SSCs to accomplish LSSSs.

As described in Section 3.12 above, OLM methods require an evaluation of the uncertainties of the portion of the instrument loop equipment that are used to transmit the output signal from the transmitter to the OLM process data monitoring system. Applicants and licensees proposing to adopt OLM methods for determining whether a transmitter needs a calibration check should carefully evaluate the results of these design basis setpoint calculation documents to determine an OLM drift acceptance criteria that is more conservative than the design basis As-Found Tolerance limits for the plant, while not being too restrictive so as to flag an acceptably-performing transmitter unnecessarily.

The AMS OLM TR describes a method for establishing this flagging criterion, however licensees may choose to use a more conservative or less conservative flagging limit, provided it is compatible with the design basis As-Found Tolerance limits established in the plant setpoint

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calculations. If the licensee or applicant does not adopt the method for establishing this flagging limit using the process described in the AMS OLM TR, it should describe its proposed methodology for establishing this limit in its application for a license application or amendment to adopt the OLM method for identifying transmitters that need calibration checks as an alternative to incorporating a fixed calibration surveillance interval in the plant TS. This is captured as ASAI 5 in Section 4.0 of this SE.

3.14. Regulatory Compliance

The OLM methodology provided in the AMS OLM TR provides an alternate means of determining when pressure, level, and flow instrument calibration checks and follow-up calibrations are required to provide adequate assurance that the necessary quality of systems and components is maintained, that facility operation will be within safety limits, and that the limiting conditions for operation will be met.

The NRC staff finds this methodology can be applied as an acceptable means of determining whether protection systems are functioning as required, by flagging when calibration of these instruments is needed. A licensee applying these methods shall perform a plant specific assessment of the transmitters being included in the OLM program to ensure that requirements of 10 CFR 36(c) can be met upon implementation of these OLM methods.

The NRC staff finds the AMS OLM TR methods for performing OLM to measure pressure, level, and flow sensor calibration performance during plant operation to be consistent with regulatory requirements of GDC 21 and 10 CFR 50.55a(h) applicable to reliability and testability of plant protection and safety systems. Therefore, the NRC staff finds that the OLM methods outlined in Section 11, "OLM Implementation Methodology," of the AMS OLM TR can be used to verify the safety systems' capability to perform its safety functions. These OLM techniques may therefore be credited in lieu of manual periodic calibration SR tests provided ASAIs in Section 4.0 of this SE are performed.

4.0 APPLICATION SPECIFIC ACTION ITEMS

ASAI 1 - **Evaluation and Proposed Mark-up of Existing Plant Technical Specifications** – When preparing a license amendment request to adopt OLM methods for establishing calibration frequency, licensees should consider markups that provide clear requirements for accomplishing plant operations, engineering data analysis, and instrument channel maintenance. Such TS changes would need to include appropriate markups of the TS tables describing limiting conditions for operation and surveillance requirements, the technical basis for the changes, and the administrative programs section.

ASAI 2 - **Identification of Calibration Error Source** – When determining whether an instrument can be included in the plant OLM program, the licensee shall evaluate calibration error source in order to account for the uncertainty due to multiple instruments used to support the transfer of transmitter signal data to the data collection system. Calibration errors identified through OLM should be attributed to the transmitter until testing can be performed on other support devices to correctly determine the source of calibration error and reallocate errors to these other loop components.

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ASAI 3 - **Response Time Test Elimination Basis** – If the plant has eliminated requirements for performing periodic RT testing of transmitters to be included in the OLM program, then the licensee shall perform an assessment of the basis for RT test elimination to determine if this basis will remain valid upon implementation of the OLM program and to determine if the RT test elimination will need to be changed to credit the OLM program rather than the periodic calibration test program.

ASAI 4 - **Use of Calibration Surveillance Interval Backstop** – In its application for a license or license amendment to incorporate OLM methods for establishing calibration surveillance intervals, applicants or licensees should describe how they intend to apply backstop intervals as a means for mitigating the potential that a process groups could be experiencing undetected common mode drift characteristics.

ASAI 5 - **Use of Criteria other than in AMS OLM TR for Establishing Transmitter Drift Flagging Limit** – In its application for a license or license amendment to incorporate OLM methods for establishing calibration surveillance intervals, applicants or licensees should describe whether they intend to adopt the criteria within the AMS OLM TR for flagging transmitter drift or whether they plan to use a different methodology for determining this limit.

5.0 CONCLUSION

The NRC staff determined that the methodology outlined in the AMS OLM TR for applying OLM techniques to pressure, level, and flow transmitters can be used to provide reasonable assurance that required TS instrument calibration requirements for transmitters will be maintained. This determination is based on the NRC staff finding that OLM techniques: a) are effective at identifying instrument calibration drift during plant operation, b) provide an acceptable means of identifying when manual transmitter calibration using traditional calibration methods are needed, and c) will maintain an acceptable level of performance that is traceable to calibration prime standards. The NRC staff determined that reliance on a carefully developed OLM program to determine appropriate calibration surveillance intervals, within the conditions and limitations described in the AMS OLM TR, supports meeting the calibration surveillance requirements for safety related pressure, level, and flow transmitters is acceptable under 10 CFR 50.36(c)(1)(ii)(A) and 10 CFR 50.36(c)(3).

The NRC staff notes that the OLM methods described in the AMS OLM TR are not applicable for meeting the instrument channel functional test surveillance requirements in the plant TS. Therefore, the NRC staff finds that implementation of an OLM program in accordance with the approved AMS OLM TR provides an acceptable alternative to periodic manual calibration surveillance requirements upon implementation of the application specific action items in Section 4.0 of this SE.

6.0 REFERENCES

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2. Re-Submittal of Analysis and Measurement Services Corporation Topical Report Monitoring Technology to Extend Calibration Intervals of Nuclear Plant Pressure Transmitters, AMS-TR-0720R1, dated November 12, 2020 (ADAMS Package Accession No. ML20317A111)
3. NRC Request for Additional Information regarding AMS Topical Report AMS-TR-0720R1, dated March 5, 2021 (ADAMS Accession No. ML21067A674)
4. AMS Response to NRC Request for Additional Information, dated May 20, 2021 (ADAMS Accession Nos. ML21140A002 - Non-Proprietary and ML21140A003 - Proprietary)
5. NRC Regulatory Audit Plan for January 26-27, 2021, Audit of AMS-TR-0720R1 Online Monitoring Technology to Extend Calibration Intervals of Nuclear Plant Pressure Transmitters (EPID L-2020-TOP-0037), dated January 15, 2021 (ADAMS Accession No. ML21014A010)
6. Extension of Regulatory Audit Plan for January 26 to February 24, 2021, Audit of AMS-TR-0720R1, "Online Monitoring Technology to Extend Calibration Intervals of Nuclear Plant Pressure Transmitters" (EPID No. L-2020-TOP-0037), dated January 28, 2021 (ADAMS Accession No. ML21027A334)
7. NRC Regulatory Audit Report for January 26 to February 24, 2021 Audit of AMS-TR0720R1, "Online Monitoring Technology to Extend Calibration Intervals of Nuclear Plant Pressure Transmitters," dated March 18, 2021 (ADAMS Accession No. ML21063A123)
8. INL/CON-17-41453, "On-Line Monitoring of I&C Transmitters and Sensors for Calibration Verification & Response Time Testing Was Successfully Implemented at ATR," dated March 31, 2017 (ADAMS Accession No. ML21140A330)
9. EPRI Report 1013486, "Plant Application of On-Line Monitoring for Calibration Interval Extension of Safety-Related Instruments," dated December 31, 2006 (ADAMS Accession Nos. ML21140A331 - Volume 1 and ML21140A332 - Volume 2).
10. DOE/ER84626, "On-Line Monitoring of Accuracy and Reliability of Instrumentation and Health of Nuclear Power Plants," dated September 30, 2011 (ADAMS Accession Nos. ML21140A333 - Volume I and ML21140A334 - Volume II).

~~11.~~ EPRI-TR-1013486, "Plant Application of On-Line Monitoring for Calibration Interval Extension of Safety-Related Instruments: Volumes 1 and 2", 2006.~~USNRC NUREG/CR-6895, "Technical Review of On-Line Monitoring Techniques for Performance Assessment," Volume 1 "State of the Art," Volume 2 "Theoretical Issues," and Volume 3, "Limiting Case Studies," Originally published in 2000, 2001, J. Wesley Hines, Univ. of Tennessee. Overview published in May 2009~~

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12. USNRC NUREG/CR-5903, "Validation of Smart Sensor Technologies for Instrument Calibration Reduction in Power Plants," 1993
13. USNRC NUREG/CR-6343, "On-Line Testing of Calibration of Process Instrumentation Channels in Nuclear Power Plants," 1995

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