July 24, 2000

Mr. Gary L. Vine
Senior Washington Representative
Electric Power Research Institute
2000 L Street, N.W., Suite 805
Washington, DC 20036

SUBJECT: EPRI TOPICAL REPORT (TR) 104965, "ON-LINE MONITORING OF INSTRUMENT CHANNEL PERFORMANCE," FINAL REPORT, NOVEMBER 1998 (TAC NO. M93653)

Dear Mr. Vine:

The staff has completed its review of Topical Report (TR) 104965, "On-Line Monitoring of Instrument channel Performance," dated November 1999. The staff's safety evaluation SE is enclosed. As agreed during a meeting with representatives of the Electric Power Research Institute (EPRI) on February 6 and 17, 2000, staff review of the subject topical report focused on the generic application of the on-line monitoring technique to be used as a tool for assessing instrument performance. The two algorithms included in the topical report were not in the scope of the staff review. The staff has determined that selection of the most suitable algorithm and associated software for calculating and analyzing data obtained during on-line monitoring should be left to the user.

The topical report proposes to relax the frequency of instrument calibrations required by the technical specifications (TS) from once every fuel cycle to once in a maximum of eight years, based on the on-line monitoring results. Implementation of the on-line monitoring technique to relax the TS-required calibration frequency will require a license amendment. The staff determined that suggested TS changes in the topical report are incomplete and require further evaluation for determining an acceptable generic model that can be used in plant-specific TS requirements. During the February 16 and 17, 2000, meeting with the staff, EPRI agreed that once the technical issues relating to generic concept of the on-line monitoring technique were resolved and the final SE was issued, EPRI would work with the NRC staff and the NEI Technical Specification Task Force (TSTF) to develop an appropriate TS structure and TS requirements consistent with the technical requirements described in the final SE. The enclosed SE resolves all technical issues as agreed upon during the February 16 and 17, 2000, meeting.

Pursuant to 10 CFR 2.790, we have determined that the enclosed SE does not contain proprietary information. However, we will delay placing the SE in the public document room for a period of ten (10) working days from the date of this letter to provide you with the opportunity to comment on the proprietary aspects only. If you believe that any information in the enclosure is proprietary, please identify such information line by line and define the basis pursuant to the criteria of 10 CFR 2.790.

We do not intend to repeat our review of the matters described in the report, and found acceptable, when the report appears as a reference in license applications, except to assure that the material presented is applicable to the specific plant involved. Our acceptance applies only to matters described in the report.

In accordance with procedures established in NUREG-0390, "Topical Report Review Status," we request that EPRI publish an accepted version of the topical report within 3 months of receipt of this letter. The accepted version shall incorporate this letter and the enclosed SE between the title page and the abstract. It must be well indexed such that information is readily located. Also, it must contain in appendices historical review information, such as questions and accepted responses, and original report pages that were replaced. The accepted version shall include an "-A" (designating accepted) following the report identification symbol.

Should our criteria or regulations change so that our conclusions as to the acceptability of the report is invalid, EPRI and/or the applicants referencing the topical report will be expected to revise and resubmit their respective documentation, or submit justification for the continued applicability of the topical report without revision of their respective documentation.

Sincerely,

/RA by Stephen Dembek for/

Stuart A. Richards, Director
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Project No. 669

Enclosure: Safety Evaluation

cc w/encl:
Mr. James Lang
Director
EPRI
1300 W.T. Harris Boulevard
Charlotte, NC 28262

Dr. Theodore U. Marston
Vice President and Chief Nuclear Officer
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3412 Hillsview Avenue
Palo Alto, CA 94304

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

APPLICATION OF ON-LINE PERFORMANCE MONITORING TO EXTEND

CALIBRATION INTERVALS OF INSTRUMENT CHANNEL CALIBRATIONS

REQUIRED BY THE TECHNICAL SPECIFICATIONS

EPRI TOPICAL REPORT (TR) 104965

"ON-LINE MONITORING OF INSTRUMENT CHANNEL PERFORMANCE"

1.0 INTRODUCTION

In a letter dated September 28, 1998, the Electric Power Research Institute (EPRI) submitted Topical Report (TR)104965, "On-Line Monitoring of Instrument Channel Performance" for NRC review and approval. EPRI presented an overview of the topical report on August 31, 1999, and participated in a meeting with the staff on February 16 and 17, 2000, to discuss EPRI's comments on the staff's draft safety evaluation (SE) dated December 13, 1999. The meeting summary is available under ADAMS No. ML003690488. By letter dated March 23, 2000, EPRI submitted its comments on the staff's draft SE.

The topical report proposes a new generic approach for monitoring instrument calibrations during normal plant operation by using an on-line monitoring technique with a calibrate-as-required approach. The report proposes to allow commercial nuclear power plant licensees to use the on-line monitoring as a calibration assessment tool to extend calibration intervals of instrument channel calibrations that are required by the technical specifications (TS).

TR 104965 demonstrates an on-line monitoring technique for obtaining real-time instrument performance data in a non-intrusive manner and incorporating these data with field calibration results to verify whether the monitored instrument channel's performance is within acceptable limits. This technique can help eliminate unnecessary field calibrations, reduce associated labor costs, limit personnel radiation exposures, and limit potential for miscalibration.

The proposed system will not be connected to the plant instrumentation permanently. It will only be temporarily connected to collect instrument data in a batch mode and be disconnected when no longer required. The collected data will later be analyzed by a separate computer to assess instrument performance and operability. Thus, in this mode of application, the on-line monitoring system will be used as measuring and test equipment (M&TE) to monitor calibration and operational status of safety-related instruments.

2.0 SYSTEM DESCRIPTION

On-line monitoring of instrument channel performance involves monitoring the steady-state output of each channel and evaluating the monitored value to determine whether the channel is operating outside its acceptable limits. During evaluation, the monitored value is compared to a calculated value of the process variable to assess deviation. The calculated value is defined as the "process parameter estimate," which represents the instantaneous value of the process at the monitored operating point.

The data acquisition from instrument channels and evaluation of the data could be performed continuously or at discrete intervals, either manually or automatically using microprocessor-based equipment. In the topical report, the proposal to use the on-line monitoring technique as a calibration extension tool is based, in part, on quarterly evaluations (at discrete intervals) using automatic means.

The topical report describes two algorithms that can be independently used to calculate and analyze instrument data obtained during on-line monitoring. The staff did not review either of the algorithms described in the topical report because the staff determined that selection of the most suitable algorithm and software should be left to the user. The staff reviewed only the acceptability of the concept of on-line monitoring as a tool to assess instrument performance and calibration status. The two algorithms are summarized below:

(1) Instrument Calibration Monitoring Program: The Instrument Calibration Monitoring Program (ICMP) algorithm developed by EPRI compares redundant channels to determine whether one or more channels are operating beyond their specified limits. The ICMP's ability to detect potentially degraded instruments is based on an algorithm that preferentially discriminates against outlying measurements from a set of redundant instruments. The ICMP algorithm calculates the value of the process parameter estimate by averaging channels that are considered to be within expected specifications. Outlier channels are not used for averaging calculations. The monitored value of each instrument channel is compared to the calculated value of the process parameter estimate to determine the channel's performance and its calibration status.

(2) Multivariate State Estimation Technique: The Multivariate State Estimation Technique (MSET) is a software-based system that uses empirical, statistically-based pattern recognition modules that interact and operate to provide the user with information needed for the safe, reliable, and economical operation of a process by detecting, locating, and identifying subtle changes that could lead to future problems well in advance of significant degradation. Modeling is based entirely on data collected during training. During monitoring, instrument data are read by MSET, an estimate of the current state of the process is determined by comparing the measured sensor data with those obtained during training, and the difference between this estimate and the measurement is calculated. The difference, or estimate error, is then analyzed by a statistically based hypothesis test (the sequential probability ratio test or SPRT) that determines whether the process is operating normally or abnormally. If an abnormal condition is detected, the initial diagnostic step identifies the cause as either a sensor degradation or an operational change in the process. MSET is a highly sensitive and accurate tool for on-line monitoring of any process and could be used for single-channel

monitoring. MSET can detect and identify malfunctions that might occur in process sensors, components, or control systems, as well as changes in process operational conditions.

The typical on-line monitoring implementation uses the following building blocks:

- Separate off-line computer hardware on which the system resides.

- Communications hardware and software to electronically obtain data from the plant process computer or other source, if data is acquired automatically. Manual data acquisition can be obtained using the appropriate test equipment.

- The on-line monitoring software, which archives, analyzes and displays the data interactively in graphs and reports.

On-line monitoring collects data from instrument channels, typically via connection to the plant computer for an automated system or at the isolator output or appropriate test point for manual data acquisition. The collected data are processed mathematically by a dedicated off-line, microprocessor-based, data acquisition and processing system. Different on-line monitoring implementations exist on microcomputer platforms, and data are input from the plant to these systems via modem, electronic media, or manual input. Output capabilities typically include graphical display of the individual instrument channel deviation from the process parameter estimate as a function of time. Some automated systems are network operable and allow multiple access to the monitoring information and results.

Regardless of the algorithm employed, the on-line monitoring technique evaluates the deviation of an instrument with reference to its process parameter estimate to determine whether the performance exhibited by the instrument is acceptable or whether the instrument must be scheduled for calibration or the instrument channel is inoperable. In the topical report, EPRI describes the following advantages that could be realized by implementing the proposed on-line monitoring technique for assessing instrument calibration:

(1) Compared to the current traditional calibration process, the on-line monitoring process is nonintrusive, more frequent, and will result in a reduced number of field calibrations.

(2) On-line process will monitor instrument performance in place on a continuous basis and will identify calibration problems as they occur. Therefore, it will be able to provide a basis for determining when adjustments are necessary. The on-line technique can detect degradation and failures as they occur in the early stage of an instrument's installed life.

(3) Elimination of unnecessary field calibrations will reduce associated labor costs, personnel radiation exposures, and the potential for miscalibration since conventional calibration frequency will be reduced.

(4) On-line monitoring accounts for installation and process condition effects on calibration. Compared to traditional calibration during a refueling outage when a plant is in the shutdown state, on-line monitoring allows evaluation of instrument performance under

normal operating conditions, and thus collects data representative of effects associated with several sources of channel uncertainty, including process effects and environmental effects.

(5) By reducing personnel radiation exposures, plant safety and efficiency will improve. By reducing time spent on conventional calibrations, refueling outages will be shorter, increasing plant availability.

(6) Long-term trends in instrument performance developed using on-line monitoring could be used for predictive maintenance tests, will enhance instrument troubleshooting capabilities, and will provide additional resources for historical root-cause analyses and post-trip reviews.

3.0 PROPOSED CHANGES

Each parameter covered by the TS has specific surveillance requirements that are performed at various frequencies. The surveillance requirements are intended to demonstrate that the associated instrumentation is operable, and actions are specified in the event that an inoperable channel is identified. The current TS requires that all redundant safety-related instrument channels be calibrated once each refueling cycle and this TS requirement could be termed as "time-directed traditional calibration." The topical report proposes to:

(1) Establish on-line monitoring as an acceptable calibration monitoring tool for assessing an instrument's performance and its calibration in-place and on-line while the plant is in normal operating mode, and

(2) Based on results of using on-line monitoring to assess instrument calibration, extend calibration intervals by revising the current once per refueling cycle calibration frequency of each of the TS-related sensors to once in a maximum of eight years by implementing the following process:

  (a) 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. (This is the most significant difference from current calibration practices, whereby all redundant sensors, regardless of their calibration status, are calibrated each outage. With four redundant sensors for each function, all sensors will be calibrated in four fuel cycles and this duration could be maximum of eight years. Calibrating at least one redundant sensor each scheduled fuel cycle ensures that common-mode failure mechanisms do not exist. Also, it ensures that each sensor continues to be periodically calibrated by a method traceable back to National Institute of Standards and Technology.)

  (b) 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. (Thus, depending on the performance of monitored channels, anywhere from one to all of the redundant sensors might be field calibrated each refueling outage.)

The topical report proposes to relax the calibration frequency only for the sensor-transmitter, and does not recommend any change in current TS-required surveillance for other devices in an instrument channel. Performance of these instruments will continue to be verified through the current TS scheduled surveillance activities, e.g., the channel check, the channel functional test, and the logic functional test.

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 change from calibrating all redundant sensors each outage to calibrating a minimum of one of the redundant sensors each outage will require changes to the TS. The topical report proposed generic changes to TS.

The staff determined that TS changes proposed in the topical report are incomplete and require further evaluation for selecting an acceptable generic model that can be used in plant specific requirements. During the February 16 and 17, 2000, meetings with the staff, EPRI agreed that once the technical issues relating to generic concept of the on-line monitoring technique were resolved and the final SE was issued, EPRI would work with the NRC staff and the NEI Technical Specification Task Force (TSTF), to develop an appropriate TS structure and TS requirements consistent with the technical requirements described in the final SE. This SE resolves all technical issues as agreed upon during the February 16 and 17, 2000, meeting.

4.0 REVIEW METHOD AND CRITERIA

The staff reviewed the technical basis presented in the topical report for using the on-line monitoring technique to evaluate instrument performance in place and extend calibration intervals based on the results of performance evaluation. Since the current traditional calibration practice would be replaced by the new calibration assessment method of on-line monitoring, the staff compared the current practice to the proposed new method, analyzed the advantages and disadvantages of each, and attempted to assess the impact on plant safety. For evaluation, the staff followed review guidance contained in Chapter 7 of the Standard Review Plan (SRP) and also considered the guidance provided by the documents included in the reference section of this SE. The staff used the following criteria to evaluate the topical report.

(1) Section 50.55a(h) of 10 CFR Part 50 endorses Institute of Electrical and Electronic Engineers (IEEE) Std. 603-1991, "IEEE Standard Criteria for Safety Systems for Nuclear Power Generating Stations." IEEE Std. 603 establishes minimum functional design criteria for the power, instrumentation, and control portions of nuclear power generating station safety systems.

(2) Section 50.36(c)(1)(ii)(A), "Technical Specifications," of 10 CFR Part 50 states, in part, "Where a limiting safety system setting is specified for a variable on which a safety limit has been placed, the setting must be so chosen that automatic protective action will correct the abnormal situation before a safety limit is exceeded." Since reactor instruments are of high quality but still imperfect, conformance to this provision can only

be ensured by acceptable evaluation or measurement of instrument performance. The staff's criterion for this provision accepts a statistical evaluation of instrument performance data, based on measurements of instrument performance that give reasonable assurance of compliance with 10 CFR 50.36(c)(1)(ii)(A).

(3) Regulatory Guide 1.153, Revision 1, "Criteria for Safety Systems," establishes conformance with IEEE Std. 603 1991 as an acceptable alternative to compliance with IEEE Std. 279 1971. IEEE Std. 603 1991, Section 6.8.1, states, in part, "The allowance for uncertainties between the process analytical limit documented in Section 4.4 and device setpoint shall be determined using a documented methodology."

(4) Criterion 13, "Instrumentation and Control," of Appendix A to 10 CFR Part 50 requires, in part, that instrumentation be provided to monitor variables and systems and that controls be provided to maintain these variables and systems within operating ranges.

(5) Criterion 20, "Protection System Functions," and Criterion 21, "Protection System Reliability and Testability," of Appendix A to 10 CFR Part 50 require that automatic initiation of safety functions to prevent fuel design limits from being exceeded occur with high reliability.

(6) Section XII of Appendix B to 10 CFR Part 50, "Control of Measuring and Test Equipment," states, "Measures shall be established to assure that tools, gages, instruments and other measuring and testing devices used in activities affecting quality are properly controlled, calibrated and adjusted at specified periods to maintain accuracy within necessary limits."

(7) NRC Generic Letter 91-04, "Changes in Technical Specification Surveillance Intervals to Accommodate a 24-Month Fuel Cycle."

(8) Section 50.65 to 10 CFR, "Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants."

5.0 EVALUATION

The topical report proposes to replace the current time-directed traditional calibration with the new and advantageous calibrate-as-required approach using on-line monitoring. Therefore, the justification for such a replacement should demonstrate either: (1) the proposed on-line monitoring technique can perform all the required designated functions better than, or as good as, the current traditional calibration, with the same or better reliability; or (2) if due to inherent deficiencies in the proposed technique, the proposed technique cannot be demonstrated to be either better than, or at least as good as, the current practice, then the justification should verify that the impact of the proposed technique on plant safety will be insignificant and the advantages of using it will outweigh the deficiencies. Therefore, throughout this SE, the staff has compared various features of the proposed on-line monitoring technique to the current calibration practice, to determine if the proposed on-line monitoring technique can replace the current practice of traditional calibration without affecting the plant safety significantly. If any area was perceived to have weaknesses that could result in safety concerns, the staff has attempted to alleviate the possible concern by recommending remedial actions. The

recommended remedial actions have been included in this SE as requirements. There are 14 requirements. A few requirements may be duplicated in more then one paragraph, but for clarity's sake, these requirements were not combined. A few requirements are taken from the topical report and are included in the SE for completeness. Not all requirements listed in this SE are applicable to every plant-specific implementation of the proposed changes. Only applicable requirements must be addressed by license amendment requests submitted to implement the proposed changes to commercial nuclear power plants. For each requirement considered by the licensee as "not applicable," a case-by-case justification must be provided in the license amendment request.

5.1 Traditional Calibration Versus On-Line Monitoring

5.1.1 Traditional Calibration

Calibration is a two-step process. The first step determines whether calibration is actually needed (calibration check). This check is normally performed by providing the instrument with a series of known simulated process signal inputs covering its entire operating range, including the trip setpoint (TSP). For each input, the instrument output is compared with the preset acceptance criteria to determine whether the instrument output meets the acceptance criteria. If the instrument output meets the acceptance criteria, the second step is not necessary, and the instrument is declared to be in calibration.

The simulated process signal inputs used in traditional calibration are of known accuracy traceable to the National Institute of Standards and Technology (NIST). Maintaining traceable accuracy has two safety effects. The first is that safety analyses are based on steam tables and material properties developed using instruments traceable to standards. Therefore, having instrument TSPs traceable to standards preserves the correlation between plant operation and the safety analyses in the licensing basis. The second is that post-accident monitoring and accident reconstruction are also based on steam tables and material properties that are traceable to standards, and post-accident response may depend upon accident reconstruction.

If, in the first step, the instrument output does not meet the acceptance criteria, the instrument is calibrated during the second step by providing a series of known inputs covering its entire range. For each input, the instrument is physically adjusted as required so that its output is within the range and accuracy required to conform with a set standard and ensure that the operation of the instrument is within the calculated limits. The calibration process eliminates known bias errors and limits uncertainty to an acceptable level. Therefore, the traditional calibration process gives confidence that instruments will operate on demand in accordance with the established design limits.

Two important concepts are associated with the traditional calibration process: (1) the as-found (AF) condition and (2) the as-left (AL) condition. AF is the condition in which a channel or a portion of it is found in the first step of calibration (calibration check). AL is the condition in which a channel, or a portion of it, is left after the second step of calibration (i.e., after physical adjustment if adjustment is needed). The difference between the AF data obtained during current calibration and the AL data from the last calibration is commonly termed “drift,” although, in reality, it is a cumulative effect of various factors, including drift. The value of this

drift is an indication of degradation in instrument TSP during the period between two consecutive calibrations.

For any monitored process variable, the preset acceptance criterion for monitoring instrument performance and calibration is a calculated drift band. The drift value used for the TSP calculation is basically the expected drift between the two consecutive calibrations. If, for the monitored variable, the observed instrument drift (the difference between AL and AF data) is found to be beyond the calculated band, the instrument is declared to be inoperable. The allowable value (AV) is established per requirements of the 10 CFR 50.36 (c)(1)(ii)(A) and is the same as the operability limit for limiting conditions for operation (LCOs). The AV is determined by TSP calculations complying with the requirements of Regulatory Guide (RG) 1.105, "Instrument Setpoints for Safety-Related Systems" and the licensee’s TSP calculation methodology.

The values of TSP and AV are selected so that, if an accident or abnormal event occurs, the designated protective actions will be initiated to correct the abnormal situation on a timely basis before the monitored process variable exceeds its analytical limit. Thus, during traditional calibration of the entire instrument loop, if the as-found drift is in the acceptable drift band, it ensures that the designated safety system will be initiated in a timely manner during an accident or abnormal event before the monitored process variable exceeds its analytical limit. In other words, during the traditional calibration, all TSP calculation assumptions (except the channel response time) are verified, including instrument drift at the TSP and the assumptions of the system safety analysis. Instrument drift is an indication of degradation in instrument settings over time, providing a mechanism for assessing instrument performance at any time after its last calibration. Therefore, during traditional calibration, if performance of an instrument (including its drift) is found to be within the acceptable limit, the instrument performance will be acceptable and the instrument will be declared operable.

The traditional calibration encompasses the entire channel, including the required sensor-transmitter, signal conditioners, bistable devices for alarm, interlock, and trip functions and displays. The calibration may be done by any series of sequential overlapping calibrations or channel steps so that the entire channel is calibrated. Per current licensing basis, all M&TE equipment used for calibrating safety-related devices meet the requirements of 10 CFR Part 50, Appendix B, Criterion XII, “Control of Measuring and Test Equipment.” Additional features of the traditional calibration are: (1) that instruments are physically inspected and their external conditions are known, (2) that the instrument technician can observe instrument output for glitches and excessive noise, and (3) that, by verifying that the AL condition of the instrument is within its acceptable limit, there is reasonable certainty that no instrument will be out of calibration for longer than one calibration interval.

Unlike on-line monitoring, where instrument performance can be monitored continuously, the conventional calibration process does not provide any indication of instrument’s performance status between calibration intervals during plant operation. A channel check function that compares redundant channel output combined with results of a channel functional test can identify a faulty sensor-transmitter pair to some extent.

5.1.2 <u>On-Line Monitoring Technique</u>

On-line monitoring of instrument channel calibration involves monitoring the steady-state output of each channel and evaluating the monitored value to determine whether the sensor-transmitter of the channel is within acceptable limits. The monitored value is compared to the calculated value of the process parameter estimate to assess deviation of the monitored value from its process parameter estimate. The process parameter estimate is the best calculated instantaneous value of the process at the monitored operating point. However, as the word “estimate” suggests, it does not represent a true process value, but it does possess uncertainties in response to various factors. Each monitored channel’s deviation from its process parameter estimate represents its variation from the estimated value of the process. The amount of this variation indicates instrument performance and instrument operability and identifies those instrument channels that are not functioning properly and that might require adjustment or corrective maintenance. Therefore, in this role, the on-line monitoring technique can perform the first step of the traditional calibration (i.e., the calibration check) to some extent, but not to the level of accuracy inherent in traditional calibration. This is because, unlike traditional calibration, which uses simulated process signal inputs of known accuracy and traceable to NIST as a reference, in on-line monitoring the process parameter estimate (which is used as reference input) is not traceable to standards and is less accurate.

Uncertainty in the process parameter estimate is derived from individual redundant channel uncertainty and the type of algorithm used for on-line monitoring. Therefore, uncertainty in on-line monitoring is not static but can vary with the number of redundant channels and the type of algorithm used. In addition, the on-line monitoring cannot perform a calibration check for the entire range of the instrument, including the TSP, but monitors instrument performance only at the point of operation. This is known as “single-point monitoring,” and instrument performance at the TSP and at any other points in the range can only be assessed by extrapolating the results of the single-point monitoring to the entire range, including the TSP, using the statistical methods.

In summary, on-line monitoring has the following inherent deficiencies:

(1) It is not capable of monitoring instrument performance for its full range including TSP,

(2) It does not have accurate reference, but compares the monitored value to a calculated reference (the process parameter estimate) that itself is less accurate compared to simulated input used in the traditional calibration process,

(3) It does not provide accuracy traceable to standards, and

(4) It does not allow frequent physical inspection of the instrument or allow technicians to observe instrument anomalies.

Because of these inherent deficiencies, on-line monitoring may be unable to verify an instrument’s performance adequately to establish its operability, a deficiency that could degrade plant safety. In response to these staff concerns, EPRI in a letter dated March 23, 2000, stated that, for assessing the capability of on-line monitoring to perform functions performed by the traditional calibration either better or as well, functions should be evaluated aggregately rather

than one function at a time. While little more uncertainty is associated with the process parameter estimate than with a simulated reference input traceable to NIST, the accuracy of the process parameter estimate is sufficient for its proposed purpose, which is to provide a reference value against which subsequent drift can be measured. Furthermore, the uncertainties associated with the process parameter estimate will be quantitatively bounded and accounted for in either the on-line monitoring acceptance criteria or the applicable setpoint and uncertainty calculations. EPRI further added that there were clear tradeoffs between the traditional calibration approach and the on-line monitoring approach proposed by the topical report, so that it cannot be claimed that on-line monitoring is superior in every way. However, EPRI believes that, taken as a whole, the on-line monitoring technique, as proposed in the topical report, is superior to the traditional calibration approach, providing greater assurance of instrument operability throughout a plant’s operating cycle.

During a presentation at the NRC headquarters on February 16 and 17, 2000, representatives of EPRI, along with the representatives of Argonne National Laboratory, Carolina Power and Light Company and Analysis and Measurement Services Corporation, stated that the inherent deficiencies of the on-line monitoring technique may introduce an insignificant error which, to a large extent, can be compensated in calculation for "test acceptance criteria." An EPRI representative further stated that the above-described deficiencies in the on-line monitoring might not result in a loss of function or a significant safety degradation, considering that: (a) the error introduced by the additional uncertainty in the process parameter estimate would be accounted for in determining the test acceptance criteria or in related setpoint calculations, (b) an additional penalty would be imposed to account for single-point monitoring, (c) at least one channel would be calibrated during each outage by a method traceable back to standards, (d) instrument performance would be monitored by the on-line monitoring technique more frequently than by the traditional calibration, and (e) redundancy exists in instrument channels. To support this statement, V.C. Summer Nuclear Station representatives stated that they had been using the proposed on-line technique for monitoring instrument performance for the last eight years and had found that the benefits of implementing this new technique were overwhelming and outweighed the insignificant degradation in plant safety due to the above-described deficiencies.

The staff agrees with EPRI’s conclusion that considering all the factors listed in (a) through (e) above, the impact of a small additional uncertainty in the process parameter estimate on plant safety will be insignificant, provided the uncertainties associated with the process parameter estimate are quantitatively bounded and accounted for in either the on-line monitoring acceptance criteria or the applicable setpoint and uncertainty calculations. Therefore, the staff requires that:

> *The submittal for implementation of the on-line monitoring technique shall confirm that the impact on plant safety of the deficiencies inherent in the on-line monitoring technique (inaccuracy in process parameter estimate, single- point monitoring, and untraceability of accuracy to standards), on plant safety will be insignificant, and that all uncertainties associated with the process parameter estimate have been quantitatively bounded and accounted for either in the on-line monitoring acceptance criteria or in the applicable setpoint and uncertainty calculations. (Requirement 1)*

5.2 Drift Evaluation

EPRI conducted a study to understand instrument performance over time, the nature of drift, and how to predict instrument performance in service. The study analyzed historical calibration data from 18 nuclear power plants on approximately 6,700 calibrations. The calibrations covered instruments of various types, makes, and models used to monitor pressure, level, flow, and temperature in safety systems of various plants based on nuclear steam supply systems (NSSSs) supplied by Westinghouse, General Electric, Babcock & Wilcox, and Combustion Engineering. Evaluation of the data focused on determining normal drift characteristics, categorizing types of drift shifts (e.g., zero shift, forward and reverse span-shift, and nonlinear shift), identifying drift trends that could affect TSP monitoring, determining which data indicate abnormal behavior, and quantifying the data to identify specific characteristics of instrument drift.

The EPRI drift evaluation produced several notable findings:

(1) For the transmitters evaluated, drift was random. Transmitters were as likely to drift up as to drift down. No significant bias effects were observed.

(2) For plants that performed a 9-point or greater calibration (5 points up and 4 points down), hysteresis was negligible.

(3) Redundant transmitters associated with a particular parameter did not exhibit a tendency to drift as a group. One transmitter out of calibration did not indicate that the other redundant transmitters were likely to be out of calibration.

(4) Single-point monitoring does not invalidate the ability of on-line monitoring to detect drift. An allowance (referred to as a "penalty") can be included in the uncertainty analysis to account for single-point monitoring.

(5) Some applications (mostly at the low end and a few at the high end of instrument span) are likely to be unsuitable for single-point monitoring because of susceptibility to potential span-shift effects.

(6) The data indicated that no failure modes were found that would be undetectable by on-line monitoring. For example, transmitters did not fail at a fixed level, the as-is type of failure in which the output signal remains constant regardless of the input signal variation.

(7) Other conclusions were that: (a) AF/AL data exhibited a zero or a near-zero mean, indicating that bias in the drift is not a key concern, (b) data were normally distributed or bounded by the assumption of normality, (c) drift tended to increase with span, (d) zero-shift and span-shift were the predominant types of instrument drift and occurred at all levels of instrument span (with forward span-shift more frequent than reverse span-shift, and nonlinear shift less common than zero-shift and span-shift), (e) it was unlikely for one or more calibration checkpoints to be significantly out-of-calibration when one point (assumed to be the monitored point) was within calibration to some specified level, and

(f) calibration data that was evaluated showed that instrument performance was suitable for on-line monitoring.

The EPRI drift evaluation indicated that on-line monitoring as a performance verification tool may not be appropriate for process parameters that normally are at either the high or the low end of an instrument's calibrated span, because such processes are more susceptible to undetected span-shift. The EPRI drift study also indicated that zero-shift and span-shift were the predominant types of instrument drift and occurred at all levels of an instrument's span. Also, the applications that would not detect any amount of span-shift drift are not suitable for on-line monitoring at a single point. Therefore, the staff requires that:

Unless the licensee can demonstrate otherwise, instrument channels monitoring processes that are always at the low or high end of an instrument's calibrated span during normal plant operation shall be excluded from the on-line monitoring program. (Requirement 2)

Values monitored by redundant instruments monitoring the same process variable at different locations may be slightly different because of delays, offset, and superimposed noises. Physical separation in sensors can also increase uncertainty in the process parameter estimate. Referring the sensor readings back to a common point can compensate for effects of physical separation, but this usually requires a reasonably accurate physical model. The topical report concludes that the timing simultaneity of measurements of redundant channels becomes an important factor in determining value for the process parameter estimate and its acceptance criterion, because, depending on the type of algorithm used, the process parameter estimate could be the result of instantaneous measured values of redundant and/or diverse channels. Also, for accurate results, the process must remain stable during monitoring and signals must be free from noise. When monitoring is done during normal plant operation, it is possible the process may not be stable and the monitored variable may be drifting.

The EPRI drift evaluation indicated that instrument drift is random and transmitters are as likely to drift up as to drift down. The staff believes it is possible that while the monitored process variable is drifting, the monitoring instrument could also be drifting, and the combined effect of process and instrument drift could adversely affect accuracy of the monitoring and the calculated value of the process variable estimate. Therefore, it is prudent to acquire redundant channel measurements within a close duration and at relatively stable plant conditions and to use an algorithm that can recognize unstable conditions of the monitored process. If a licensee believes, that in a plant-specific physical configuration, monitored values are susceptible to location difference, process instability, and non simultaneous measurements, the staff requires that:

The algorithm used for on-line monitoring shall be able to distinguish between the process variable drift (actual process going up or down) and the instrument drift and shall be able to compensate for uncertainties introduced by unstable process, sensor locations, non-simultaneous measurements, and noisy signals. If the implemented algorithm and its associated software cannot meet these requirements, administrative

controls, including the guidelines in Section 3 of the topical report for avoiding a penalty for non-simultaneous measurement, could be implemented as an acceptable means to ensure that these requirements are met satisfactorily. (Requirement 3)

5.3 Single-Point Monitoring

The EPRI drift study noted that zero-shift and span-shift are the predominant types of instrument drift and occur at all levels of instrument span. Forward span-shift occurs more frequently than reverse span-shift, and the nonlinear shift is less common than zero-shift and span-shift.

Zero-shift manifests itself as an offset, the value of which remains constant throughout the span, whereas with forward span-shift, drift tends to increase with the span. Considering this observation, the EPRI drift study concluded that the drift exhibited by an instrument at one operating point could be considered representative of the drift over its calibrated range, provided an allowance (penalty) to compensate for the effects of zero and span-shifts is included in the uncertainty analysis for calculating acceptance criteria for on-line monitoring. Thus, by including a calculated value of penalty for each instrument, the on-line monitoring technique will be able to detect drift at any other point in the calibrated span using single-point monitoring.

Sections 3.4.3.2 and 8 of the topical report includes EPRI-recommended values of compensatory allowance (penalty) for single-point monitoring. EPRI derived these penalty values by analyzing the observed AF/AL data from the drift study using statistical methods. The topical report includes curves with "95%/95% Allowance for Single Point Monitoring" on the Y-axis and "Drift Limit for Monitored Channel" on the X-axis, plotted for 0-25%, 25%-50% and 50%-100% values of instrument span. Evaluation of these plots indicated that monitoring a process low in the span carries a higher penalty then monitoring high in the span. The recommended allowance depends on the channel drift limit, which can vary with the monitored parameter. However, the topical report recommends 0.25% as a minimum value for allowance, although the plots would permit a lower value for the penalty. Also, the topical report recommends that the single-point monitoring penalty be treated as a random uncertainty in the overall uncertainty evaluation for on-line monitoring.

EPRI concludes that by using the calculated value of penalty for each instrument, the on-line monitoring technique can detect drift at any other point in the calibrated span using single-point monitoring. The topical report indicates that the basis for this conclusion is that, in most samples, drift was due to zero-shift, forward span-shift, or some combination of the two. The staff believes this may not be true in every case. It is possible that drift could be the result of zero-shift, forward or reverse span-shift, or any form of non-linear shift, or a combination thereof. Therefore, imposing a penalty based on the general assumption that drift is due to zero-shift, forward span-shift, or some combination of the two may not be correct for all instruments. It is acceptable to use the EPRI recommended values in the topical report, to determine the "allowance or penalty" to compensate for single-point monitoring, provided the monitored instrument is of similar type and make evaluated in the EPRI drift study. If the instrument designated for on-line monitoring was not included in the EPRI study, the topical

report's recommended penalty should not be used unless justified by an evaluation. Therefore, the staff requires that:

> *For instruments that were not included in the EPRI drift study, the value of the allowance or penalty to compensate for single-point monitoring must be determined by using the instrument's historical calibration data and by analyzing the instrument performance over its range for all modes of operation, including startup, shutdown, and plant trips. If the required data for such a determination is not available, an evaluation demonstrating that the instrument's relevant performance specifications are as good as or better than those of a similar instrument included in the EPRI drift study, will permit a licensee to use the generic penalties for single- point monitoring given in EPRI Topical Report 104965. (Requirement 4)*

5.4 On-Line Monitoring Acceptance Criteria

Acceptance criteria depend on the type of algorithm selected for on-line monitoring, but regardless of the algorithm, the steady-state output of each channel is compared with its process parameter estimate (PE) during monitoring to assess deviation of the monitored value from the calculated value of the process variable. This step is similar to the first step in the traditional calibration (the calibration check).

Each channel's deviation from its PE represents its variation from the estimated value of the process. The amount of this variation is compared with preestablished "acceptance criteria" and the instrument performance and its operability status are determined in accordance with three bands described in Sections 5.4.1, 5.4.2 and 5.4.3, and the figure, Deviation Zones for Acceptance Criteria. The acceptance criteria are established by calculating acceptable limits of deviation in these three bands. It is possible that, due to changes in error factors (e.g., test equipment uncertainty, AL tolerance) implementing on-line monitoring may require revisiting the current TSP and uncertainty calculations. The staff requires that:

> *Calculations for the acceptance criteria defining the proposed three zones of deviation ("acceptable," "needs calibration," and "inoperable") should be done in a manner consistent with the plant-specific safety-related instrumentation setpoint methodology so that using on-line monitoring technique to monitor instrument performance and extend its calibration interval will not invalidate the setpoint calculation assumptions and the safety analysis assumptions. If new or different uncertainties require the recalculation of instrument trip setpoints, it should be demonstrated that relevant safety analyses are unaffected. The licensee should have a documented methodology for calculating acceptance criteria that are compatible with the practice described in Regulatory Guide 1.105 and the methodology described in acceptable industry standards for TSP and uncertainty calculations. (Requirement 5)*

Figure: Deviation Zones for Acceptance Criteria

```
I
I          Instrument inoperable
I          (5.4.3)
I---------------------------------------------- ADVOLM (allowable deviation value for on-line monitoring)
I                                                Positive direction with reference to PE
I           Routine calibration
I           scheduling band/region
I           (5.4.2)
I---------------------------------------------- MAVD (maximum acceptable value of deviation)
I                                                Positive direction with reference to PE
I           Acceptable band/region
I           (5.4.1)
I---------------------------------------------- PE (process parameter estimate) at operating point
I
I          Acceptable band/region
I           (5.4.1)
I---------------------------------------------- MAVD (maximum acceptable value of deviation)
I                                                Negative direction with reference to PE
I          Routine calibration
I          scheduling band/region
I          (5.4.2)
I---------------------------------------------- ADVOLM (allowable deviation value for on-line monitoring)
I                                                Negative direction with reference to PE
I          Instrument inoperable
I          (5.4.3)
```

5.4.1 <u>Acceptable Band or Acceptable Region</u>

As described in the topical report, this zone will be between the PE and maximum acceptable value of deviation (MAVD) for the monitored parameter in reference to the PE. Using the on-line monitoring technique, if the deviation between the monitored value and its PE is found anywhere in this zone, no action is needed and the instrument is considered operable. In accordance with the existing calibration practice, the instrument is considered operable when its observed drift (the difference between AL and AF conditions) is found to be within the value used in the TSP calculations. In other words, when setpoint calculation assumptions are verified by instrument performance, the instrument is considered operable. Considering this current practice, the staff requires that:

> *For any algorithm used, the maximum acceptable value of deviation (MAVD) shall be such that accepting the deviation in the monitored value anywhere in the zone between PE and MAVD will provide high confidence (level of 95%/95%) that drift in the sensor-transmitter or any part of an instrument channel that is common to the instrument channel and the on-line monitoring loop is less than or equal to the value used in the setpoint calculations for that instrument channel. (Requirement 6)*

5.4.2 Routine Calibration Scheduling Region or Band

This zone falls between the MAVD and the allowable deviation value for on-line monitoring (ADVOLM). During on-line monitoring, if the deviation between the monitored value and its PE is found anywhere in this zone, the instrument channel will be scheduled for calibration in the next refueling outage. The staff understands that when deviation between the monitored value and its PE is found in this zone, the instrument may need adjustment or maintenance, but will still be considered operable. Therefore, the staff requires that:

> *The instrument shall meet all requirements of the above requirement 6 for the acceptable band or acceptable region. (Requirement 7)*
>
> *For any algorithm used, the maximum value of the channel deviation beyond which the instrument is declared "inoperable" shall be listed in the technical specifications with a note indicating that this value is to be used for determining the channel operability only when the channel's performance is being monitored using an on-line monitoring technique. It could be called "allowable deviation value for on-line monitoring" (ADVOLM) or whatever name the licensee chooses. The ADVOLM shall be established by the instrument uncertainty analysis. The value of the ADVOLM shall be such to ensure:*
>
> *(a) that when the deviation between the monitored value and its PE is less than or equal to the ADVOLM limit, the channel will meet the requirements of the current technical specifications, and the assumptions of the setpoint calculations and safety analyses are satisfied; and*
>
> *(b) that until the instrument channel is recalibrated (at most until the next refueling outage), actual drift in the sensor-transmitter or any part of an instrument channel that is common to the instrument channel and the on-line monitoring loop will be less than or equal to the value used in the setpoint calculations and other limits defined in 10 CFR 50.36 as applicable to the plant-specific design for the monitored process variable are satisfied. (Requirement 8)*

5.4.3 Operability Assessment Region or Band

This zone will be beyond the ADVOLM limit for on-line monitoring. During on-line monitoring, if the deviation between the monitored value and its PE is found anywhere in this zone, the instrument channel will be declared inoperable immediately and statements of all required TS actions will become applicable. The staff requires that:

> *Calculations defining alarm setpoint (if any), acceptable band, the band identifying the monitored instrument as needing to be calibrated earlier*

than its next scheduled calibration, the maximum value of deviation beyond which the instrument is declared "inoperable," and the criteria for determining the monitored channel to be an "outlier," shall be performed to ensure that all safety analysis assumptions and assumptions of the associated setpoint calculation are satisfied and the calculated limits for the monitored process variables specified by 10 CFR 50.36 are not violated. (Requirement 9)

5.5 Instrument Failures

The proposed on-line monitoring system, will allow the instruments to remain unattended for longer periods. Therefore, there could be a possibility that certain types of instrument failures may remain undetectable by the on-line monitoring system while the instrument is being monitored at only one point in its operating range.

An instrument can fail in any one of the three modes: (1) it can fail low, which means, regardless of the value of its input, instrument output is at or near zero; (2) it can fail high, which means, regardless of the value of its input, instrument output is at or near 100%; (3) it can fail as-is, which means, regardless of the input, instrument output remains constant somewhere between 0% and 100%. Failures that cause a large shift (deviation) in the instrument's output signal compared to its PE are not a concern because just as the drift is detectable so is the large shift. But failures where the instrument output compared to its PE does not change much upon instrument failure could be a concern. For example,

- The process parameter is at or near the low end of the span and the instrument fails low.
- The process parameter is near the high end of the span and the instrument fails high.
- The process parameter is somewhere between the low and high span limits and the instrument fails as-is.

The as-is types of failures were not observed in the EPRI drift study, but failing low (loss of signal) was found to be more likely than failing high. The topical report indicated that very few instruments operate near the 100% span point, and even if they operate high in the span, there is generally some room for detecting a high signal failure (fail high) as drift. But the failed-low condition of the instrument could remain undetected in applications where the process parameter is normally at the lower end of the span; therefore, the topical report recommends that such applications should be avoided. The following are three examples of the kinds of cases which are susceptible to loss of signal failures (failed low) and, therefore, are not considered suitable for on-line monitoring.

- Auxiliary feedwater flow: At normal plant operation, there is no flow and the signal is at the bottom of the span.

- Engineered safeguards system actuation equipment: At normal plant operation, the equipment is usually off and the associated pressure or flow indication will be at or near 0% of the span.

- Containment pressure: At normal plant operation, depending on the calibrated span, the signal might be about 0% of the span.

In response to related concerns in the staff's draft SE, EPRI stated that the approach to on-line monitoring outlined in TR-104965 provides greater assurance of sensor operability than is currently provided by calibrations each refueling interval and channel checks each shift. The channel checks will continue to identify gross failures. Failures where sensors drift only slightly more than their allowances in applicable setpoint or uncertainty calculations will be identified during plant operations by on-line monitoring. EPRI believes that the increased ability to detect these sorts of failures will more than compensate for instrument failures that are undetectable by on-line monitoring while the instrument is being monitored at one point in the operating range. During the February 16 and 17, 2000, presentation, EPRI stated that there was no potential that any type of failure would remain undetected while the instrument was being monitored by an on-line monitoring technique. EPRI's drift study analyzed all possible failure modes, including fail low, fail high, and fail as-is, and demonstrated that the probability of failure modes in which transmitters failed in ways that would be undetectable by on-line monitoring is extremely low. Also, to verify that no common-mode failure exists, the topical report proposes to calibrate at least one redundant channel during each outage.

The staff believes that in plant-specific situations there could be many more examples of cases like those described above. Therefore, it is prudent that an evaluation for each instrument should be performed, considering all possible types of failure modes and operating point of the process parameter with respect to the instrument's span during normal plant operation, to verify that no possible instrument failure in any condition may remain undetected. If it is suspected that the plant-specific implementation of on-line monitoring could in any way impact the existing plant safety analyses demonstrating a coordinated defense-in-depth against instrument failures, the staff requires that:

> *The plant specific submittal shall confirm that the proposed on-line monitoring system will be consistent with the plant's licensing basis, and that there continues to be a coordinated defense-in-depth against instrument failure. (Requirement 10)*

5.6 On-Line Monitoring Loop

A typical instrument channel consists of a process sensor-transmitter, the power source, signal conditioners, indicators, and bistable devices. The on-line monitoring will not monitor the entire instrument channel, but only a portion of it. A typical on-line monitoring loop will consist of a sensor-transmitter (and in some cases will also include a portion of the signal processing circuitry), a class 1E to non-1E isolator, non-safety-related data transmitting hardware, and a non-safety-related microprocessor-based data processing device.

On-line monitoring collects data from instrument channels, typically via connection to the plant computer for an automated system or at a qualified class 1E to non-1E isolator output terminal or at an appropriate test point for manual data acquisition. Signals taken from the non-1E terminals of the isolator or at the plant computer are transmitted to a microprocessor-based processing device via communications hardware and software and analyzed to determine the state of the instrument's calibration and its operability status. There are various on-line monitoring implementations on microcomputer platforms. Data are input from the plant to these systems via modem or electronic media or manually. Output capabilities typically include graphical display of the individual instrument channel deviation from the PE as a function of time. Some automated systems are network operable and allow multiple access to the monitoring information and results.

Except for the sensor-transmitter, typically all components of an instrument channel are located on instrument racks. According to the current TS requirements, performance of components on an instrument rack, including bistable units, is monitored through periodic surveillance activities, including functional checks. The topical report does not recommend any change in current practices; therefore, performance of these components will continue to be verified through the current TS scheduled surveillance activities.

Although equipment used for on-line monitoring are non-safety-related, they interface with safety-related instrument channels and therefore, the staff requires that:

> *Adequate isolation and independence, as required by Regulatory Guide 1.75, GDC 21, GDC 22, IEEE Std. 279 or IEEE Std. 603, and IEEE Std. 384, shall be maintained between the on-line monitoring devices and Class 1E instruments being monitored. (Requirement 11)*

Although equipment used for the on-line monitoring technique are non-safety-related, the instruments monitored are safety-related and, based on results of on-line monitoring, the frequency of the current TS-required instrument channel calibrations could be relaxed from "once per refueling cycle" to "once per a maximum period of 8 years" as discussed in section 3.0(2)(a) of this document. These class 1E instruments are set to initiate protective actions to mitigate accidents or abnormal events before the monitored process variable exceeds its analytical limit, and may be required to guide plant operators through emergency operating procedures (EOPs). Because of its important mission, the on-line monitoring system, including its hardware and software, must be designed with quality assurance (QA) requirements compatible with the QA requirements for the Class 1E devices being monitored. Therefore, the staff requires that:

> *(a) QA requirements as delineated in 10 CFR Part 50, Appendix B, shall be applicable to all engineering and design activities related to on-line monitoring, including design and implementation of the on-line system, calculations for determining process parameter estimates, all three zones of acceptance criteria (including the value of the ADVOLM), evaluation and trending of on-line monitoring results, activities (including drift assessments) for relaxing the current TS-required instrument calibration*

frequency from "once per refueling cycle" to "once per a maximum period of 8 years," and drift assessments for calculating the allowance or penalty required to compensate for single-point monitoring.

(b) The plant-specific QA requirements shall be applicable to the selected on-line monitoring methodology, its algorithm, and the associated software. In addition, software shall be verified and validated and meet all quality requirements in accordance with NRC guidance and acceptable industry standards. (Requirement 12)

Basically, the equipment associated with the on-line monitoring serves as an M&TE to assess calibration of class 1E instruments; therefore, the staff requires that:

All equipment (except software) used for collection, electronic transmission, and analysis of plant data for on-line monitoring purposes shall meet the requirements of 10 CFR Part 50, Appendix B, Criterion XII, "Control of Measuring and Test Equipment." Administrative procedures shall be in place to maintain configuration control of the on-line monitoring software and algorithm. (Requirement 13)

5.7 System Algorithms

Although many algorithms could be used in on-line monitoring, this topical report addresses only two. The staff did not review, and does not endorse, either of the two algorithms or the associated software. The staff believes that numerous algorithms and associated software could be suitable, and the choice of which to use should be left to the user. Since the algorithm will be used to monitor calibration and determine operability of safety-related instruments, every user would be prudent to carefully evaluate the algorithm selected to ensure that the assumptions of safety analyses, and of TSP calculations and plant commitments to separation, independence, QA, and conditions of applicable requirements specified in this SE; and that NRC policy statements for TS criteria are not violated by implementation of the selected algorithm and/or its software for on-line monitoring. The staff, therefore, requires that:

Before declaring the on-line monitoring system operable for the first time, and just before each performance of the scheduled surveillance using an on-line monitoring technique, a full-features functional test, using simulated input signals of known and traceable accuracy, should be conducted to verify that the algorithm and its software perform all required functions within acceptable limits of accuracy. All applicable features shall be tested. (Requirement 14)

6.0 CONCLUSION

Based on the above evaluation, the staff concludes that the generic concept of an on-line monitoring technique, as presented in the topical report, is acceptable for on-line tracking of instrument performance. The staff agrees with the topical report's conclusion that on-line monitoring has several advantages, including timely detection of degraded instrumentation. The staff believes that on-line monitoring can provide information on the direction which instrument performance is heading and, in that role, it can be useful in determining preventive maintenance activities. As agreed during the February 16 and 17, 2000, meeting with the staff, EPRI would work with the NRC staff and the NEI TSTF to develop an appropriate TS structure and TS requirements consistent with the requirements discussed in this SE.

For establishing instrument operability, verifying the drift to be within an acceptable limit is the most vital function of the conventional calibration. Although the proposed on-line monitoring technique compared to traditional calibration process will render results with less accuracy, the staff finds EPRI's conclusion acceptable that accuracy rendered by the process parameter estimate is sufficient to assess instrument operability; also, compared to traditional calibration once per refueling outage, the on-line monitoring technique when taken as a whole provides higher assurance of instrument operability throughout a plant operating cycle. However, if results of the on-line monitoring technique are being applied to relax the TS-required calibration frequency of the safety-related RPS, ESFAS, and PAM instrumentation, the staff requires that every plant-specific license amendment submittal for implementing on-line monitoring to relax the TS-required calibration frequency of the safety-related instrumentation, address all applicable requirements discussed in this SE.

7.0 REFERENCES

(1) NUREG/CR-6343, "On-Line Testing of Calibration of Process Instrumentation Channels in Nuclear Power Plants," Phase II Final Report, dated November 1995.

(2) Lawrence Livermore National Laboratory, Report 1, Task 29, "Assessment of On-line Monitoring Techniques," dated January 17, 1996.

(3) G. Preckshot of the Fission Energy and Systems Safety Program, Lawrence Livermore National Laboratory, On-Line Calibration System Requirements and Review Guidance, dated December 22, 1998.

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