Enclosure 3

Reactor Oversight Process Task Force FAQ Log
November 16, 2017

Dated December 8, 2017

FAQ 17-04

Watts Bar Unit 2 MSPI Effectiveness Date

Plant: **Watts Bar Nuclear Plant, Unit 2 (WBN 2)**

Date of Event: 3/23/2017 (Condenser Failure)
Submittal Date: 11/26/2017
Engineer/Licensee Contact: Clinton Woolson/Beth Wetzel Tel/email: (423) 365-8848/(423)751-2403
NRC Contact: Jared Nadel Tel/email: (423) 365-1776

Performance Indicator:

MS06 WBNU2 Mitigating System Performance Index (Emergency AC Power System)
MS07 WBNU2 Mitigating System Performance Index (High Pressure Injection System)
MS08 WBNU2 Mitigating System Performance Index (Auxiliary Feedwater System)
MS10 WBNU2 Mitigating System Performance Index (Cooling Water Systems)

Site-Specific FAQ (Appendix D)? Yes

FAQ requested to become effective when approved.

Question Section:

TVA requests the effective date of Watts Bar Unit 2 MSPI indicators to be extended until sufficient data is available to provide an accurate assessment value. This date has been determined to be the second quarter of 2018. The extension gives WBN Unit 2 four quarters of data and allows enough information to develop a trend.

The NRC documented the full transition of WBN Unit 2 to the Reactor Oversight Process (ROP) and the effective dates of the ROP indicators. The NRC also approved using the FAQ process if the information shows that the ROP indicators do not provide an accurate assessment value (Reference NRC Letters to TVA dated November 21, 2016 and October 22, 2015). This scheduled the indicators to be effective four quarters after the cornerstone is transitioned to the ROP. These MSPI indicators become effective the first quarter of 2018.

NEI 99-02 Guidance needing interpretation :

Items:

1. FAQ 14-02
2. NRC Letters to TVA dated November 21, 2016 and October 22, 2015.

Event or circumstances requiring guidance interpretation:

During March 2017, during the first operating cycle Watts Bar U2, the Condenser failed and required extensive repair to return to service. The reactor was shut down while the work on the secondary side was performed. This resulted in a loss of 3100 critical hours. The cause of the failure was inadequate vendor design (1970's) of the condenser wall support structure leading to support and wall failure. In addition, a 35-day refueling outage is planned for fourth Quarter of 2017 with an additional loss of 840 critical hours.

If licensee and NRC resident/region do not agree on the facts and circumstances explain:

The NRC Watts Bar Site Resident Inspector was informed of this FAQ. No feedback was provided by the resident.

Potentially relevant existing FAQ numbers:
FAQ 14-02, "Simulation of MSPI Indicator Reaction to Plant in Long Shutdown and Initial Startup." Fort Calhoun

Response Section:
Proposed Resolution of FAQ:

Extend the effective date of the Watts Bar Unit 2 MSPI indicators to April 1, 2018 due to the loss of a significant number of critical hours. This loss of critical hours would significantly affect the accuracy of the assessment value.

The basis of Fort Calhoun FAQ 14-02 was a simulation that concluded the indicator was accurate after four quarters of critical hours. The WBN Unit 2 condenser failure and refueling outage loss of critical hours makes the indicators a three quarter assessment at the present effective date. The forecasted value of critical hours for Watts Bar U2 on December 31, 2017 is 6378 hours (including condenser failure and outage) compared to the four quarter maximum value of 8760.

Recommend the new effective date for Watts Bar U2 indicators MS06, 07, 08, and 10 be set at April 1, 2018. The NRC will continue to gray out the affected Watts Bar U2 indicators on NRC web site for the first quarter of 2018.

If appropriate, provide proposed rewording of guidance for inclusion in next revision:
None

PRA update required to implement this FAQ? No
MSPI Basis Document update required to implement this FAQ? No

FAQ 17-05

Watts Bar 2 MSPI MS09 Effectiveness Date

Plant: **Watts Bar Nuclear Plant, Unit 2 (WBN 2)**

Date of Event: 3/23/17 (Condenser Failure)
Submittal Date: 11/2/2017
Engineer/Licensee Contact: Clinton Woolson/Beth Wetzel Tel/email: (423) 365-8848/423-751-2403
NRC Contact: Jared Nadel Tel/email: 423-365-1776

Performance Indicator:
MS09 WBN U2 Mitigating System Performance Index (Residual Heat Removal System)

Site-Specific FAQ (Appendix D)? Yes

FAQ requested to become effective when approved.

Question Section:

TVA requests the effective date of Residual Heat Removal (RHR) MS09 MSPI indicator be extended until sufficient data is available to provide an accurate assessment value. This date has been determined to be the First quarter of 2019. The extension gives WBN Unit 2 RHR sufficient data and allows enough time to develop a trend.

The NRC documented the full transition of WBN Unit 2 to the Reactor Oversight Process (ROP) and the effective dates of the ROP indicators. The NRC also approved using the FAQ process if the information shows that the ROP indicators do not provide an accurate assessment value (Reference NRC Letters to TVA dated November 21, 2016 and October 22, 2015). This scheduled the indicators to be effective four quarters after the cornerstone is transitioned to the ROP. This MSPI indicator becomes effective the first quarter of 2018.

NEI 99-02 Guidance needing interpretation (include page and line citation):
Items:

1. FAQ 14-02
2. NRC Letters to TVA dated November 21, 2016 and October 22, 2015.

Event or circumstances requiring guidance interpretation:

During March 2017 during the first operating cycle Watts Bar U2 Condenser zone B failed and required extensive rework. The unit was not critical during this time resulting in a loss of 3100 critical hours. The cause of the failure was inadequate vendor design (1970's) of the condenser wall support structure leading to support and wall failure. In addition a 35 day refueling outage is planned for fourth Quarter of 2017 with an additional loss of 840 critical hours.

The RHR MSPI value will not have an accurate assessment value at four quarters due to the reliability value associated with the Motor Operated Valve (MOV) group. The group failure value is dominated by two MOVs that provide Loss of Coolant Containment Sump recirculation flow. The INPO CDE failure value as of September, 2017 is 6.4E-07.

If licensee and NRC resident/region do not agree on the facts and circumstances explain:

The NRC Watts Bar Site Resident Inspector was informed of this FAQ. No feedback was provided by the resident.

Potentially relevant existing FAQ numbers:

1. FAQ 14-02 Fort Calhoun MSPI startup from extended shutdown. White paper discussed during the February 21, 2013 ROP WB Public Meeting -"Simulation of MSPI Indicator Reaction to Plant in Long Shutdown and Initial Startup."
2. FAQ 17-00 Watts Bar U2 extension of MSPI 1 quarter due to loss of critical hours.

Response Section:
Proposed Resolution of FAQ:

Extend the effective date of the Watts Bar U2 Residual Heat Removal MSPI indicator 1 quarter due to the loss of critical hours and 3 quarters based on an inaccurate assessment value.

Details are contained in Watts Bar FAQ 17-00 due to the loss of critical hours associated with U2 condenser failure 1 additional quarter will be added before this indicator is effective.

The following details are provided to justify additional 3 quarters due to assessment value inaccuracy:

The additional 3 quarters is needed due to high risk (Xd =6.44E-7) and low demands of RHR MOV valve group. The group is made up of the same 9 valves for both units with similar risk values. Based on MSPI calculation methods each failure of a MOV is evaluated at the same risk value. The U2 valve group has had 118 demands presently. The U1 RHR MOVs group, monitored over 12 quarters, has 271 demands and Xd =5.7E-7. Based on the proposed effective date of the indicator, being January 2019 the demands for U2 is forecast to be same as U1. This would lower the U2 Xd to a value similar to U1.

The table below shows U1 and U2 Actual Data from INPO CDE.

Residual Heat Removal Actual September 2017

Measured Element	U2 Margin	U1 Margin
Residual Heat Removal Pump FTS	2	3
Residual Heat Removal Pump FTR	4	4
Motor Operated Valve	1	2
UA Residual Heat Removal Pump 2A	333	1644
UA Residual Heat Removal Pump 2B	333	1644

MSPI Results	-4.8E-08	-2.1E-07

Both units' data does not include any failures and the only difference is the time frame of the monitoring period (Critical hours, demands, and run hours). This table shows that U2 can have only one failure while U1 can have two failures and remain green. This is considered an inaccurate assessment (false positive condition) because if U2 was using data from three years like U1, then the indicator would be green with two failures instead of white.

TVA had a contractor (author of NUREG 1816) prepare a report to document the basis for a three-year monitoring period used in NEI 99-02 for MSPI, which is attached. The report notes that false positives are possible during short monitoring periods. RHR MOVs are a good example where a four-quarter monitoring period does not provide an accurate assessment tool.

To determine when U2 data could tolerate two MOV failures like U1, the actual U2 data from September 2017 was placed in spread sheet. The monitoring period was increased in the spread sheet to determine when two MOV failures and 100 hours of unavailability would maintain the indicator green. This resulted in a January 2019 implementation date for RHR. The data results are shown below:

U2 Residual Heat Removal Case Forecast January 2019.

Quarters	No failures	1 MOV failures plus 60hrs UU	2 MOV failures plus 100hrs UU
Measured Element			
Residual Heat Removal Pump FTS	2 failure	1 failures	0 failures
Residual Heat Removal Pump FTR	4 failure	2 failures	0 failures
Motor Operated Valve	2 failures	1 failure	0 failure
UU Residual Heat Removal Pump 2A	986 hours	507 hours	10 hours
UU Residual Heat Removal Pump 2B	986 hours	507 hours	10 hours
MSPI Results	-1.7E-07	3.9E-06	9.9E-07

The RHR indicator evaluation determined that a January 2019 implementation date is needed to have an accurate assessment value.

Recommend the new effective date for Watts Bar U2 RHR indicator MS07 be set at January 1, 2019. The NRC will continue to gray out the affected Watts Bar U2 indicators on NRC web site for the through the fourth quarter of 2018.

If appropriate, provide proposed rewording of guidance for inclusion in next revision:
None

PRA update required to implement this FAQ? No
MSPI Basis Document update required to implement this FAQ? No

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TECHNICAL BASIS FOR THE 3-YEAR MONITORING PERIOD IN THE MITIGATING SYSTEMS PERFORMANCE INDEX

Prepared For

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Revision: 0

Project #: 1DAD06041.000.000
Project Name: Review of WBN U2 MSPI
Report #: 006041-RPT-001

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Review Method	Design Review ☒ Alternate Calculation ☐
Approver:	Jeff R. Gabor 2/10/17

REVISION RECORD SUMMARY

Revision	Revision Summary
0	Initial Issue

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EXECUTIVE SUMMARY

This paper provides the technical basis for the 3-year performance monitoring period in the Mitigating Systems Performance Index (MSPI). Historical documents including NUREG-1753 and NUREG-1816 were reviewed and are discussed below. NUREG-1753 clearly established the 3-year monitoring period for unreliability based on statistical analyses. Those analyses assessed a range of 1 to 5 year periods and recommended the 3-year monitoring period based on the balancing of potential false positives from too short of a monitoring period, and non-responsiveness of the indicator from too long of a period. Furthermore, the appropriateness of the 3-year monitoring period was demonstrated in the 20-reactor pilot program, and subsequent analyses as described in NUREG-1816. Additionally, this paper discusses how both the risk cap and the performance limit in the current MSPI formulation were established based on a 3-year monitoring period. Implementation of a shorter monitoring period such as 12 or 24 months using only unit-specific performance data is inconsistent with the original technical basis for the MSPI and could be problematic.

1.0 REVIEW OF HISTORICAL DOCUMENTS

1.1 NUREG-1753

In NUREG-1753, "Risk-Based Performance Indicators: Results of Phase 1 Development" [1], the technical feasibility of providing improved performance indicators for the Reactor Oversight Process (ROP) was examined by the U.S. Nuclear Regulatory Commission (NRC) staff and its contractors. Indicators related to the initiating events cornerstone, the mitigating systems cornerstone, and the containment portion of the barrier integrity cornerstone were considered. Unreliability indicators were developed at the component/train/system level. As follow-up to NUREG-1753, the NRC and industry identified unreliability and unavailability indicators for six systems to be piloted starting in 2002. The indicators would come to be known as the MSPI.

One to five year monitoring periods were considered in NUREG-1753. On page 3-2, it is noted that "the associated monitoring period must be long enough to reduce the probabilities of false negatives and false positives to acceptable levels, but no longer." Based on statistical analyses as documented in Appendix F, the authors recommended 1 year for the unavailability and 3 years for the unreliability indices as shown in Table F-8. However, this recommendation did not have the benefit of piloting. The unavailability index would have no prior distribution, while the unreliability index was to have the constrained noninformative prior (CNIP). The CNIP is a prior distribution using industry-averaged performance in a Bayesian process. Its technical basis is described in Appendix J of NUREG-1816. For practical data collection and reporting purposes, and since the unavailability index was found to be less sensitive to the monitoring period than unreliability, the MSPI pilot was implemented in 2002 with a 3-year rolling monitoring period for both unreliability and unavailability.

1.2 Overview of the Development of the MSPI

The MSPI evolved following the conceptual development of risk-based performance indicators in NUREG-1753 and after several public workshops and meetings. Reference 2 provided an overview of the MSPI formulation, its characteristics, benefits and limitations, and key issues to be addressed. Table 2 with regard to the treatment of operating experience states: "Three year observation period is used to determine estimate of current performance; chosen duration balances the need for good statistics against need to detect performance changes within a reasonable time." In Section 7.2 on False Assignment Probabilities, the paper cautions that "As long as the MSPIs make use of the statistics of infrequent events occurring within short time windows, substantial false indication probability will remain for high-B (i.e., Birnbaum) elements."

1.3 NUREG-1816

In NUREG-1816 [3], the NRC staff extensively tested and improved the MSPI methodology during the 12-month pilot plant application phase, and evaluated technical issues related to the new indicator's sensitivity to probabilistic risk assessment (PRA) modeling detail. Section 2.2 describes the Unreliability Index (URI) formulation in great detail. Twelve quarters of data and the CNIP are key elements of the URI. In addition, the extensive verification of the MSPI is described in Appendix A of NUREG-1816, while the numerical simulation is discussed in Appendix L. A rolling 3-year data collection period for the MSPI is central to the validity of the verification effort and the numerical simulation.

1.3.1 Formulation of the Risk Cap

NUREG-1816 found some system indicators associated with the MSPI had significant "false positive" issues. That is, for statistical reasons, there was in the early formulation of the MSPI a significant probability that a plant system at baseline performance would cross over the Green/White threshold. As discussed in detail in Appendix D of that report, random failures that occur at a rate consistent with the industry performance are not indicative of a performance issue. That is, one failure over a 3-year performance monitoring period, or one failure above the normal expectation, can be argued not to constitute a significant trend.

To address the concern with "false positives," the concept of a frontstop (or what has come to be known as the risk cap) was introduced. Any such risk cap should:

- Reduce false positives
- Be compatible with, but not ignore, the Unavailability index contribution
- Maintain sensitivity (without adversely impacting false negatives)

Mathematically, the risk cap of $5x10^{-7}$ was placed on the **single** most risk-significant failure within a system in the 3-year monitoring period. This addressed the concern with false positives without adversely impacting false negatives by virtue of the following properties:

- Two significant failures (each with a risk contribution greater than $5x10^{-7}$) would very likely result in a White indication
- One significant failure with other less-significant failures could exceed the Green/White threshold
- One significant failure with a significant UAI contribution could exceed the Green/White threshold

The risk cap of $5x10^{-7}$ was chosen with great deliberation. Given baseline system performance (MSPI ~ 0) just prior to the failure, the risk cap of $5x10^{-7}$ from a single failure combined with incremental unavailability (i.e., UAI) due to corrective maintenance should normally result in an MSPI under the Green/White threshold of $1x10^{-6}$. In effect, the risk cap allowed up to an incremental $5x10^{-7}$ for UAI. As discussed in NUREG-1816 Appendix D, the incremental UAI of $5x10^{-7}$ was itself consistent with Regulatory Guide 1.177 at that time [4]. Moreover, data from the 20-reactor pilot program were used to provide reasonable confidence that most, although not all, outage times from corrective maintenance in combination with the component failure would place the MSPI just below the Green/White threshold.

The 3-year monitoring period is a key element of the risk cap formulation. As discussed above, given a risk cap of $5x10^{-7}$ allows up to an incremental $5x10^{-7}$ for the UAI contribution before $1x10^{-6}$ is reached. The incremental UAI comes about from the product of the Birnbaum for unavailability of the train or segment and incremental unavailability from the corrective (unplanned) maintenance. The unplanned unavailability is the unplanned maintenance hours divided by the critical hours of the 3-year monitoring period.

Incremental UAI = B_i * [incremental unplanned maintenance/critical hrs in 12 qtrs.]

What if a monitoring period other than 3 years was used, for example, 1 year? The incremental train or segment unplanned unavailability would be about 3 times higher because of 3 times fewer critical hours in the 1-year period compared to a 3-year period, and the incremental UAI would also be about 3 times higher. In effect, substantial margin to the Green/White threshold would be lost, negating the full benefit of the risk cap as currently formulated, and increasing the probability of false positives.

In effect, a monitoring period other than 3-years is inconsistent with the basic formulation of the risk cap.

1.3.2 Formulation of the Performance Limit

If the risk cap was formulated to address *false positives* in the MSPI, the *backstop* (or what has come to be called the *component performance limit*) was instituted to address, to some degree, *false negatives*. The concern was that during the MSPI pilot, large numbers of component failures were observed to be needed for some components in some systems in certain pilot plants before the MSPI turned White at $1x10^{-6}$.

Conceptually, the performance limit is a limit on the total number of failures, of all failure modes and of all components of one type in one system of a single nuclear power plant unit. If the number of failures seen in the 3-year performance period exceeds the performance limit, the system MSPI is denoted as White. The criterion is based on statistical significance of the observed number of failures, relative to prior expectations.

As described in Appendix E of NUREG-1816, the performance limit was chosen to be the smallest number indicative of degraded performance such that:

- The probability of false positive ≤ 0.01
- The fraction of positives that are false ≤ 5%.

Thus, the performance limit is defined to ensure that false positives are very rare, and if a positive occurs, it is most likely a true positive.

The performance limit given in Section F.4 of NEI 99-02 [5] is derived from a linear regression as shown in Figure E.3 of NUREG-1816 and is reproduced below as Figure 1-1.

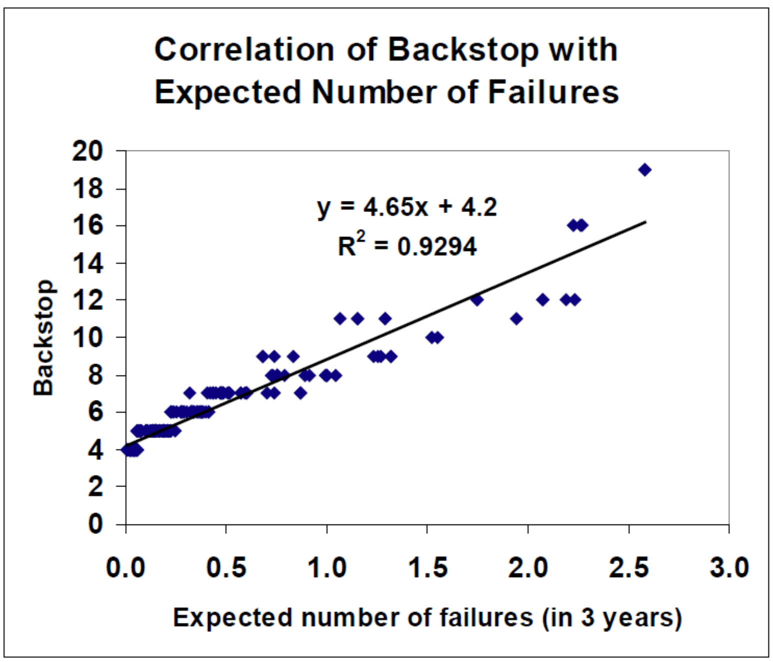

Figure 1-1 - Variable Backstop

The correlation in Figure 1-1 shows the backstop, or number of allowable component failures of a given component type within a system, as a function of the expected number of failures. The expected number of failures, in turn, depends on the number of demands (and run hours if applicable) as well as industry-averaged component failure rates. The component performance limit clearly relied on 3 years' worth of performance data from the pilot plants.

What if a monitoring period other than 3 years was used, for example, 1 year? The correlation per Figure 1-1 would remain valid since the expected number of failures would clearly lie within the domain of the graph given about one-third of the demand data (demands and run-hours). However, for some components within a system, the licensee could be disadvantaged. With only about one-third of the demands and run-hours, the expected number of failures (based on industry–averaged failure rates) is about one-third the value for a 3-year monitoring period. Thus, the backstop or performance limit would be somewhat less for a 1-year monitoring period, all other things being equal.

By way of a simplified example, presume that the expected number of failures for a component type in a given system is 1.5 for a 3-year monitoring period based on actual demand and test data. This might be typical for a case with four emergency diesel generators (EDGs), for example. The component performance limit would be exceeded at 12 failures according to the correlation. If the monitoring period were just 1 year, there would be about 3 times fewer demands, with the expected number of failures equaling about 0.5, all other things being equal. The component performance limit would then be exceeded at 7 failures. In practice, this difference may or may not be significant depending on the risk worths of the EDGs, unplanned maintenance hours, and remaining margin to White. This author is not aware of any instance where exceedance of the performance limit caused a system indicator to turn White. Nevertheless, the linear regression assumed 3 years of performance data in deriving the statistical correlation, not 1 or 2 years.

2.0 ISSUES WITH OTHER THAN 3-YEAR MONITORING PERIOD

A monitoring period other than 3 years would be inconsistent with the basic formulation of the MSPI. While it would be theoretically possible to use a shorter monitoring period, the MSPI values would be volatile and subject to large fluctuations as component failures and uncharacteristic high train/segment unavailabilities roll in and out of the monitored period. For a newly commissioned plant, volatility could be expected for the first few years of monitoring. Whether the MSPI gave “reasonable” results based on indicated values for each system and margins to White would be based mostly on fortune rather than the deliberately crafted and statistically tested MSPI formulation. One need only look at the one indicator for Fort Calhoun when it returned to service after an extended outage to realize that a volatile indicator is not in any of the stakeholders’ best interest (see Figure 2-1). The volatility in the Emergency AC Power indicator arose because the denominators in the UAI and URI formulations were not sufficiently large to buffer small deviations in diesel generator maintenance, and a failure.

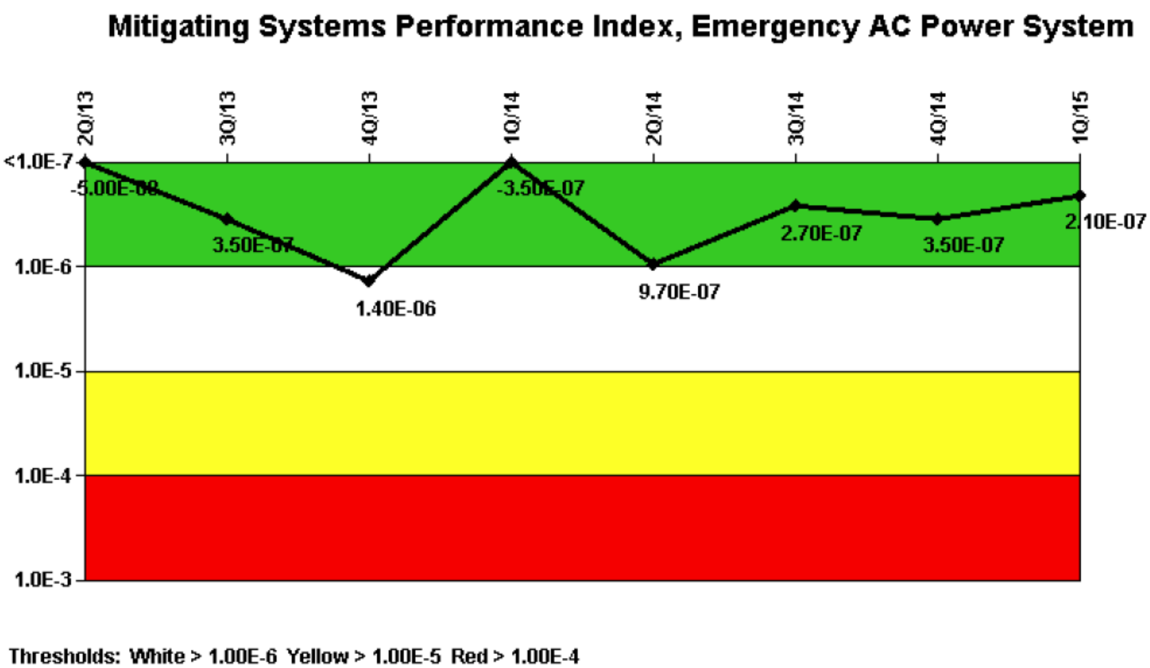

Figure 2-1 - 1Q/2015 Performance Indicators - Fort Calhoun

3.0 CONCLUSIONS

The key features of the MSPI are that it:

- Is Risk-informed and performance-based.
- Allows trade-offs between Unreliability and Unavailability to optimize system performance.
- Has no penalty for on-line preventive maintenance hours up to the pre-planned baseline.
- Reflects plant-specific design and operation.
- Has features to address false positives and false negatives.
- Uses 3 years of performance data to provide stability against large fluctuations in the indicators.

Historical documents such as NUREG-1753 and NUREG-1816 founded the MSPI based on a 3-year monitoring period. The 3 year observation period was found to balance the need for good statistics against the need to detect performance changes within a reasonable time. The verification of the MSPI and numerical simulation that led to confidence in the robustness of the MSPI were both based on a 3-year monitoring period. Both the risk cap and the performance limit are formulated on a 3-year rolling indicator.

Any option that phases in the MSPI at a newly operating plant before 3 years of plant-specific performance data have been obtained compromises the original basis of the MSPI. Whether these options give “reasonable” results based on indicated values for each system and margins to White would be based mostly on fortune rather than the deliberately crafted and statistically tested MSPI formulation. The Emergency AC Power MSPI for Fort Calhoun after an extended outage is not a good precedent.

4.0 REFERENCES

1. NUREG-1753, “Risk-Based Performance Indicators: Results of Phase 1 Development,” U.S. Nuclear Regulatory Commission, April 2002.
2. U.S. Nuclear Regulatory Commission, Interoffice Memorandum from Scott F. Newberry (RES/DRAA) to John A. Zwolinksi (NRR), “Request for Review of Mitigating Systems Performance Indices White Paper,” May 12, 2003. (Adams Accession No. ML031350208 and ML031360121).
3. NUREG-1816, “Independent Verification of the Mitigating Systems Performance Index (MSPI) Results for the Pilot Plants, Final Report,” U.S. Nuclear Regulatory Commission, February 2005.
4. Regulatory Guide 1.177, “An Approach for Plant-Specific, Risk Informed Decisionmaking: Technical Specifications,” U.S. Nuclear Regulatory Commission, August 1998.
5. NEI 99-02, “Regulatory Assessment Performance Indicator Guideline,” Revision 7, Nuclear Energy Institute, August 31, 2013.