Comments on NRC White Paper
Mitigating Systems Performance Indicators for New Reactor

High Level Comments

The “tabletop” exercises in the NRC Staff white paper using AP1000 PRA data provide useful insights into the feasibility and effectiveness of establishing performance indicators (PIs) for selected systems. The observation in the NRC white paper that “No RTNSS functions were found to have a high enough risk significance to result in sensitive indicators” is consistent with the Industry’s white paper on the matter. Agreement also can be found with the NRC Staff proposal “to maintain the MSPI risk thresholds consistent with the NRC Commissioners’ direction and proposes to maintain the at-power focus of the current MSPI framework.”

However, virtually all of options that the NRC Staff has proposed amount to the monitoring of the *reliability of selected active valves across passive safety-related systems* of the AP1000. This is hardly the original MSPI framework which assesses, within clearly defined system boundaries, both the unreliability of multiple component types and the unavailability of system trains which implicitly includes passive components (e.g., piping and heat exchanger unavailability). Section 2.3 of NUREG-1816 highlights that one of the benefits of the MSPI is that, in theory, it should optimize the balance between unreliability and unavailability “when the proper amount of preventive maintenance (PM) is applied. (Too little PM causes the unreliability term to become unacceptably high, while too much PM drives the unreliability term to near-zero but at the expense of too much downtime.)” The NRC Staff proposed options address only one aspect of system performance, reliability, and only for selected active valves and a few other components.

Section 2.3 of the industry white paper identifies five key attributes of what makes a good risk-informed performance indicator:

1. There is a strong nexus with reactor safety and public safety
2. The performance is measurable
3. There are sufficient data so that the indicator is robust: small changes in input data do not cause large gyrations (or volatility) in indicator response
4. The PI should not result in unintended consequences
5. The PI is not overly burdensome

Most of these attributes appear to be met as outlined in the NRC Staff options. However, the relative burden of, first, establishing the infrastructure of a customized MSPI framework for what is at present four AP1000 reactor units; and, secondly, maintaining the PRA and reliability data in a basis document, is not insignificant. Since, in theory, the four AP1000 units are to be operated and maintained in a very similar manner, a key attribute of the MSPI -- that it establishes plant-specific thresholds acknowledging the large dissimilarities in design and operation of nuclear power plants, is moot. In essence, there is less need for variable performance thresholds between reactor units, and even over time for a single unit. *If* some form of PI is to be implemented, more consideration should be given to fixed thresholds, in this author’s opinion, consistent with unplanned reactor scrams and safety system functional failures in the current ROP.

Specific Comments

1) Executive Summary:
    a. Concur with the statement "direct application of the active and mechanical-equipment-focused MSPI framework to the AP1000 design is not practical without changes to its scope and formulation."

    b. Concur with the statement "This paper proposes to maintain the current MSPI risk thresholds for the AP1000 monitored systems consistent with the NRC Commissioners' direction. It also recognizes that the current statistically-based performance limits may be more valuable due to the expected increase in risk margin associated with the AP1000…"

    c. "The test indicators were developed to address a single component type with no system boundary limitations." This is contrary to the basic MSPI formulation of measuring total system performance in different systems. In essence, the MSPI would degenerate to being a *risk-informed measure of the reliability of selected active valves across passive safety-related systems.*

2) Section 5:
    a. Section 5.3 Backstop Options: Concur that "If a reduction in the three-year or six-month performance indicator is desired in order to enhance its ability to detect degraded performance, then additional analysis will be required to determine the change in false positives that could result." It is observed that if backstops were the only performance indicators, these options essentially become fixed-threshold type indicators like unplanned scrams per 7000 critical hours.

    b. Section 5.3: Few plants have crossed an MSPI threshold due to reaching the PLE backstop. Even if we adjusted (lowered) PLE criteria, active valve failures in the passive safety systems are going to get a tremendous amount of attention; maintaining the elements of an MSPI would not add any additional value for the safety systems.

3) Section 6:
    a. Concur with the statement "risk-significant systems that support functions other than those mitigating at-power internal events are excluded in this paper from consideration as MSPI-monitored functions."

    b. Section 6.2: Concur with the statement "The inclusion of the ancillary generators is not recommended by this paper as they provide no contribution to reducing the calculated core damage frequency."

    c. Editorial comment: Table 6.3-1, In-Containment Refueling Water Storage Tank, and Containment Recirculation Sump Valves lines have a typo in the Failed Position column. Both first lines say "As is As" and the second line "is", instead of both lines being "As is".

4) Section 10: Although this section covers emergency AC power for legacy plants, why is vital DC (IDS) not considered for the AP1000, since it is the Emergency power source? On-site stand-by and ancillary diesels only address RTNSS.

5) Section 11:
    a. Do <u>not</u> agree that Automatic Depressurization System (ADS), In-containment Refueling Water Tank, and Accumulators are analogous to the High Pressure Injection function as formulated in the current MSPI defined functions. By this logic, BWR ADS and low pressure injection are commensurate with high pressure injection in the current MSPI formulation.

    b. Why weren't the high pressure injection functions of the Make-up pumps considered as part of High Pressure injection, even though they are non-safety related? Could they be considered RTNSS in this function?

6) Section 12:
    a. Why is the Passive Containment Cooling system (PCS) not included? It is the ultimate heat sink (Cooling water?) for long term decay heat removal and is an integral portion of long term PRHR or PXS cooling.

    b. Section 12.1: Concur with the statement "The inclusion of the startup feedwater system is not recommended as the pumps provide no contribution to reducing the calculated core damage frequency."

7) Section 16
    a. Section 16.2: This section states that MOVs will be tested on a Quarterly frequency. However, the current version of the OM Code being proposed for use by the NRC in 10CFR50.55a, is the 2012 edition. This version or subsequent versions will likely be in use for the AP1000 fleet. The 2012 Edition and later, include Appendix III for MOV testing, which limits testing to once every outage (2 years). This would reduce the number of demands of the 12 ADS valves to 12 or 24 depending on the outage scheduling in the 3 year period, as opposed to the 144 calculated in the White Paper.

    b. Section 16.2: Editorial comment: Third paragraph, "A Category A valves" should be "Category A valves".

    c. Section 16.3: The table which lists the IST expectations for the AP1000, lists the PRHR outlet valves as Cold Shutdown test frequency, which would reduce the number of expected demands (for these valves to 2 or 4 per 3 year period depending on outage scheduling, as opposed to 24 assumed in the White paper) from 96 to 74 or 76.

8) Section 17: Concur with the statement "Systems that are identified as being RTNSS for modes other than Mode 1, 2 or 3 are excluded from consideration in order to be consistent with the current internal events, at-power focus of the MSPI program."

9) Section 18: White paper should clarify whether or not these are the basic event importance measures for full-power internal events (non-flood) consistent with the current MSPI formulation.

10) Section 19:
    a. Section 19.1: The containment temperature detectors that provide the DAS input redundant to Containment pressure in PMS. Why are these looked at without considering that they are a backup to the containment pressure sensors? Also, it does not appear to take into consideration that it takes both sensors to actuate DAS containment isolation and PCS actuation.

b. Section 19.1: Generally concur with the narrowing of candidate components for monitoring to those listed.

11) Section 12.2: Generally do not concur with the functionally based MSPI scope [OPTION SCOPE-2]. A lesson learned from the current MSPI formulation is that low risk importance systems add unnecessary burden while providing no risk monitoring benefit. Likewise, it has already been established in the NRC Staff white paper that non-safety-related systems [OPTION NSR-1] provide no risk monitoring benefit, and this latter option also should not be implemented.

12) Section 20:

a. Section 20.2, Squib Valve MLE Indicator: Given the importance of these valves, and the large uncertainties in their failure rate, it seems inconceivable that seven failures would occur before NRC inspectors/senior reactor analysts would question the fundamental valve reliability. Moreover, the significance of the inspection finding, or SDP, would have been performed well before the seven failures, much like BWR safety relief valves (SRVs) failures are currently inspected and their significance determined. Given this, squib valves are better addressed under the NRC inspection process and not monitored as a PI.

b. Section 20.3: Similar arguments to those on Section 20.2 hold for ADS MOVs. They are best addressed under inspection.

c. Section 20.4: Agree that passive AOV indicator would be an ineffective performance index. Likewise for Section 20.5, SOV MLE indicator.

d. Section 20.6: Steam Generator Safety Valve MLE Indicator deserves closer review. It is important to understand the success criterion for this function and how the uncontrolled steam generator depressurization contributes to a core damage scenario. Moreover, failure mode interpretation issues will inevitably arise in the MSPI (how much of a depressurization is too much and are short-duration failures of the safety valves to reclose functional failures?). Since these valve failure modes would rarely be tested, are they deserving of their own indication and wouldn’t the valves be better treated under inspection?

e. Section 20.7: Containment Temperature Element Indicator deserves close consideration. Note that the table is incorrectly labeled “Steam Generator Safety Valve MLE Indicator.” Again, if one is considering only these two components are they deserving of their own indication or better treated under inspection?

f. Section 20.9: Concur with the statement “As an indicator for the standby diesel generators was found to be risk insensitive, it is therefore postulated that the identified other RTNSS systems will also be insensitive.”

13) Section 22:

a. Section 22.3: Concur that “the use of the risk-informed approach does not require the inclusion of non-safety-related systems.”

b. Section 22.4: Concur with the statement "Based on the test indicators, all test indicators proved to be insensitive when the current CNIP approach to processing unreliability data was used. However, several indicators appear to behave reasonably in that they do not appear to be overly sensitive when MLE was employed. A more comprehensive assessment of this method should be performed prior to implementation."

14) Section 23.2: Deviation from Exclusion of Low-Risk Valves: Do <u>not</u> concur with the position of not excluding low Birnbaum valves. The NRC Staff white paper provides no technical basis for its position. Section 5.5 together with Appendix G of NUREG-1816 provides the original basis for the exclusion of low Birnbaum importance valves. Based on all of the valves monitored by the 20 pilot plants, it is possible to exclude low importance valves without affecting the overall results of the MSPI using the $1x10^{-6}$ /yr Birnbaum cutoff. This fundamental argument should not change with the AP1000 reactor design, given the same White, Yellow, and Red numerical thresholds.

<u>Overall Conclusions and Recommendations</u>

The NRC Staff white paper has provided useful insights into the feasibility and effectiveness of establishing PIs for the AP1000 reactors. However, the fundamental arguments in Industry's white paper have not changed: An MSPI-type performance indicator is found to be inappropriate for all systems included under RTNSS. Moreover, there are only a handful of high importance valves (only eleven valves including steam generator code safeties) that meet the traditional $1x10^{-6}$ /yr Birnbaum cutoff per NUREG-1816 and NEI 99-02 guidance, plus two containment temperature elements. To create an entire PI infrastructure akin to the MSPI for the current reactor fleet for this handful of components appears to be overly burdensome. In essence, the MSPI would degenerate to being *a risk-informed measure of the reliability of selected active valves across passive safety-related systems.* Reliance on the NRC inspection process for these dozen or so components seems to be the preferred approach.