TECHNICAL BASIS DOCUMENT

MAINTENANCE RISK ASSESSMENT AND RISK MANAGEMENT
SIGNIFICANCE DETERMINATION PROCESS

I. INTRODUCTION

This document provides the basis for IMC 609, Appendix K for the assessment of licensee performance deficiencies related to licensee assessment and management of the risk associated with performing maintenance activities. Oversight of licensee performance in assessing and managing the risk of plant maintenance activities is conducted principally by baseline inspection procedure (IP) 71111.13, "Maintenance Risk Assessment and Emergent Work Control," or supplemental inspection IP 62709, "Configuration Risk Assessment and Risk Management Process."

II BASIS

The NRC requirements in this area are set forth in paragraph (a)(4) of 10 CFR 50.65, "Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," effective November 28, 2000.

The intent of paragraph (a)(4) is to have licensees appropriately assess the risks of proposed maintenance activities that will (1) directly, or may inadvertently, result in equipment being taken out of service, (2) involve temporary alterations or modifications that could impact structure, system, or component (SSC) operation or performance, (3) be affected by other maintenance activities, plant conditions, or evolutions, and/or (4) be affected by external events, internal flooding, or containment integrity. Paragraph (a)(4) requires management of the resultant risk using insights from the assessment. Therefore, licensee risk assessments should properly determine the risk impact of planned maintenance configurations to allow effective implementation of RMAs to limit any potential risk increase when maintenance activities are actually being performed. Although the level of complexity in an assessment would be expected to differ from plant to plant, as well as from configuration to configuration within a given plant, it is expected that licensee risk assessments would provide insights for identifying risk-significant activities and minimizing their durations.

II BACKGROUND

During the initial implementation phase of the reactor oversight process (ROP), a task group was formed to review the adequacy of the reactor safety SDP to assess the significance of maintenance rule (MR) related inspection findings. The task group, consisted of staffs from NRR and the regions, recommended that the existing reactor SDP did not address issues related to risk assessment and risk management associated with performance of maintenance activities and a new SDP be developed to assess the risk significance of these findings. This recommendation was based on the following reasons: (1) existing SDP phase 1 worksheet may inappropriately screen risk-significant plant

maintenance configurations to “green,” (2) phase 2 site-specific inspection notebooks lack the necessary level of detail and completeness to assess maintenance configurations with multiple equipment out-of-service, and (3) licensees are already using phase 3 type analyses (and tools) to assess the at-power risks of maintenance configurations. The task group developed a draft SDP to evaluate the significance of MR (a)(4) issues, such as (1) failure to perform an adequate risk assessment, and (2) failure to manage risk. The proposed SDP concept was first discussed with industry groups in a public workshop held on March 2001and further SDP refinements were discussed during routine ROP public meetings to obtain industry feedback. The subject SDP incorporated internal and external feedback and recommendations. The appendix K is to be used as a Phase 2 Significance Determination Process (SDP) tool for assessing the significance of inspection findings related to compliance with Maintenance Rule (a)(4) requirements.

III. METRICS USED

The incremental core damage probability deficit (ICDPD) and the incremental large early release probability deficit (ILERPD) are the metrics used to evaluate the magnitude of the error in the licensee’s inadequate risk assessment of the temporary risk increases due to maintenance activities/configurations. Note that this SDP uses Incremental Core Damage Probability (ICDP) metric rather than ªCDF (annualized risk increase) used in other reactor SDPs. The incremental plant risk (ICDP) is a function of the amount of the time in which the plant configuration change exists (time dependent). Thus the risk increase of a configuration can be best represented in terms of probability metric.

IV DEFINITIONS USED

The following are definitions of terms used throughout this SDP .

Incremental Core Damage Frequency (ICDF). The ICDF is the difference between the actual (adequately/accurately assessed) maintenance risk (configuration-specific CDF) and the zero-maintenance CDF. The configuration-specific CDF or ICDF is the annualized risk estimate with the out-of-service or otherwise affected SSCs considered unavailable. The term, “Incremental Core Damage Frequency” is also equivalently referred to as delta CDF, or change in CDF.

Incremental Core Damage Probability (ICDP). The ICDP is the product of the incremental CDF and the annual fraction of the duration of the configuration [i.e., ICDP = ICDF x (duration in hours)÷(8760 hours per reactor year)]. Note that the ICDP is sometimes expressed as the integrated or integral ICDP (i.e., the delta CDF or ICDF integrated over the time of its duration which increases as the elevated-risk configuration persists). Figure 1 is a graphical representation of this concept.

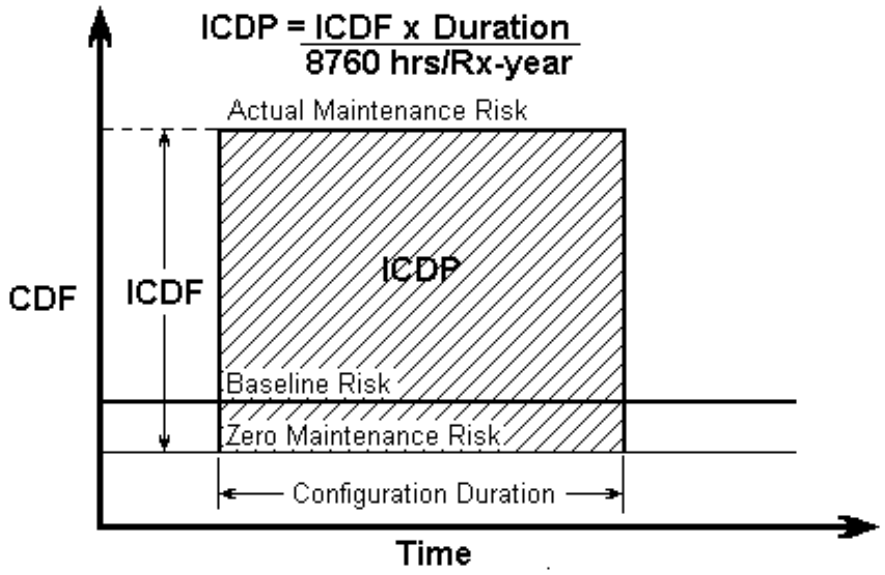

Figure 1 - Relationship of ICDF to ICDP

Incremental Core Damage Frequency Deficit (ICDFD). The ICDFD is that portion of the ICDF defined as the difference between the actual maintenance-configuration-specific CDF (called $ICDF_{actual}$ for purposes of this definition) and the maintenance-related ICDF as originally and inadequately assessed (flawed) by the licensee ($ICDF_{flawed}$). Therefore, the $ICDFD=ICDF_{actual} - ICDF_{flawed}$. Note that if the licensee has failed to assess maintenance risk entirely when required (i.e., there is no licensee risk assessment), then the ICDFD will be equal to the entire value of the ICDF. The safety significance of the ICDFD (i.e., the magnitude of the licensee's underestimate (or lack of estimate) of the risk) is determined by means of this SDP.

Incremental Core Damage Probability Deficit (ICDPD). The ICDPD is the product of the ICDFD and the Exposure (i.e., the annual fraction of the duration of the unassessed or inadequately assessed configuration, or that portion of the annual fraction of the duration of the maintenance configuration during which its risk remained unassessed or inadequately assessed). Thus the ICDPD = ICDFD x (exposure in hours) ÷ (8760 hours per reactor-year). Note that similar to the ICDFD, the ICDPD equals the ICDP when there is no risk assessment, rather than a flawed risk assessment. Note also that Exposure equals Duration if the risk remained unassessed or inadequately assessed for the entire duration of the configuration. The safety significance of the ICDPD (i.e., the magnitude of the licensee's underestimate (or lack of estimate) of the risk (in terms of ICDP)), may also be determined by means of this SDP. Figure 2 is a graphical representation of this concept.

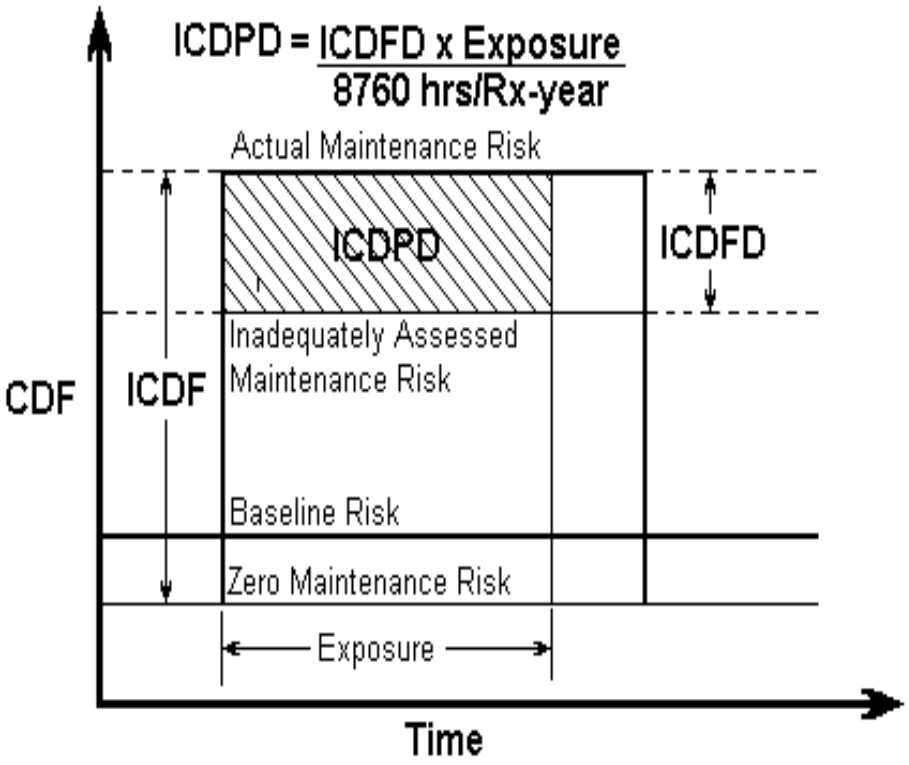

Figure 2 - Relationship of ICDFD to ICDPD

Incremental Large Early Release Frequency (ILERF). The ILERF is the difference between the actual, adequately determined maintenance activity/configuration-specific LERF and the zero maintenance LERF, if determinable. Note that LERF and ILERF are determinable only if the plant has a Level-II probabilistic risk analysis/probabilistic safety assessment (PRA/PSA) and a risk tool or process capable of quantitatively assessing Level-II risk beyond a qualitative assessment of the impact of containment integrity. If calculated, the ILERF may also be referred to as the delta LERF or LERF difference.

Incremental Large Early Release Frequency Deficit (ILERFD). The ILERFD is used to evaluate the significance of a finding under the following conditions (1) an impact on containment integrity from or concurrent with the maintenance activity occurs, (2) this impact is/was not qualitatively assessed, and (3) the impact is/was quantitatively assessed, but not adequately. Then the ILERFD is meaningful and is that portion of the ILERF defined as the difference between the actual maintenance-configuration-specific LERF (called $ILERF_{actual}$ for purposes of this definition) and the maintenance-related ILERF as originally and inadequately assessed by the licensee ($ILERF_{flawed}$). Therefore, the $ILERFD=ILERF_{actual} - ILERF_{flawed}$. Note that if the licensee has failed to assess maintenance risk entirely when required (i.e., there is no licensee risk assessment) and there is an impact on containment integrity from or concurrent with the maintenance activity, this impact can be neither qualitatively nor quantitatively assessed. Therefore, the

ILERFD will be equal to the entire value of the ILERF. The safety significance of the licensee's underestimate (or lack of estimate) of the Level-II risk (i.e., ILERFD) may also be determined by means of this SDP, if appropriate.

Incremental Large Early Release Probability (ILERP). The ILERP is the product of the incremental large early release frequency (ILERF) and the annual fraction of the duration of the configuration. The ILERP=(ILERF x duration in hours)÷(8760 hours per reactor-year).

Incremental Large Early Release Probability Deficit (ILERPD). The ILERPD is the product of the ILERFD with the annual fraction of the duration of the unassessed or inadequately assessed configuration, or that portion of the annual fraction of the duration of the maintenance configuration during which its risk (in terms of ILERF or ILERP) remained unassessed or inadequately assessed.

NOTE: Although an adequate maintenance risk assessment is expected to include the impact of containment integrity, at least qualitatively, there is no regulatory requirement for a quantitative risk assessment using a Level-II PRA. Paragraph (a)(4) of 10 CFR 50.65 neither prohibits nor explicitly discourages incurring maintenance risk. It only requires that the risk of maintenance activities be assessed (which can be done qualitatively, quantitatively, or, as is often the case, in a blended fashion) and managed.

Loss of Function. This is the condition in which an SSC becomes incapable of performing its intended purpose. This can mean a complete functional failure or impaired or degraded performance or condition such that the affected SSC is incapable of meeting its functional success criteria. Functional success criteria include having the required trains, adequate speed, flow, pressure, load, startup time, mission time, etc. These are defined or assumed in the design and/or licensing bases (i.e., updated final safety evaluation report, license conditions, or technical specifications and/or their bases). For the purposes of determining risk/safety significance, the functional success criteria of particular interest would be those assumed in the plant's PRA and/or the licensee's risk assessment tool.

In some cases SSCs out of service for testing are considered unavailable, unless the test configuration is automatically overridden by a valid starting signal, or the function can be promptly restored either by an operator in the control room or by a dedicated operator stationed locally for that purpose. Restoration actions must be contained in a written procedure, must be uncomplicated (a single action or a few simple actions), and must not require diagnosis or repair. Credit for a dedicated local operator can be taken only if (s)he is positioned at the proper location throughout the duration of the test for the purpose of restoration of the train should a valid demand occur. The intent of this paragraph is to allow licensees to take credit for restoration actions that are virtually certain to be successful (i.e., probability nearly equal to 1) during accident conditions.

If the restoration actions are virtually certain to be successful due to emergent conditions, the risk assessment may consider the time necessary for restoration of the SSC's function, with respect to the time at which performance of the function would be needed.

Zero-Maintenance CDF(Risk). The CDF estimate of plant baseline configuration where all SSCs modeled in PRA are considered available.

Baseline CDF(Risk). The CDF estimate derived from a PRA model that considers average annual maintenance (preventive and corrective maintenance) unavailability data, and plant specific reliability data (failure rates).

Note that inadequate risk assessment or risk management for work not yet started is not an (a)(4) violation, but it still represents a licensee performance deficiency and may be indicative of deficiencies in previous risk assessments, RMAs and/or in the licensee's (a)(4) program. This SDP is not suited for determining the significance of this type of performance deficiency. This issue will be screened to Green in accordance with Reactor SDP Phase 1 screening.

V. SDP METHODOLOGY

Once an inspection finding satisfies the Inspection Manual Chapter (IMC) 0612 minimum threshold process, the finding can then be evaluated using the following Table (Table 1) or SDP flowcharts in IMC 0609, Appendix K. The input to the maintenance rule (a)(4) Significance Determination Process (SDP) is an inspection finding that has some significance due to the licensee's underestimate of plant risk or lack of risk assessment from ongoing or completed maintenance activities and/or the licensee's ineffective implementation of risk management actions (RMAs).

The SDP methodology described below does not directly apply to those licensees who perform qualitative analyses of plant configuration risk due to maintenance activities. When performance deficiencies are identified with qualitative assessments, the inspector should determine significance of the deficiency by an internal NRC management review using risk insights where possible. Use of risk insights may include an independent NRC quantitative risk assessment (e.g., use of plant specific Standardized Plant Analysis Risk model). It is expected that most licensees will perform quantitative assessments for at-power conditions but not necessarily for plant shutdown conditions. In addition, quantitative risk assessments for the large early release frequency (LERF) and external events (e.g., fire, seismic) risk effects are not normally performed due to the lack of probabilistic risk tools for these effects. For these risk effects, a qualitative assessment is more common and the approach described above should also be used to determine significance. Therefore, this guidance does not apply to the following situations: (1) those licensees who only perform qualitative analyses of plant configuration risk due to maintenance activities, or (2) performance deficiencies related to maintenance activities affecting SSCs needed for fire or seismic mitigation. When performance deficiencies are identified with either 1 or 2 above, the significance of the deficiencies must be determined by an internal NRC management review using risk insights where possible in accordance with IMC 612, “Power Reactor Inspection Reports.”

Underestimating or not estimating the risk of maintenance activities may not significantly increase the expected overall plant risk, in terms of core damage frequency (CDF) or LERF. However, underestimating the risk may result in lack of risk awareness that could

preclude RMAs and allow a high-risk configuration to persist unrecognized and uncompensated. Allowing a high-risk configuration with an unassessed CDF increase to persist longer than necessary, or desirable, may increase the exposure time and hence the incremental (integrated) core damage probability (ICDP) and/or the incremental large early release probability (ILERP). Finally, unawareness of unassessed or inadequately assessed risk may allow actions or events to occur that could directly increase risk or hamper recovery from accidents or transients.

Licensees who have adopted RMA color thresholds that are not ICDP or ILERP based, may need to have performance converted to correspond to a probability unit of measure.

When the inspector has identified that the licensee has performed an inadequate risk assessment (or none at all), the actual maintenance risk (configuration-specific core damage frequency [CDF]) must first be adequately or accurately assessed. The inspector should discuss the results of the risk assessment with the licensee before proceeding with any further risk assessment. The new risk assessment value may be obtained in several ways including having the licensee perform the omitted maintenance risk assessment; or re-perform it, correcting those errors and/or omissions that rendered its original risk assessment inadequate. Alternatively, the inspector may request the regional senior reactor analyst(s) or the headquarters risk analyst(s) to independently evaluate the risk using the plant-specific SPAR model or other tools. For this, the inspector needs to provide information as shown in the SDP. For findings that have significance preliminarily determined to be White, Yellow or Red, an SRA may perform a Phase 3 analysis, if necessary.

The original flawed risk assessment value is subtracted from the actual/correct ICDF to obtain the risk deficit or ICDFD. The ICDFD is converted into ICDPD. Note that ICDPD is equal to ICDP when there was no risk assessment performed by the licensee. If ICDP is significantly greater than 1E-6 (i.e., one order of magnitude or greater), the net risk impact must be assessed by subtracting 1E-6 from the risk deficit (ICDPD) as determined above, prior to determining an SDP color. This is because licensees are not normally expected to take RMAs for ICDP,1E-6. Therefore, the net risk deficit that should be considered for quantitative significance determination should be that portion of the ICDPD that is in excess of 1E-6. The safety significance of the licensee's underestimate (or lack of estimate) of the risk is then determined by entering Table 1 or flowchart 1(IMC 0609, Appendix K) with the value of ICDPD as determined above and finding the matching color. The color of the ILERPD, if applicable, is determined in a similar fashion.

In general, the following two types of licensee performance deficiencies in meeting (a)(4) requirements can be defined.

a. Failure to Perform an Adequate Risk Assessment. The failure to perform an adequate risk assessment in accordance with 10 CFR 50.65 (a)(4) prior to the conduct of maintenance activities includes the following deficiencies which result in underestimating the risk.

    1. failure to perform a risk assessment for maintenance configuration changes.

2. failure to update a risk assessment for changes in the assessed plant conditions (e.g., changes in maintenance activities or emergent conditions). However, performance or re-evaluation of the assessment should not interfere with, or delay, the operator and/or maintenance crew from taking timely actions to restore the equipment to service or take compensatory actions. If the plant configuration is restored prior to conducting or re-evaluating the assessment, the assessment need not be conducted, or re-evaluated if already performed.

3. failure to perform a complete risk assessment including all affected/involved SSCs within the scope of SSCs required for (a)(4) assessments, and considering (or adequately considering) all plant-relevant plant conditions or evolutions, external events, internal flooding, and/or containment integrity

4. failure to consider maintenance activities which have historically had a high likelihood of introducing a transient leading to an initiating event that would result in risk-significant configurations

5. Improper use of the risk assessment tool or process (i.e., beyond its capabilities or limitations, or under plant conditions for which it was neither designed nor in accordance with site procedures)

6. deficient risk-informed evaluation process for limiting the scope of SSCs to be included in (a)(4) risk assessments as identified by NRC inspection in accordance with IP 62709

7. flawed risk assessment tool or process as identified by NRC inspection in accordance with IP 62709

b. Failure to Manage Risk. Failure to manage the risk impacts of proposed maintenance activities means a failure to implement, in whole or in part, the key elements of the licensee's risk management program. However, this deficiency will not result in an additional risk increase to the assessed risk of the maintenance configuration in terms of CDF or LERF, unless an event actually occurs that results in additional risk impacts. Measures to minimize the duration of the risk associated with a maintenance activity/configuration are a principal RMA. Nevertheless, failure to implement such measures when they are possible and practicable will allow the ICDP and/or the ILERP to increase further as the elevated risk condition persists. Appropriate and suitable RMAs can only reduce the risk incurred from a given configuration change.

RMAs should be implemented in a graduated manner, commensurate with various increases above the plant's baseline risk, to control the overall risk impact of an assessed maintenance configuration. However, licensees use a variety of methods for categorizing risk significance and managing the risk according to the category. In Regulatory Guide 1.182, the NRC endorsed the RMA levels or categories/bands prescribed in the revised Section 11 of NUMARC 93-01, Revision 2, and subsequently incorporated in Revision 3 of NUMARC 93-01. These risk bands are

defined in terms of the ICDP, making them readily comparable to the risk levels used in determining the significance of the risk deficits. For licensees that have adopted this guidance, normal work controls are allowed by site procedures for ICDPs less than 1 E-6. For ICDPs of 1E-6 or greater, RMAs are prescribed. Section 11 of NUMARC 93-01 states that maintenance risk configurations above ICDP value of 1E-5 should not be entered voluntarily. Site procedures will typically prohibit this activity entirely or will allow it only with fairly rigorous restrictions that typically include the plant manager's written permission along with extensive RMAs. Site procedures may further define specific detailed RMAs or plans for routinely allowable risk categories as well. It should be noted that when evaluating the adequacy of a licensee's RMAs, the inspector should consider only those actions that could have potential risk implications and required by the licensee's procedures, such as working around the clock, installing backup equipment, and reducing duration of maintenance activity for effective implementation of RMAs.

Table 1
SDP Matrix for Quantitative Risk Assessment

Risk Results		SDP Colors for Licensee Performance Deficiency
Incremental Core Damage Probability Deficit (ICDPD)	Incremental Large Early Release Probability Deficit (ILERPD)	Failure to Perform an Adequate Risk Assessment (without any mitigation for risk management)
< 1E-6	< 1E-7	GREEN
>1E-6 ~ <1E-5	>1E-7 ~ <1E-6	WHITE
>1E-5 ~ <1E-4	>1E-6 ~ <1E-5	YELLOW
> 1E-4	> 1E-5	RED

VI. RISK MANAGEMENT ACTIONS

In accordance with licensee procedures, RMAs should be implemented in a graduated manner, commensurate with various increases above the plant's zero maintenance risk. However, the risk reduction benefits of these actions are generally not quantifiable. These actions are aimed at increasing the risk awareness of key plant personnel, providing more rigorous planning and control of maintenance activities, and controlling the duration and magnitude of the increased risk. RMAs should be considered in the development of work schedules in accordance with the licensee's program and procedures. RMAs can include (but are not limited to) the following:

1. Actions to provide increased risk awareness and control

- Discussion of planned maintenance activity with the affected operating shift(s). Ensuring operator awareness of risk level, RMAs, protected SSCs, contingency plans, etc., and obtain operations approval. Documenting risk information in logs, on status boards, etc

- Conducting pre-job briefing of maintenance personnel, emphasizing risk aspects of planned maintenance evolution

- Requesting system engineers to be present for the maintenance activity, or for applicable portions of the activity

- Obtaining plant management approval of the proposed activity

- Ensuring risk and RMA information on all work schedules, plans, etc.

- Announcing the plant risk band in effect and what risk-significant activities are in progress on the public system (e.g., Gaitronics) periodically and when changes occur.

2. Actions to reduce duration of maintenance activity

- Pre-staging parts, materials, tools and other equipment

- Walking down tagouts, equipment lineups (e.g., valves and switches) and the maintenance activity prior to starting work

- Conducting training on mockups to familiarize maintenance personnel with the activity (similar to ALARA strategies)

- Working jobs during back shifts as well as day shift

- Establishing contingency plan to restore out-of-service equipment (or functions) rapidly if needed

3. Actions to minimize magnitude of risk increase

- Minimizing other work in areas that could affect initiators (e.g., reactor protection system areas, switchyard, emergency diesel generator rooms, switchgear rooms) to decrease the frequency of initiating events that are mitigated by the function performed/supported by the out-of-service SSC

- Minimizing other work in areas that could affect other redundant systems (e.g., high pressure coolant injection/reactor core isolation cooling rooms, auxiliary feedwater pump rooms)

- Establishing alternate success paths for performance of the safety function of the out-of-service SSC (note: equipment used to establish these alternate success paths need not be within the scope of the maintenance rule). Use of administrative controls to ensure that backup equipment is protected.

- Establishing other compensatory measures

- Re-prioritizing and/or rescheduling maintenance activities

4. A final action threshold should be established so that risk significant configurations are not normally entered voluntarily.

Because the benefits of these RMAs are generally not readily quantifiable, the approach chosen for quantitatively determining the significance of failure to manage risk is to assign some credit to the effectiveness of these actions in reducing the risk impact of the assessed configuration. Therefore, the simple screening rule used in this SDP is to assign a credit of half-decade reduction in risk to the correctly calculated risk if the licensee effectively implemented one or two categories of the RMAs to control risk. If the licensee effectively implemented three or more categories of the RMAs, an order of magnitude reduction in risk can be credited against the actual maintenance risk. This approach allows the significance of failure to manage risk to be expeditiously determined without using quantitative approaches that may require intensive resources. Flowchart 2 (IMC0609, App. K) is to used for evaluating the significance of failure to implement RMAs when the maintenance risks are adequately assessed.

If inspection staff needs assistance from the Agency technical experts in determining the adequacy of RMAs, follow the guidance in inspection procedure 71111.13, “Maintenance Risk Assessments and Emergent Work Control.”

VII. EXAMPLES OF (a)(4) FINDINGS

The following examples are provided to illustrate the use of the subject SDP using flow charts 1 and 2 for inspection findings that involve failure to perform an adequate risk assessment and failure to manage risk. These examples neither represent risk assessments of actual configurations nor actual examples of any MR findings.

I. During the period January 14-16, 2003, plant “X” was operating at 75 percent power with a Division 1 partial outage in which the residual heat removal (RHR) heat exchanger “A,” ESW “A” 4.16-kV switchgear breaker, and Division 1 emergency diesel generator (EDG) had already been assessed for the risk of their removal from service for up to 100 hours. The licensee calculated the ICDF (^{a}CDF) as 8.76E-4. (ICDF or ^{a}CDF = CDF_{actual} - $CDF_{zero\text{-}maintenance}$ = 8.77E-4 - 1.0E-6).

ICDP = ICDF x [100 hrs/(8760hrs/reactor-year)]. Therefore, the resultant ICDP in this case was about 1.0E-5.

The inspectors reviewed work orders, control room logs, and risk assessments for the maintenance activities performed during the above period. The inspector noted that the licensee failed to consider the following maintenance ongoing work activities for the above risk assessment (1) maintenance on switchyard breakers and relays by the offsite group, and (2) routine maintenance on train "B" Class 1E Battery system. In addition, during this time, the licensee's contractors were working near the switchyard with cranes and other heavy equipment which had the potential for causing a loss-of-offsite power. Also, the licensee's Division 1 partial outage was extended for an additional 18 hours (from the original schedule) due to the unavailability of parts and other documentation issues.

The SRA reassessed the risk with the above conditions and found the actual ICDF to be about 6.09E-3. The corresponding ICDP was 8.2 E-5.

The inspector reviewed licensee's risk management actions for the above maintenance configurations and note the following deficiencies.

- The RMAs did not contain actions to provide increased risk awareness and control, such as coordinating switchyard and other yard work activities that could affect the availability of offsite power sources; obtaining management review and approval of the proposed maintenance work; coordinating work activities with those assigned to offsite organizations; and requiring risk assessments prior to conducting maintenance activities and applicable risk management guidance.

- The RMAs did not contain actions to reduce the duration of maintenance activity, such as verifying and pre-staging parts, materials, tools and other equipment; encouraging the performance of maintenance work during back shifts, as well as day shifts; and establishing contingency plans to restore out-of-service equipment (or functions) rapidly, if needed.

- The RMAs did not contain actions to reduce the magnitude of a risk increase, such as minimizing work that could affect the frequency of initiating events which are mitigated by out-of-service SSCs; establishing alternate success paths for performance of the safety function of the out-of-service SSC; minimizing work that could affect redundant systems; developing administrative controls to ensure that backup equipment is protected; establishing other compensatory measures; and reprioritizing and/or rescheduling maintenance activities.

- The RMAs did not establish risk thresholds so that risk significant configurations could not be normally entered voluntarily.

The inspectors reviewed this issue against the guidance contained in Appendix B, "Issue Dispositioning Screening," of Inspection Manual Chapter (IMC) 0612, "Power Reactor Inspection Reports." The inspectors concluded that the issue was more than minor since the licensee's risk assessment failed to consider unavailable SSC during the maintenance. This finding is associated with inadequate 10 CFR 50.65 (a)(4) risk assessment/management and it impacted the mitigation system cornerstone. Accordingly, the inspectors determined the significance of the finding using IMC 0609,

Appendix K, "Maintenance Risk Assessment and Risk Management Significance Determination Process."

The following steps should be followed to determine the significance of the finding using this SDP (IMC 0609, Appendix K).

1. Calculate the risk deficit (ICDPD) as follows :

   Actual lCDP - original flawed ICDP-1E-6 = 8.2 E-5 - 1.0 E-5 - 1.0 E-6 = 7.1 E-5.

2. In order to determine the significance of this value (SDP color), use flowchart1 in IMC 0609, Appendix K.

   For ICDPD = 7.1 E-5, the SDP color is **Yellow**. (Decision blocks “Is Risk Deficit > 1E-6", and ”Is Risk Deficit >1E-5?” were answered “Yes” and decision block ”Is Risk Deficit >1E-4?” is answered “No”with no RMAs taken).

3. Next, use flowchart-1, follow the decision block “Is Risk Deficit >1 E-4" path “No” to determine whether any RMA credit should be applied to the risk deficit.

Section 4.3 of this SDP lists the following categories of appropriate RMAs..

- increased risk awareness and control
- reducing duration of maintenance activity
- Minimizing magnitude of risk increase
- establishing other compensatory measures to provide alternate success paths for maintaining the safety function of the out-of-service SSC (e.g., using diverse means of accomplishing the intended safety function).

Based on the deficiencies identified in all four RMA categories, no credit is given to the licensee for RMAs. Therefore, the final significance color is Yellow.

This example illustrates a case where the licensee assessed the risk, but the risk assessment was flawed (incomplete or inadequate). This is because the licensee did not include the following in their risk assessment: all out-of-service components, additional hours due to extension of the maintenance, increased risk of a plant trip from switchyard work. The risk deficit was recalculated as shown above. The risk deficit value was assigned an SDP color “Yellow” using flowchart 1. The significance color remained the same (did not get any credit) because the licensee did not implement any risk management actions.

II. On August 2, 2000, the inspectors questioned the licensee’s overall risk assessment of plant XY due to several maintenance activities. The licensee had evaluated the increase in risk (ICDF) due to maintenance activities as 1.18E-5 using their Plant Risk Analysis Program (ORAM/SENTINEL) tool. The corresponding ICDP was 1E-6. The licensee implemented only the normal work controls because the ICDP was not >1E-6.

Based on plant status review the inspectors noted that the licensee had taken RCIC system out of service for maintenance and were on an LCO. The inspectors identified that the licensee had not accurately input the RCIC system maintenance activity for 12 days in their

risk assessment. The inspectors asked the licensee to perform the overall risk assessment using ORAM/SENTINEL with the RCIC system unavailable since that was the plant configuration and it was credited for accident mitigation. When the licensee made the RCIC system unavailable in the ORAM/SENTINEL program, the overall risk (ICDF) changed to 6.36E-5.

The inspectors reviewed this issue against the guidance contained in Appendix B, "Issue Dispositioning Screening," of Inspection Manual Chapter (IMC) 0612, "Power Reactor Inspection Reports." The inspectors concluded that the issue was more than minor since the licensee's risk assessment failed to consider unavailable SSC during the maintenance. This finding is associated with inadequate 10 CFR 50.65 (a)(4) risk assessment/management and it impacted the mitigation system cornerstone. Accordingly, the inspectors determined the significance of the finding using IMC 0609, Appendix K, "Maintenance Risk Assessment and Risk Management Significance Determination Process."

The following steps should be followed to determine the significance of the finding using this SDP.

1. If not already done, covert actual incremental core damage frequency ($ICDF_{actual}$) to actual incremental core damage probability ($ICDP_{actual}$)
   i.e., $ICDP_{actual} = ICDF_{actual}$ x [12x24 hrs/(8760hrs/reactor-year)]
   $ICDP_{actual}$ =6.36E-5 x [12x24 hrs/(8760hrs/reactor-year)]. = 2.09 E-6.

2. Calculate the risk deficit (ICDPD) as follows :

   Actual lCDP - original flawed ICDP= 2.09E-6 - 1E-6=1.09E-6

3. In order to determine the significance (SDP color) of this value, use flowchart1 in IMC 0609, Appendix K. For ICDPD = 1.09 E-6, the SDP color is **White**. (The decision block"Is Risk Deficit >1E-6?" was answered "Yes"; the decision block "Is Risk Deficit >1E-5?" was answered "No"; and no RMAs were taken).

This example illustrates a case where the licensee's risk assessment was flawed (incomplete or inadequate), and the licensee had not taken any risk management actions because they did not realize the actual risk was above 1E-6. Also, note that in this example ICDP was not significantly greater than 1E-6 (i.e., one order of magnitude or greater). Therefore, the net risk impact remained the same (did not subtract 1 E-6 from the risk deficit prior to determining an SDP color).

III. The online risk was evaluated by the licensee for plant YY to be at an elevated level (ORANGE) during a designated work window for preventive maintenance on the 2A EDG and other scheduled maintenance work including a surveillance test on the Unit 2 Solid State Protection System. The inspectors questioned operators and the work week manager concerning the plant configuration and the published risk condition for that maintenance. The licensee assessed the increase in risk (ICDP) associated with the maintenance activities to be 4.1 E-6. The inspectors verified the risk assessment to be adequate and it reflected the actual plant configurations. However, the inspectors noted that this configuration would not have been allowed by plant risk procedure PRK-001without implementing appropriate risk

management actions. The inspectors reviewed the licensee's risk management actions for the above maintenance configurations. The licensee had taken the following risk management actions: conducted pre-job briefing of maintenance personnel, obtained plant management approval of the proposed activity, ensuring risk and RMA information are highlighted on all work schedules, pre-staged parts, performed walkdown of affected systems and hung and verified boundary and caution tags. The inspectors determined that the licensee has taken adequate RMAs to provide increased risk awareness and control and actions to reduce duration of the maintenance activity, but did not take actions to minimize the magnitude of risk increase as specified in the licensee's procedure.

The inspectors reviewed this issue against the guidance contained in Appendix B, "Issue Dispositioning Screening," of Inspection Manual Chapter (IMC) 0612, "Power Reactor Inspection Reports." The inspectors concluded that the issue was more than minor since the licensee did not adequately manage the increase in risk due to maintenance activities. This finding is associated with inadequate 10 CFR 50.65 (a)(4) risk management and it impacted the mitigation system cornerstone. Accordingly, the inspectors determined the significance of the finding using IMC 0609, Appendix K, "Maintenance Risk Assessment and Risk Management Significance Determination Process."

The following steps should be followed to determine the significance of the finding using this SDP.

Since the finding is related to RMAs only, go to SDP flowchart 2.

For ICDP= 4.1E-6, the SDP color is determined as **Green.** (The decision block "Is Risk Deficit >1E-6?" was answered "Yes"; the decision block "Is Risk Deficit >1E-5?" was answered "No"; the decision block "3 or RMAs taken" was answered "No"; the decision block "1or 2 RMAs taken" was answered "Yes"; and the decision block "Is ICDP< 5E-6" was answered as "Yes").

This example illustrates a case where the licensee's risk assessment was adequate, but the licensee had not implemented all required risk management actions. Since the licensee had effectively implemented 2 RMAs and the risk increase was <5E-6, the significance was mitigated from a potential White finding to a Green finding.

VIII. REFERENCES

Section 50.65 of Part 50 of Title 10 of the *Code of Federal Regulations* (10 CFR 50.65), "Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants"

Regulatory Guide 1.160, "Monitoring the Effectiveness of Maintenance at Nuclear Power Plants"

Regulatory Guide 1.182, "Assessing and Managing Risk Before Maintenance Activities at Nuclear Power Plants"

Regulatory Guide 1.187, "Guidance for Implementation of 10 CFR 50.59, Changes, Tests and Experiments," November 2000

Inspection Procedure 71111.13, “Maintenance Risk Assessments and Emergent Work Control”

The Nuclear Energy Institute's (NEI's), NUMARC 91-06, "Industry Guideline for Shutdown Operations"

NUMARC 93-01, "Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants"

Revised Section 11, dated February 22, 2000, “Assessment of Risk Resulting from Performance of Maintenance Activities,” of NUMARC 93-01

END