NEI 06-09 (Revision 0)

Risk-Informed Technical Specifications Initiative 4b

Risk-Managed Technical Specifications (RMTS) Guidelines

Industry Guidance Document

November 2006

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Risk-Managed Technical Specifications (RMTS) Guidelines

EPRI Report 1013495

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EXECUTIVE SUMMARY

This document provides guidance for implementation of a generic Technical Specifications improvement that establishes a risk management approach for voluntary extensions of completion times for certain Limiting Conditions for Operation. This document provides the risk management methodology, which will be approved through an NRC safety evaluation, and will be referenced through a paragraph added to the Administrative Controls section.

This methodology uses a risk-informed approach for establishment of extended completion times, and is consistent with the philosophy of NRC Regulatory Guide 1.174. Probabilistic Risk Assessment (PRA) methods are used to determine the risk impact of the revised completion times. PRA technical adequacy is addressed through NRC Regulatory Guide 1.200, which references the ASME PRA standard, RA-S-2005b for internal events at power. Quantification of risk due to internal fire and other significant external events is also necessary for this application, through PRA or bounding methods.

Section 2.0 of the document provides requirements for implementation. Section 3.0 provides additional implementation guidance relative to these requirements. Section 4.0 presents attributes of the PRA and configuration risk assessment tools. The extension of completion time must take into account the configuration-specific risk, and is an extension of the methods used to comply with paragraph (a)(4) of the maintenance rule, 10 CFR 50.65. Plants implementing this initiative are expected to use the same PRA analyses to support their maintenance rule (a)(4) programs. A deterministic backstop value is imposed to limit the completion time extension regardless of low risk impact. Results of implementation are monitored, and cumulative risk impacts are compared to specific risk criteria. Corrective actions are implemented should these criteria be exceeded.

Report Development History

This report presents nuclear utilities with a framework and associated general guidance for implementing Risk Managed Technical Specifications (RMTS) as a partial replacement of existing Technical Specifications. This report was initially prepared for EPRI with extensive technical input and review by the Nuclear Energy Institute (NEI) Risk-Informed Technical Specifications Task Force (RITSTF), which includes input from the PWR Owner's Group. This report is a substantial Technical Update to EPRI Report 1011758, which was published in December 2005. A draft of the revision provided in this report was submitted to the Nuclear Regulatory Commission (NRC) staff to support pilot applications of RITSTF Initiative 4B. This revision incorporates modifications to address comments provided by NRC staff and is intended for use by plants implementing the RITS Initiative 4B application.

Background

Since 1995, the methodology for applying PRAs to risk-informed regulation has been advanced by the publication of many reports. Related to the area of Risk-Informed Technical Specifications alone, EPRI has published the *PSA Applications Guide* (TR-105396), *Guidelines for Preparing Risk-Based Technical Specifications Change Request Submittals* (TR-105867), *Risk-Informed Integrated Safety Management Specifications (RIISMS) Implementation Guide* (1003116), and *Risk-Informed Configuration-Based Technical Specifications (RICBTS) Implementation Guide* (1007321). NRC has issued Regulatory Guide 1.177 and a Standard Review Plan providing guidance on Risk-Informed Technical Specifications. Over the past four years, the NEI RITSTF has addressed several generic initiatives to further risk-inform station Technical Specifications. One of these, Initiative 4B, entitled Risk-Managed Technical Specifications, is the subject of this report. As of August 2006, two pilot implementations of Initiative 4B have been submitted by utilities to NRC for their approval with a third plant indicating its intention to also participate as a pilot plant. An earlier version of this report, EPRI Report 1002965 was submitted to NRC in support of these pilot submittals. Based on NRC reviews, EPRI Report 1009474 was produced and docketed with NRC. This report is a further revision based on NRC review, industry and NRC workshops on the subject, and industry experience using the guidelines.

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Objectives

- To provide utilities with an approach for developing and implementing nuclear power station Risk-Managed Technical Specifications programs.
- To complement and supplement existing successful Configuration Risk Management applications such as the Maintenance Rule.
- To serve as NRC-approved guidelines for widespread implementation of RITSTF Initiative 4B.

Approach

Starting with available industry and NRC documentation, experienced PRA practitioners, acting through the NEI RITSTF, developed an approach and methodology for implementing Risk-Informed Technical Specifications. The method uses the guidance developed for the Maintenance Rule, 10CFR50.65 (a)(4), in Section 11 of NEI document NUMARC 93-01 as a starting point. The approach described in this report is a logical extension of that guidance to address the additional challenges of Risk-Managed Technical Specifications. The primary additions to the (a)(4) processes are 1) the calculation of a flexible risk-informed completion time (RICT) as an alternative to the static Allowed Out-of-service Times in current Technical Specifications, and 2) calculation of cumulative risk incurred through the use of these RICTs. Other extensions of the (a)(4) process are associated with the elevation of the process to a higher regulatory significance through its incorporation into Technical Specifications. This report provides the culmination of the RITS 4B initiative and serves as the industry implementation guidance for application of Risk Managed Technical Specifications.

Results

This report presents a recommended approach and technical framework for an effective RMTS program and its implementation following NRC approval. This report also provides, together with the industry consensus standards on PRA as modified by experience with NRC Regulatory Guide 1.200, the requirements for PRA scope and capability for this RMTS application.

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This project is an important element of the nuclear industry's strategic objective to use more risk-informed regulations and operational decisions. It is a logical extension of traditional Technical Specifications that builds upon the current Configuration Risk Management (CRM) requirements of the NRC Maintenance Rule. All U.S. nuclear stations meet these requirements, and many have more extensive CRM programs to support work planning and scheduling, evaluation of events during operation, response to NRC inspection findings, and other day to day applications. These capabilities have proven to be both risk and cost-effective. Furthermore, their regular use has fostered a desirable risk management culture at well-run stations. EPRI expects to support this RMTS effort in the future as it continues through the regulatory approval process and through its early implementation. Furthermore, this project will interface with the related activities of the EPRI Configuration Risk Management Forum (CRMF), which addresses a wide range of CRM issues.¶

Keywords¶
Probabilistic risk assessment
Risk-informed applications
Technical Specifications
NRC regulations and Licensing

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1 INTRODUCTION

The purpose of this report is to provide specific guidance on how to implement Risk-Managed Technical Specifications (RMTS) programs at existing and planned nuclear power stations using configuration risk management tools and techniques. It is a direct derivative of previous EPRI work, in particular EPRI Report 1011758 [1]. This report provides guidance for stations desiring to implement RMTS for a single system as well as those desiring to implement a global "whole plant" RMTS approach. This report is organized and presented as follows:

- Section 1 is an overview of the history preceding RMTS programs.
- Section 2 provides the RMTS program requirements.
- Section 3 presents detailed RMTS guidance approach and methodology.
- Section 4 presents the attributes of a PRA and associated Configuration Risk Management (CRM) Tools that are required for RMTS implementation.
- Section 5 presents RMTS references.
- Appendix A provides a glossary of terms.

10CFR50.36, "Technical Specifications," requires that each specification contain a Limiting Condition for Operation (LCO). The LCO is the minimum functional capability or performance level of equipment required for safe operation of the facility. When an LCO is not met, 10 CFR 50.36 requires the licensee to shut down the reactor or follow any remedial action permitted by the Technical Specifications until the condition can be met. No specific timing requirements were included in the regulation. However, in practice, each specification contains actions to follow when the LCO is not met and these actions are associated with one or more fixed time limit. Within the context of the plant Technical Specifications, these time limits are termed the Allowed Outage Times (AOTs) or Completion Times (CTs). These time limits were established at the time of station licensing or in subsequent license amendments. In this document, the term completion time (CT) refers to completion time and/or allowed outage time.

The nuclear industry has applied risk-informed techniques to extend various CTs originally established in the Technical Specifications. The RMTS described in this report builds on that experience to establish a process to apply configuration risk management to enable a licensee to vary the CT in accordance with the risk calculated for the plant configuration.

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This guideline is applicable to risk informing the Technical Specifications CTs for plant configurations in which structures, systems, and components (SSCs) are inoperable. The primary use of this guidance is anticipated to be for configurations (either preplanned or emergent) that occur during the conduct of maintenance. It is expected that implementation of RMTS will allow utilities to more fully utilize risk-informed tools and processes in the management of maintenance. These Technical Specifications enhancements will reduce plant risk by allowing flexibility in prioritizing maintenance activities, improving resource allocation, and avoiding unnecessary plant mode changes. The RMTS under development are specifically directed toward equipment outages and will not change the manner in which plant design parameters are controlled.

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This guide supplements Nuclear Energy Institute (NEI) guidance for implementation of the Maintenance Rule (see Section 11 of Reference [2]) for stations implementing RMTS. Additional key references include EPRI's PSA Applications Guide [3] and NRC's Regulatory Guide 1.174 [4]. Maintenance activities are performed to ensure the level of equipment reliability necessary for safety, and should be carefully managed to achieve a balance between the benefits and potential impacts on safety, reliability, and availability. The benefits of well managed maintenance conducted during power operations include increased system and unit availability, reduced equipment and system deficiencies that could impact operations, more focused attention on safety due to fewer activities competing for specialized resources, and reduced work scope during outages.

This report is a key part of the NEI Risk Informed Technical Specifications Task Force (RITSTF) initiatives. RMTS is designed to be consistent with, and provide enhancement to, the guidance provided for Maintenance Rule risk management described in Reference [2]. The guidance contained in this report is applicable to the determination of risk-informed completion times (RICTs), Risk Management Action Times (RMATs) (reference Appendix A for definitions of these terms) and specification of appropriate compensatory risk management actions (RMAs) applicable to requirements of the Technical Specifications. In application of this guidance to maintenance activities on plant SSCs governed by Technical Specifications, both the provisions of the RMTS and the requirements specified under the provisions of Maintenance Rule section (a)(4) are applicable. This section summarizes the enhancements that this initiative brings to prudent safety management.

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It is not the intent of the RITSTF initiatives to modify the manner in which the Maintenance Rule requirements are met by various utilities. However, it is the intent of this report to provide the guidance for integrating Risk-Managed Technical Specifications with the Maintenance Rule process. While the fundamental process to be used for the RMTS is not different from the Maintenance Rule process, the proposed risk assessment process has an increased quantitative focus and requires a more formal mechanism for dispositioning configuration management decisions.

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RMTS features balance the flexibility in performing maintenance within a structured risk informed framework so as to adequately control the risk impact of maintenance decisions.

The RMTS process discussed in this report may be used within the current configuration risk management program that implements the Maintenance Rule (a)(4) requirements. Specifically, this report describes integration of the present 10CFR50.65(a)(4) evaluation process with selected supplementary processes to create an enhanced process that will support the implementation of flexible CTs within the Technical Specifications. However, there is a fundamental difference between the two programs. RMTS is specifically applicable to Technical Specification operability of SSCs, while the provisions of Maintenance Rule section (a)(4) are concerned with functionality of a broader scope of SSCs. Due to this fundamental difference, the provisions of both programs are applicable and must be performed during applications of RMTS.

The RMTS process is intended to provide a comprehensive risk informed mechanism for expeditious identification of risk significant plant configurations. This will include implementation of appropriate compensatory risk management actions, while retaining the current Technical Specifications action statement requirements, including the action to shut down the plant when prudent. In practice, this program is consistent with 10CFR50.65(a)(4) maintenance planning conditions. That is, the program retains the current 10CFR50.65(a)(4) thresholds for identifying normal and high risk plant configurations. The processes described herein provide additional requirements to those required by the Maintenance Rule (a)(4) In addition, the revised process ensures timely risk assessments of emergent (unscheduled) plant configurations to ensure that high-risk conditions associated with multiple component outages are identified early. This document also includes guidance on the scope and quality of the risk-informed tools used in performing the configuration risk assessments.

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RMTS PROGRAM REQUIREMENTS

This Section delineates the requirements for RMTS applications. In this chapter, the conditions under which the RMTS program is applicable are defined. Then, requirements applicable to the activities necessary for RMTS implementation are provided. These activities are comprised of the following:

- Configuration risk management process and application to Technical Specification requirements.
- Documentation requirements.
- Training requirements.
- PRA technical adequacy requirements.
- Configuration risk management tool requirements.

Information associated with the purpose and details associated with the implementation of the individual RMTS requirements are provided in Chapters 3 and 4. Chapter 3 provides detailed guidance on the RMTS programmatic requirements and the conduct of activities necessary to implement the RMTS program. Chapter 4 provides information associated with the PRA and configuration risk management models and tools used in the RMTS program.

2.1 Applicability

A RMTS program is designed to apply the risk insights and results obtained from a plant PRA to identify appropriate Technical Specifications CTs and appropriate compensatory risk management actions associated with plant SSCs that are inoperable. A RMTS program defines the scope of equipment used to define plant configurations to which calculation of a risk-informed completion time (RICT) may be applied. These SSCs have front-stop CT requirements, and can be evaluated via the RMTS-supporting PRA and CRM program. Technical Specifications for Safety Limits, Reactivity Control, Power Distribution, and Test Exceptions are excluded from utilizing RICTs.

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PRAs that support RMTS are typically plant specific at-power PRAs. Thus, these PRA's are directly applicable to plant configurations during operation in Modes 1 and 2. For PWRs, RMTS may be extended on a plant-specific basis to apply in operating Modes 3 and 4 (with cooling via steam generators) while for BWRs it may be extended to Mode 3 (with cooling via main condenser). However, licensees who

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want to apply RMTS for plant configurations in these other operating modes shall either have a PRA and configuration risk calculation tool that adequately calculates a RICT in these modes for the specific plant configurations or perform sufficient analyses to demonstrate that the at-power PRA results provide conservative bounding estimates of risk, and thus can be used to set the RICT. Applicability to these modes must be justified as part of the license application, and approved by NRC. Also, the station configuration risk management (CRM) program (see definition in Appendix A) shall establish the program-specific requirements for application of an at-power PRA to non-power operating modes. Technical Specifications associated with the Cold Shutdown and Refueling modes are not within the scope of this guidance. Table 2-1 provides the applicability of the RMTS program during various operating modes.

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Table 2-1
Applicability of At-Power PRA for RMTS to Plant Operational Modes. Note: Mode numbers are in accordance with Improved Technical Specification definitions.

Applicability of At-Power PRA to RMTS	PWR	BWR
Direct Application	1, 2,	1, 2,
Plant Specific Applicability*	3, 4*	3*
Not Applicable	4*, 5, 6	3*, 4, 5

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* RMTS is applicable to PWR Modes 3 and 4 for cooling via steam generators or BWR Mode 3 for cooling via main condenser, when justified and approved by NRC as part of the plant specific application; RMTS is NOT applicable to PWR Mode 4 or BWR Mode 3 for cooling via shutdown cooling.

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2.2 RMTS Thresholds

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Risk management thresholds for RMTS program application are established quantitatively by considering the magnitude of the instantaneous core damage frequency (CDF), instantaneous large early release frequency (LERF), incremental core damage probability (ICDP), and the incremental large early release probability (ILERP) for the plant configuration of interest. The risk management thresholds presented in Table 2-2 are the basis for RMTS program action requirements.

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Table 2-2
RMTS Quantitative Risk Management Thresholds

Criterion*		RMTS Risk Management Guidance
CDF	LERF	
≥10^{-3} events/year	≥10^{-4} events/year	- Voluntary entrance into configuration prohibited. If in configuration due to emergent event, implement appropriate risk management actions.
ICDP	ILERP	
≥10^{-5}	≥10^{-6}	- Follow the Technical Specification requirements for required action not met.
≥ 10^{-6}	≥ 10^{-7}	– RMAT and RICT requirements apply – Assess non-quantifiable factors – Implement compensatory risk management actions
<10^{-6}	<10^{-7}	– Normal work controls

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* In application of these RMTS criteria, the criteria for both columns apply simultaneously and actions are taken based on the more restrictive one.

2.3 RMTS Program Requirements

This section provides a concise listing of RMTS programmatic requirements. Detailed discussion of the configuration risk management and Technical Specification requirements applicable to RMTS are provided in Chapter 3. Chapter 4 provides a detailed discussion of requirements associated with the PRA models and CRM tools used in RMTS program implementation.

2.3.1 Configuration Risk Management Process & Application of Technical Specifications

Existing Technical Specifications for nuclear power stations specify completion times for completing actions when specific plant equipment is inoperable. Under the RMTS concept, these CT values are maintained and referred to as “front-stop”

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CT values. In the RMTS program, operation beyond the front-stop CT is allowed provided the risk of continued operation can be shown to remain within established limits as determined by the CRM program and supported by the PRA.

The station's CRM program and RMTS process shall be performed in accordance with station procedures which include the following process requirements:

1. Risk assessments used in RMTS shall be performed in accordance with guidance provided in Sections 2 and 3 of this document and supported by the implementing plant's PRA and CRM program. Risk assessments involve computation of a Risk Management Action Time (RMAT) and a Risk Informed Completion Time (RICT)

   - The RMAT is the time interval at which the risk management action threshold is exceeded. It is the time from discovery of a condition requiring entry into a Technical Specifications action for a SSC with the provision to utilize a RICT until the 10^{-6} ICDP or 10^{-7} ILERP RMA threshold is reached, whichever is the shorter duration.

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   - The RICT is a plant-specific SSC plant configuration CT calculated based on maintaining plant operation within allowed risk thresholds or limits and applying a formally approved configuration risk management program and associated probabilistic risk assessment. The RICT is the time interval from discovery of a condition requiring entry into a Technical Specifications action with the provision to utilize a RICT until the 10^{-5} ICDP or 10^{-6} ILERP threshold is reached, or 30 days, whichever is shorter. The maximum RICT of 30 days is referred to as the "back-stop CT." Note that each Technical Specification within the scope of RITS 4B has a front-stop and back-stop CT specifically applicable to it. However, the RICT is applicable to the plant configuration.

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2. Risk Managed Technical Specifications are applied under the following conditions:

   2.1. To extend a CT beyond its front-stop CT.
   2.2. To evaluate configuration changes once a RICT is being used beyond the associated front-stop CT.

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3. For plant configurations in which the RMAT either has been exceeded (emergent event) or is anticipated to be exceeded (either planned condition or emergent event), appropriate compensatory risk management actions shall be identified and implemented. For preplanned maintenance activities for which a RICT will be entered, RMAs shall be implemented at the earliest appropriate time.

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4. Upon implementation of the RMTS program for an inoperable SSC within the program scope, prior to exceeding the RMTS front-stop CT the station shall perform a risk calculation to determine the applicable risk management action time (RMAT) and risk- informed completion time (RICT).

5. When a system within the scope of the RMTS program is in a RICT (i.e., when it is Technical Specification inoperable and beyond its front-stop CT – see definition in Appendix A), and the functional / operable status of any subsequent SSC within the scope of the plant CRM program changes (i.e., a functional / operable SSC becomes non-functional / inoperable), the plant shall perform a risk calculation to determine a revised risk management action time (RMAT) and risk-informed completion time (RICT) applicable to the new plant configuration. This calculation shall be performed prior to exceeding the most limiting applicable Technical Specification front-stop CT (for SSCs governed by Technical Specifications) but not later than 12 hours from the plant configuration change. For plant configuration changes in which a non-functional / inoperable SSC is returned to service, the plant may perform a risk calculation to determine a revised risk management action time (RMAT) and risk-informed completion time (RICT).

   - The revised RICT from the evaluation shall be effective from the time of implementation of the original RICT for the original non-zero maintenance plant configuration.
   - In the RMTS framework, a RICT can be revised, occasionally many times, but the associated "time clock" cannot be re-set until all LCOs associated with front-stop CTs that have been exceeded have been met (i.e., are operable) or the applicability for the LCOs exited.

6. Should the RICT be reached the plant shall consider the required action to not be met and follow the applicable Technical Specification requirements, including any associated requirement for plant shutdown implementation.

7. RMAT and RICT calculations are performed in accordance with the following rules:

   - RMAT and RICT risk levels are referenced to Core Damage Frequency (CDF) and Large Early Release Frequency (LERF) associated with the plant "zero-maintenance" configuration. The "zero-maintenance" state is established from the baseline PRA by assuming all components to be available (i.e., SSC unavailability and test and maintenance events are set to zero in the PRA model; train modeling is consistent with plant alignments).

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When a system within the scope of the RMTS program is inoperable and in a RICT

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- RMAT and RICT levels are referenced from the time of initial entry into the first RMTS and can only be reset once all RMTS action statements for SSCs beyond their front-stop CTs have been exited.
- The RMAT and RICT calculations may use conservative or bounding analyses.
- RMTS evaluations shall evaluate the instantaneous core damage frequency (CDF), instantaneous large early release frequency (LERF). If the SSC inoperability will be due to preplanned work, the configuration shall not be entered if the CDF is evaluated to be $\geq 10^{-3}$ events/year or the LERF is evaluated to be $\geq 10^{-4}$ events/year. If the SSC inoperability is due to an emergent event, if these limits are exceeded, the plant shall implement appropriate risk management actions to limit the extent and duration of the high risk configuration.
- Compensatory risk management actions may only be credited in the calculations to the extent they are modeled in the PRA and are proceduralized.
- The probability of repair of inoperable SSCs within the scope of the CRM program cannot be credited in the RMAT or RICT calculations.

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- The impact of fire risks shall be included in RMAT and RICT calculations.
- The impact of other external events risks shall be addressed in the RMTS program. This may be accomplished via one of the following methods:

    A. Provide a reasonable technical argument (to be documented prior to implementation of the RMTS program) that the external events that are not modeled in the PRA are not significant contributors to configuration risk.

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    B. Perform an analysis of the external event contribution to configuration risk (to be documented prior to implementation of the RMTS program) and incorporate these results in the RMTS program. This may be accomplished via performing a reasonable bounding analysis and applying it along with the internal events risk contribution in calculating the configuration risk and the associated RICT.

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    C. Provide direct modeling of the external events in the PRA / CRMP plant model.

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8. The RMTS completion time shall not exceed the back-stop CT limit of 30 days. This RMTS provision applies separately to each ACTION for which it is entered.

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9. A RICT may not be applied for pre-planned activities when all trains of equipment required by the Technical Specification LCO would be inoperable.

10. For emergent conditions, a RICT may be applied when all trains of equipment required by the Technical Specification LCO would be inoperable, provided one or more of the trains are considered PRA functional as defined in item 11.

> Deleted: <#>In a RMTS program, a RICT exceeding the current front-stop CT may not be applied in cases where a total loss of function has occurred (e.g., all trains of a required Technical Specifications system are determined to be incapable of performing its intended function such as, all trains of Safety Injection or all trains of Component Cooling Water).¶
> ¶
> <#>Unless otherwise permitted by the Technical Specifications, application of RMTS for an entry into a configuration involving a total loss of function is not allowed. ¶

11. PRA Functionality Assessment Guidance

An inoperable component shall be considered non-functional when performing the RICT calculation unless the provisions specified in 11.1 through 11.3 are met. If these provisions are met, the remaining function(s) of the system, subsystem, or train which are not affected by the condition which caused the SSC to be declared inoperable may be considered PRA functional when performing the RICT calculation.

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The following provides the requirements for conditions when PRA functionality may be applied to a SSC for the calculation of a RICT.

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11.1 If a component is declared inoperable due to degraded performance parameters, but the affected parameter does not and will not impact the success criteria of the PRA model, then the component may be considered PRA functional for purposes of the RICT calculation. For the provisions of this section to apply, the following must occur:

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11.1.1 The degraded condition must be identified and its associated impact to equipment functionality known.

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11.1.2 Further additional degradation that could impact PRA functionality is not expected during the RICT.

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11.2 If the functional impact of the condition causing the inoperability is capable of being assessed by the PRA model, then the remaining unaffected functions of the component may be considered PRA functional in the RICT calculation.

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11.3 If the function(s) affected by the condition causing a component to be inoperable is not modeled in the PRA, and the function has been evaluated and documented in the RMTS program as having no risk impact, then the RICT may be calculated assuming availability of the inoperable component and its associated system, subsystem or train. If there is no documented basis for exclusion, or if the condition was screened as low probability, then the inoperable component must be considered not functional.

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Note: Section 3.2.3 provides examples for application of PRA Functionality.

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12. If a component within the scope of the CRM program is inoperable and PRA functionality cannot be quantified, then the component shall be considered non-functional for the RICT calculation. In any case where equipment declared as "inoperable" is being classified as "functional" for purposes of a RICT calculation, the reasoning behind such a consideration shall be justified in the documentation of the RICT assessment.

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14. The as-occurred cumulative risk associated with the use of RMTS beyond the front-stop CT for equipment out of service shall be assessed and compared to the guidelines for small risk changes in Regulatory Guide 1.174 [4] and corrective actions applied as appropriate. This assessment shall be conducted every refueling cycle on a periodicity not to exceed 24 months.

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15. Operability determinations should follow regulatory guidance established in Part 9900 of the NRC Inspection Manual [9]. RMAT and RICT calculations performed for emergent conditions shall be performed assuming that all equipment not declared inoperable during the operability determination process are functional. However, the station shall establish appropriate RMAs based on an assessment of the potential for increased risks due to common cause failure of similar equipment. (Note that if there is not evidence for increased potentiual for common cause failures, no RMAs are required).

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2.3.2 Documentation

1. The CRM program process shall be documented in station procedures delineating appropriate responsibilities and related actions.

2. The process for conducting and using the results of the risk assessment in station decision-making shall be documented.

3. Procedures should specify the station functional organizations and personnel, including operations, engineering, work management and risk assessment (PRA) personnel, responsible for each action required for RMTS program implementation.

4. Procedures should clearly specify the process for conducting a RICT assessment and developing applicable RMAs.

5. Individual RMTS RICT evaluations shall:

   5.1. Be documented in an appropriate log.

   5.2. Document any quantified bounding assessments or other conservative quantitative approaches used.

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5.3. In cases where equipment declared as inoperable is being credited as possessing PRA functionality for the purposes of a RICT calculation, the basis behind this determination shall be provided in the RICT documentation.

6. Relative to extended CTs beyond the front-stop CT, the following shall be documented:

6.1. The date/time an LCO(s) is not met requiring entry into a RICT.

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6.2. The date/time for restoration of compliance with the LCO(s) or the exiting of the RICT.

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6.3. If applicable, an assessment of PRA functionality based on the degree of SSC degradation.

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6.4. The configuration specific risk (i.e., CDF and LERF) for the duration of extended CTs identifying inoperable equipment and associated plant alignments. This may include more than one CDF/LERF calculation to account for plant configuration changes during the extended CT.

6.5. Risk management actions implemented.

6.6. For emergent conditions, the extent of condition assessment for redundant components.

6.7. The total accumulated ICDP and ILERP accrued during the extended CTs.

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7. Periodic Documentation:

7.1. The accumulated annual risk above the zero maintenance baseline due to equipment out of service beyond the front-stop CT and comparison to the guidelines for small risk changes in Regulatory Guide 1.174 shall be documented every refueling cycle not to exceed 24 months.

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2.3.3 Training

1. Those organizations with functional responsibilities for performing or administering the CRM program shall have required training (e.g., licensed operators, work control personnel, PRA personnel, and station management).

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2. Training shall be provided to personnel responsible for performance of RMTS actions. This training should be commensurate with the respective responsibilities of the personnel in the following areas:

    2.1. Programmatic requirements of RMTS program.

    2.2. Fundamentals of PRA including analytical methods employed and the interpretation of quantitative results. This training should include training on the potential impact of common cause failures, model assumptions and limitations, and uncertainties. The training also should address the implications of these factors in the use of PRA results in decision-making applicable to RMTS.

    2.3. Plant specific quantitative and qualitative insights obtained from the PRA.

    2.4. Operation of the plant configuration risk management tool and interpretation of results derived from its application.

2.3.4 PRA Technical Adequacy

Stations electing to implement RMTS shall have a PRA model with the following attributes:

1. The PRA model shall incorporate the attributes contained in Section 4 of this report. The intent of these attributes is to ensure that the PRA provides a reasonable representation of the plant risks associated with the removal of plant SSCs from service.

2. The PRA shall be reviewed to the guidance of Regulatory Guide 1.200 Rev 0 for a PRA which meets Capability Category 2 for the supporting requirements of the ASME internal events at power PRA standard. Deviations from these capability categories relative to the RMTS program shall be justified and documented.

3. The scope of the PRA model shall include Level 1 (CDF) plus large early release frequency (LERF). In addition, RICT and RMAT calculations shall include contributions from external events, internal flooding events, and internal fire events. Inclusion of these factors within the PRA is not explicitly required provided alternate methods (e.g., conservative or bounding analyses) are used to accomplish this requirement.

4. The PRA shall be capable of providing quantitative configuration specific impacts due to planned or unplanned unavailability of equipment within the scope of the CRM program for the operational mode existing at the time an existing CT is extended.

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5. If the PRA model is constructed using data points or basic events that change as a result of time of year or time of cycle (examples include moderator temperature coefficient, summer versus winter alignments for HVAC, seasonal alignments for service water), then the RICT calculation shall either 1) use the more conservative assumption at all time, or 2) be adjusted appropriately to reflect the current (e.g., seasonal or time of cycle) configuration for the feature as modeled in the PRA. Otherwise, time-averaged data may be used in establishing the RICT.

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6. Common cause treatment as applied in the CRM model is consistent with the PRA model and RMTS guidance.

7. The PRA shall be maintained and updated in accordance with approved station procedures to ensure it accurately reflects the as-built, as-operated plant.

   7.1 The PRA shall be maintained and updated in accordance with approved station procedures on a periodic basis not to exceed two refueling cycles.

   7.2 A process for evaluation and disposition of proposed facility changes shall be established for items impacting the PRA model (e.g., design modifications, procedure changes, etc.). Criteria shall exist in PRA configuration risk management to require PRA model updates concurrent with implementation of facility changes that significantly impact RICT calculations.

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   7.3 In the event a PRA error is identified that significantly impacts RICT calculations, corrective actions shall be identified and implemented as soon as practicable in accordance with the station corrective action program.

8. PRA quantification software shall satisfy station software quality assurance requirements.

9. For plants with an at-power PRA that does not directly address lower operating modes, as discussed in Section 2.1, and the plant desires to use the PRA results to calculate RMAs and RICTs for plant configurations that originate in lower plant operating modes, a technically-based argument for application of the Mode 1 and 2 model to other plant operating modes shall be provided (e.g., provide assurance that risk associated with other modes addressed in the RMTS is bounded by the Modes 1 and 2 PRA model).

10. PRA modeling (i.e., epistemic) uncertainties shall be considered in application of the PRA base model results to the RMTS program. This uncertainty assessment is intended to be performed on the PRA base model prior to implementation of the RMTS program and provide insights such that applicable compensatory risk

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management actions may be developed to limit the potential impact of these uncertainties. This evaluation should include an LCO specific assessment of key assumptions that address key uncertainties in modeling of the specific out of service SSCs. For LCOs in which it is determined that identified uncertainties could significantly impact the calculated RICT, sensitivity studies should be performed for their potential impact on the RICT calculations. (Reference EPRI-1009652 [6] for one method to determine key uncertainties.) Insights obtained from these sensitivity studies should be used to develop appropriate compensatory risk management actions. Such activities may include highlighting risk significant operator actions, confirming availability and operability of important standby equipment, and assessing the presence of severe or unusual environmental conditions. The intent of these risk management actions is to (in a qualitative manner) minimize the potential adverse impact of the uncertainties. This assessment is only intended to be performed prior to initial implementation of the RMTS program and after a substantial update of the PRA.

2.3.5 Configuration Risk Management Tools

The following specific CRM tool attributes are required for RMTS implementation:

1. Initiating event models include external conditions and effects of out-of-service equipment.
2. Model truncation levels are adequate to maintain associated decision-making integrity.
3. Model translation from the PRA to a separate CRM tool is appropriate; CRM fault trees are traceable to the PRA. Appropriate benchmarking of the CRM tool against the PRA model shall be performed to demonstrate consistency.
4. Any modeled recovery actions credited in the calculation of a RICT shall be applicable to the plant configuration.
5. Configuration of the plant is correctly mapped from systems / components and real time activities to CRM model parameters.
6. Each CRM application tool is verified to adequately reflect the as-built, as-operated plant, including risk contributors which vary by time of year or time in fuel cycle or otherwise demonstrated to be conservative or bounding.
7. Application specific risk important uncertainties contained in the CRM model (that are identified via PRA model to CRM tool benchmarking) are identified and evaluated prior to use of the CRM tool for RMTS applications.
8. CRM application tools and software are accepted and maintained by an appropriate quality program. CRM application tool quality requirements for RMTS include:

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8.1 Model configuration control.

8.2 Software quality assurance.

8.3 Training of responsible personnel.

8.4 Development and control of procedures.

8.5 Identification and implementation of corrective actions.

8.6 Program administration requirements.

9. The CRM tool shall be maintained and updated in accordance with approved station procedures to ensure it accurately reflects the as-built, as-operated plant.

9.1 The CRM tool shall be maintained and updated in accordance with approved station procedures on a periodic basis not to exceed two refueling cycles.

9.2 A process for evaluation and disposition of proposed facility changes shall be established for items impacting the CRM tool (e.g., design modifications, procedure changes, etc.). Criteria shall exist to require CRM updates concurrent with implementation of facility changes that significantly impact RICT calculations.

9.3 In the event a PRA or CRM modeling error is identified that significantly impacts RICT calculations, corrective actions shall be identified and implemented as soon as practicable in accordance with the station corrective action program. Entrance into RMTS shall be suspended until these corrective actions have been implemented.

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3
IMPLEMENTATION GUIDANCE

This Section provides guidance supporting the RMTS programmatic requirements described in Section 2. This document has been developed to provide the commercial nuclear power industry guidance on risk management issues associated with implementation of Risk-Managed Technical Specifications (RMTS) programs at their facilities. Specifically, this guide is designed to support the implementation of a risk-informed approach to the management of Technical Specification completion times related to SSC safety functions. The report will generally refer to a CT in association with a “plant configuration.” The term “plant configuration,” a fundamental term applied in this report, is defined in Appendix A and is simply the consolidated state of all plant equipment functionality, (i.e., either functional or non-functional) and associated plant risk-impacting conditions analyzed in the PRA. This term applies to plant equipment functionality or loss thereof for any reason, including applications of both preventive and corrective maintenance. See Appendix A of this guide for a glossary of key terms applicable to RMTS program development and implementation.

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Existing conventional Technical Specifications for nuclear power plants specify maximum CT values for specific plant equipment related to the out-of-service time of SSCs that perform plant safety functions. Under the proposed RMTS concept, these CT values are retained in the Technical Specifications as the front-stop CT values. The front-stop CT values may be either those that have historically been established via conventional deterministic engineering methods and judgment or those more recently justified via risk-informed methods in accordance with RG 1.177. Implementation of a RMTS program does not preclude subsequent revision of front-stop CT values in accordance with RG 1.177. Under a RMTS program, operation beyond these front-stop CTs is allowable provided the risk of continued operation can be shown to remain within established risk thresholds.

This report focuses on RMTS implementation to meet the intent of RITSTF Initiative 4B (see Section 1 for background). A RMTS program does not change any of the conventional Technical Specifications LCOs or associated “action statement” requirements. A RMTS program focuses on managing plant risk to prudently allow configuration-based flexible LCO CT values greater than the front-stop CT values and less than or equal to a maximum back-stop CT value. The RMTS process presented in this report integrates regulatory guidance currently in place for other risk-informed applications. In particular, in RMTS applications, the overall plant

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risk is assessed via processes consistent with the maintenance rule (10CFR50.65), its attendant Regulatory Guide (RG 1.182), and industry implementation guidance (NUMARC 93-01). It is expected that licensees implementing RMTS will use the same PRA models and risk assessment tools for RMTS and 10 CFR 50.65(a)(4).

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3.1 RMTS Program Technical Basis

3.1.1 Risk Management Thresholds for RMTS Programs

Risk management thresholds for RMTS program application are established quantitatively by considering the magnitude of the instantaneous core damage frequency (CDF), instantaneous large early release frequency (LERF), incremental core damage frequency (ICDF), and the incremental large early release frequency (ILERF) for the plant configuration of interest. It is important to note that these incremental frequency values are measured from their respective “no-maintenance” or “zero-maintenance” baseline frequencies as determined via the PRA (see definitions of terms in Appendix A).

Guidance for evaluating temporary risk increases by considering configuration-specific risk is provided in NUMARC 93-01, Revision 3 [2]. The risk management thresholds presented in Table 3-1 provide the basis for RMTS program implementation. Table 3-1 presents RMTS quantitative risk management thresholds and RMTS action guidance as well as a comparison of the respective applicable Maintenance Rule thresholds and action guidance from Reference 3.

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Table 3-1
RMTS Quantitative Risk Management Thresholds

Criterion*		Maintenance Rule Risk Management Guidance	RMTS Risk Management Guidance
CDF	LERF		
≥10^{-3} events/year	≥10^{-4} events/year	- Careful consideration before entering the configuration (none for LERF)	- Voluntary entrance into configuration prohibited. If in configuration due to emergent event, implement appropriate risk management actions.
ICDP	ILERP		
≥10^{-5}	≥10^{-6}	– Configuration should not normally be entered voluntarily	- Follow the Technical Specification requirements for required action not met.
≥ 10^{-6}	≥ 10^{-7}	– Assess non-quantifiable factors – Establish compensatory risk management actions	– RMAT and RICT requirements apply – Assess non-quantifiable factors – Implement compensatory risk management actions
<10^{-6}	<10^{-7}	– Normal work controls	– Normal work controls

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* In application of these RMTS criteria, the criteria for both columns apply simultaneously and actions are taken based on the more restrictive one.

In a RMTS program the 10^{-6} and 10^{-7} thresholds for ICDP and ILERP, respectively, are referred to as Risk Management Action (RMA) thresholds and the RMAT is the corresponding risk management action time. The 10^{-5} and 10^{-6} thresholds for ICDP and ILERP, respectively, are referred to as Risk Informed Completion Time (RICT) Thresholds. These thresholds are deemed appropriate for RMTS programs because they relate to integrated plant risk impacts that are occasional and temporary in nature (versus permanent) and are consistent with Reference [4] guidance that has been previously endorsed by the NRC.

3.1.2 RMTS Risk Management Time Intervals

The RMTS process for allowing continued plant operation beyond the conventional Technical Specifications front-stop CT values requires performance of risk

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assessments based on configuration-specific plant conditions to calculate the Risk Management Action Time (RMAT) and Risk-Informed Completion Time (RICT). The RMAT is the time interval from discovery of a condition requiring entry into a Technical Specification with provisions for utilizing a RICT and which results in a plant configuration other than the zero-maintenance state until the 10^{-6} ICDP or 10^{-7} ILERP RMA threshold is reached, whichever is the shorter duration. The RICT is the time interval from discovery of a condition requiring entry into a Technical Specifications action for a SSC which has the provision to utilize a RICT and which results in a plant configuration other than the zero-maintenance state until the 10^{-5} ICDP or 10^{-6} ILERP threshold is reached, or 30 days, whichever is shorter. The maximum RICT of 30 days is referred to as the back-stop CT. The back-stop CT limit of 30 days is judged to be a prudently conservative administrative limit for configuration risk management. Similar to the 90-day limit for a temporary alteration for maintenance without performing a 10 CFR 50.59 evaluation established in NEI 96-07 “Guidelines for 10 CFR 50.59 Implementation”, the 30-day back-stop CT limits the time that is in a condition that is not consistent with the design basis. The 30-day back-stop CT was established based on the fact that some conventional Technical Specification front-stop CT limits are as long as 30 days, and because many nuclear stations would require up to this time period to complete some required complex corrective maintenance and testing for system function recovery. The RMTS approach evaluates the nuclear safety impacts (i.e., changes in risk levels) of specific plant configurations (i.e., equipment unavailability) to produce risk-informed equipment out-of-service times that permit licensees to monitor and manage activities associated with inoperable Technical Specification SSCs while maintaining nuclear safety risk within acceptable limits.

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3.2 RMTS Program Implementation

3.2.1 RMTS Process Control and Responsibilities

Implementation of the RMTS risk assessment process should be integrated into station-wide work control processes. The process requires identification of current and anticipated plant configurations and the performance of a quantitative risk assessment applicable to those configurations (i.e., a risk profile). Appropriate actions to manage the risk impacts shall then be determined and implemented if risk thresholds are expected to be exceeded.

The RMTS program structure includes the following attributes:

1. Current (conventional) Technical Specifications structure is retained but applicable systems contain contingencies that allow the use of Risk Managed Technical Specifications.

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2. Operability determinations are performed in accordance with existing regulatory guidance and requirements (e.g., NRC Inspection Manual Part 9900 [9]).

3. Defined risk management thresholds (RMA threshold, RICT threshold) are specified.

4. Defined time interval periods (i.e., front-stop CT, RMAT, RICT, and back-stop CT) corresponding to applicable Technical Specification and risk management thresholds are determined.

5. Reference to defined actions in Technical Specifications are specified.

6. Ultimate risk limits are specified to prevent voluntary operation in plant configurations that correspond to high risk conditions (i.e., 10^{-3} CDF or 10^{-4} LERF per year).

The RMTS is intended to supplement the fixed CTs of the current Technical Specifications with provisions that allow the use of specific risk management methods to determine a risk informed completion time based on specific plant configurations in which one or more plant SSC is Technical Specification inoperable. An example structure for implementing the proposed RMTS is illustrated in Table 3-2. Table 3-2 shows an example structure for one system only, but this structure could be repeated for other SSCs.

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Table 3-2
Generic Risk-informed CTs with a Back-stop: Example Format.

Actions Condition	Required Action	Completion Time
B. Subsystem inoperable.	B.1 Restore subsystem to OPERABLE status.	72 hours
	OR	
	B.2.1 Determine that the completion time extension beyond 72 hours is acceptable in accordance with established RMTS thresholds.	72 hours
	AND	
	B.2.2 Verify completion time extension beyond 72 hours remains acceptable.	In accordance with the RMTS Program.
	AND	
	B.2.3 Restore subsystem to OPERABLE status.	30 days or acceptable RICT, whichever is less.

Quantitative risk assessments used to support RMTS evaluations shall be performed with a plant specific PRA model approved by station management in accordance with approved station procedures. Fire, seismic and/or flood risks shall also be considered when establishing the duration of a proposed CT extension (See Section 4, PRA Attributes).

In the conduct of RMTS, procedural guidance is required for conducting and using the results of the risk assessment. These procedures should specify the station functional organizations and personnel, including operations, engineering, work management and risk management (PRA) personnel, responsible for each step of the procedures. The procedures should also clearly specify the process for calculating the applicable RICT, implementing RMAs, conducting, reviewing, and approving decisions to exceed the front-stop CT and remove equipment from service.

For stations implementing a RMTS program, the development and maintenance of a "pre-analyzed" list of plant configurations with associated RICT values is permitted. This list does not necessarily need to address all SSCs governed by the Technical Specifications, but should address reasonable or expected combinations of SSCs that would be removed from service.

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3.2.2 RMTS Implementation Process

A RMTS program defines the scope of equipment used to define plant configurations. Generally, equipment included within the evaluation of a specific plant configuration is associated with SSCs that are included within the scope of the Technical Specifications and are included in a station's CRM program. Therefore, these SSCs have front-stop CT requirements and can be evaluated via the RMTS-supporting PRA and CRM program. Technical Specifications for Safety Limits, Reactivity Control, Power Distribution, and test exceptions are not in the scope of the RMTS guidelines.

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Stations implementing a RMTS program are required to perform a RICT assessment whenever (1) the front-stop CT for an SSC within the scope of the RMTS program is expected to be exceeded, (2) whenever an SSC within the scope of the RMTS program is beyond its front-stop CT and a plant configuration change within the scope of the CRM program occurs (e.g., a SSC within the scope of the plant CRM program is removed from or returned to service).

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The PRA provides the analysis mechanism to identify SSCs for which RICT calculations can be applied. The PRA considers dependencies, support systems, and, through definition of top events, cut sets, and recovery actions, it includes those SSCs that could, in combination with other SSCs, result in risk impacts. Thus, an appropriate technical basis exists for RICT calculations. The risk informed assessment scope of SSCs included in a plant CRM program generally includes the following:

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1. Those SSCs included in the scope of the plant's Level 1 and LERF (or Level 2 if available), internal (and, if available, external) events PRA, and;

2. Those SSCs not explicitly modeled in the PRA but whose functions can be directly correlated, with appropriate documentation, to those in 1 above (e.g., actuation instrumentation for a PRA modeled function).

Figure 3-1 provides a process flowchart for implementation of the RMTS program.

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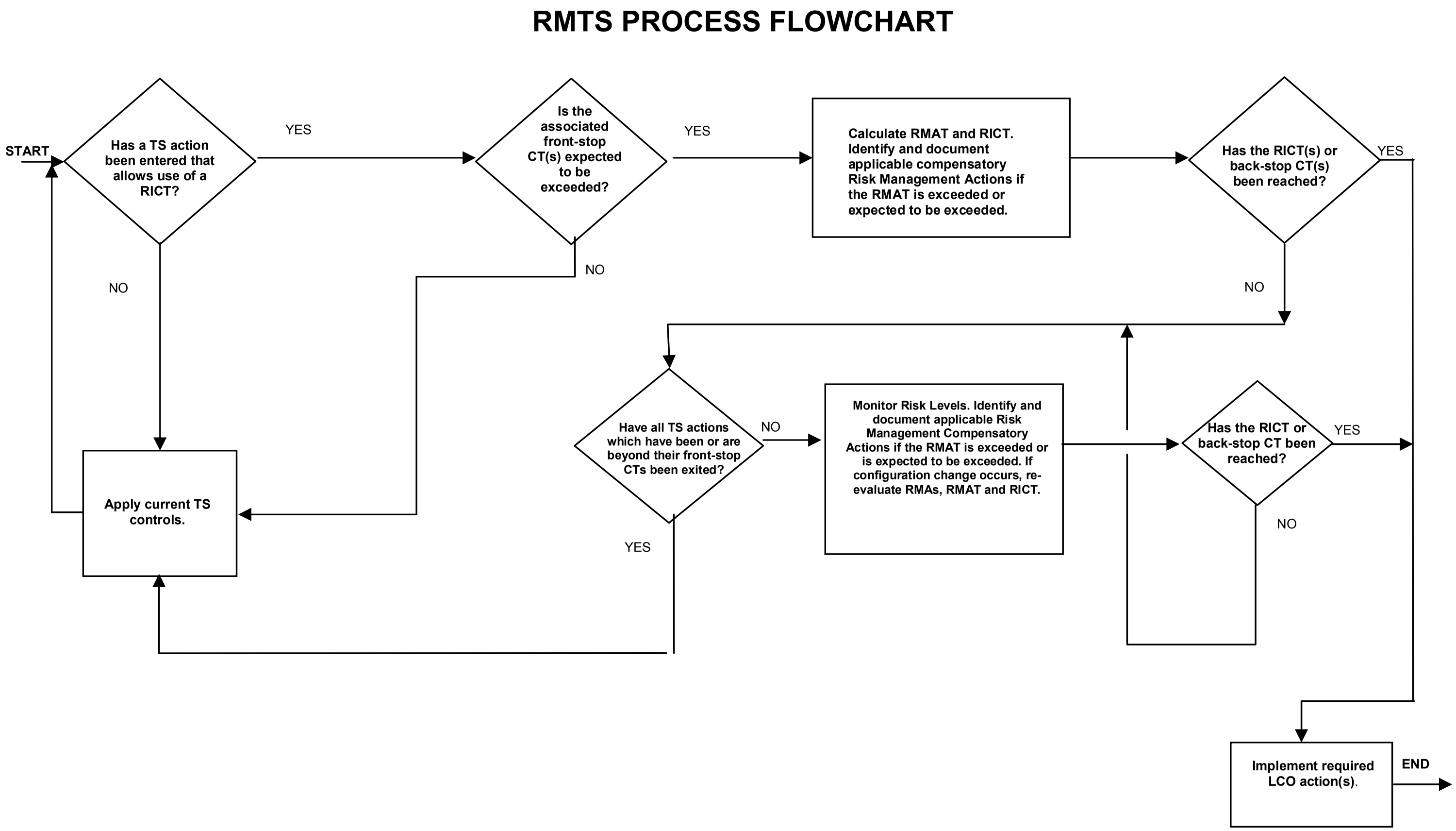

Figure 3-1
Process Flowchart for RMTS RICT Assessment and Implementation

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The following provides general guidance for implementation and conduct of a RMTS program.

1. Plant operating conditions (modes) for which RMTS may be applied are defined in Section 2.1.

2. The determination of an applicable RMAT and RICT shall use quantitative analysis approaches. Qualitative risk insights may be used to develop appropriate compensatory risk management actions.

3. The RICT assessment shall assume equipment declared inoperable is also non-functional unless a condition exists that is explicitly modeled in the PRA and the PRA functionality criteria provided in Section 2.3.1 Item 11 are satisfied. In a RMTS program, a RICT exceeding the current front-stop CT may not be applied in cases where a total loss of function has occurred (e.g., all trains of a required Technical Specifications system are determined to be non-functional, such as all trains of Safety Injection or all trains of Component Cooling Water). Unless otherwise permitted by the Technical Specifications, application of RMTS for an entry into a configuration involving a loss of function is not allowed.

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4. RICT assessments may be pre-determined (i.e., performed prior to an actual need), or they may be performed on an as-needed basis.

5. Emergent events or conditions (see definition in Appendix A) could change the conditions of a previously performed RICT assessment. Consequently, a revised RMAT and RICT may be required. Emergent conditions may include events such as plant configuration or mode changes, the removal of additional SSCs from service due to failures, or significant changes in external conditions (e.g., selected weather conditions or offsite power availability). The following guidance, consistent with Reference 2, should be applied to such situations:

   - A RICT assessment shall be performed or re-evaluated to address the changed plant configuration on a reasonable schedule commensurate with the safety significance of the condition. This assessment shall be performed within the shorter of 12 hours or the most limiting front-stop CT after a configuration change that affects an RMTS RICT has occurred.

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   - Performance (or re-evaluation) of the RICT assessment shall not interfere with, or delay, the operator and/or maintenance crew from taking timely actions to place the plant in a stable configuration, restore the equipment to service, or take appropriate compensatory actions.

   Additionally, the RICT may be recalculated when an affected SSC is restored to an operable condition (i.e., the plant configuration changes).

6. A Technical Specification action statement with the provision to utilize a RICT shall be considered not met whenever the RICT is exceeded. In the event a

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   Deleted: or (2) the computed configuration specific risk associated with being in multiple actions (with at least one having provisions to utilize a RICT) has an equivalent CDF greater than or equal to 10^{-3} or LERF greater than or equal to 10^{-4} per year

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Technical Specification LCO is not met, the applicable actions specified by the Technical Specification Action Statement shall be taken.

3.2.3 RMAT and RICT Calculations

In a RMTS program, the conventional Technical Specification definition of equipment “operability” (see Appendix A) applies, just as it does under existing Technical Specifications. Thus, equipment “operability” is applied by station operating staffs to evaluate whether SSC LCOs are met and whether to enter or exit Technical Specifications actions. The information contained in NRC Inspection Manual 9900 [9] should be used as guidance in making operability determinations.

If a degraded or nonconforming condition existing on a component can be explicitly modeled by the station’s PRA, then a situation specific RICT can be calculated. In these cases the PRA analysis supporting the RICT calculation must be documented, retrievable, and able to be referenced using normal operator documentation mechanisms (e.g., Control Room Logs or other equivalent methods). In the RICT calculation, equipment PRA functionality may be considered. The evaluation for the applicability of crediting “PRA functionality” shall be conducted in accordance with the guidance provided in Item 11 of Section 2.3.1. This guidance is intended to address separate operability and PRA functionality assessments which would allow a component to be considered both inoperable and PRA functional based on an evaluation of the same degraded condition. Specific examples are provided for each of the conditions identified in Items 11.1 through 11.3 of Section 2.3.1.

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Item 11.1 Examples (If a component is declared inoperable due to degraded performance parameters, but the affected parameter does not and will not impact the success criteria of the PRA model, then the component may be considered PRA functional for purposes of the RICT calculation.)

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Example 1: A valve fails its in-service testing stroke time acceptance criteria, but the response time of the valve is not relevant to the ability of the valve to provide its mitigation function (i.e., the valve is normally open and required to be open in the PRA). The valve may be considered PRA functional in the RICT calculations.

Example 2: A pump is declared inoperable due to increasing bearing temperatures. Although the temperature of the bearing is not immediately impacting on the pump success criteria (i.e., pump flow), the basis for declaring it inoperable is the anticipated degradation and loss of function. Since the condition has been judged to warrant declaring the pump inoperable, it should not be simultaneously considered PRA functional for the RICT calculations.

Item 11.2 Examples (If the functional impact of the condition causing the inoperability is capable of being assessed by the PRA model, then the remaining unaffected functions of the component may be considered PRA functional in the RICT calculation.)

Example 1: A valve is inoperable but secured in the closed position, and can be addressed in the PRA model by failing functions which require an open valve, but crediting functions which require a closed valve.

Example 2: A component is inoperable due to a non-functional seismic support, and can be addressed in the PRA model by failing the component for seismic initiators but crediting the component function for other initiators.

Example 3: A component is inoperable due to unavailability of a normal power supply when a backup is PRA functional, and can be addressed in the PRA model by failing the normal power supply when the backup power supply is appropriately included in the model.

Example 4: A component is inoperable due to invalid qualification for a harsh environment, but the PRA provides the capability to discern the scenarios which result in harsh environments.

Item 11.3 Examples (If the condition causing a component to be inoperable is not modeled in the PRA, and the condition has been evaluated and documented in the RMTS program as having no risk impact, then the RICT may be calculated assuming availability of the inoperable component and its associated system, subsystem or train. If there is no documented basis for exclusion, or if the condition was screened as low probability, then the inoperable component must be considered not functional.)

Example 1: A pump backup start feature is inoperable and the feature is not credited in the PRA model (assumed failed); the RICT calculation may assume availability of the associated pump since the risk of the non-functional backup start feature is part of the baseline risk.

Example 2: An interlock is inoperable and is not modeled in the PRA because it was identified as highly reliable. In this case the RICT calculation must assume the affected system, subsystem, or train is not functional.

RICT assessments do not allow credit to be taken for probability of repair of the affected Technical Specifications equipment in a configuration-specific RICT calculation.

For planned maintenance in which a condition requiring a RICT assessment is applicable, a plant configuration-specific RICT assessment should be performed to determine RMAT and RICT values prior to commencing the maintenance.

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- If the anticipated duration of the maintenance does not extend beyond the RMAT, normal work controls may be used to perform the maintenance in accordance with Maintenance Rule (a)(4) requirements.

- If the anticipated duration of the maintenance extends beyond the RMAT or an emergent condition has caused the RMAT to be exceeded, appropriate compensatory risk management actions shall be defined and implemented as necessary to control plant risk.

- If the anticipated duration of maintenance extends beyond the RICT, the configuration should not be entered.

Note that for preplanned maintenance activities for which the RMAT is anticipated to be exceeded, RMAs shall be implemented at the earliest appropriate time.

In instances in which an emergent event occurs, calculation of an applicable RICT is always secondary to performance of actions necessary to place the plant in a stable configuration. Additionally, during events in which Technical Specifications LCOs are not met but for which the plant remains in a state in which conditions continue to change, the Technical Specifications CTs shall be governed by the current Technical Specifications front-stop CTs until a stable configuration is reached. An explicit example of this situation is provided for clarity. Consider the case where the plant DC electrical distribution system is in a condition where the batteries are discharging and DC bus voltage is decreasing. In this condition, the plant should not consider extension of the Technical Specifications CT until such time as the plant is placed in a stable condition.

If during application of a specified RICT, the plant transitions to a different plant configuration that impacts SSCs within the scope of the CRM program (e.g., due to emergent conditions), then a revised RICT is required to be calculated. Stations implementing RMTS shall have configuration risk management tools (i.e., safety monitors, risk monitors, pre-solved configuration risk databases, etc.) that can be applied to calculate configuration risk by the on-shift station staff within relatively short periods of time following identification of the configuration. In the event emergent conditions occur while a RICT is in effect, the plant would (1) take actions appropriate to managing risk in the current condition, and then (2) assess the risk significance of the condition. The plant would then calculate a revised RMAT and RICT. This calculation must be accomplished within the front-stop CT of the most limiting action applicable to the new plant configuration; however, this calculation shall be completed within a maximum time period of 12 hours from the time the configuration change occurred.

In a RMTS program the revised RMAT and RICT are effective from the time of entry into the condition of the initial RMTS for which a RICT is applied. The associated RICT "time-clock" is not reset to zero at the time the modified or new

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Quantification of the RICT shall incorporate the cumulative risk from the time the first of the affected actions were entered. Once the RICT is applicable, the configuration shall be monitored for additional changes that might affect the RICT and the RICT recalculated if necessary. ¶

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configuration occurs. Thus, it is possible in a RMTS framework, that a RICT can be revised several times as SSCs are removed from and returned to service. Only when the plant satisfactorily exits all applicable Technical Specifications actions where the associated front-stop CT has been exceeded can the RICT "time-clock" be re-set to zero. The RICT re-evaluation process is required whenever emergent conditions change the configuration risk profile of the plant. This includes non-Technical Specifications equipment functions that are in the scope of the CRM program and which are involved in the emergent conditions. By incorporating a configuration risk management approach to Technical Specifications, a RMTS program can result in lower cumulative risk over time for the RMTS-implementing station as compared to a conventional Technical Specifications safety management process for the same station.

In cases where an emergent condition arises that may place the plant in a condition where it has exceeded the revised RMAT, the station staff would implement appropriate compensatory measures or compensatory risk management actions, including, as appropriate, transitioning the plant to a lower-risk configuration (i.e., restoring equipment to service or transition to a lower plant operating mode). In any case where a plant reaches or is found to have exceeded the specified configuration specific RICT thresholds of Table 2-2 are exceeded, the plant shall consider the required action to not be met and follow the Technical Specification requirements, including any associated requirement for plant shutdown implementation.

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3.2.4 Examples Demonstrating Application of RMAT and RICT in RMTS Programs

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An important feature of RMTS that is not present in conventional Technical Specifications is the requirement that whenever multiple SSCs are inoperable and have the provision to utilize a RICT, the plant configuration is analyzed to verify the individual front-stop CTs remain acceptable (i.e., the calculated RICT is greater than the front-stop CT of each of the inoperable SSCs). This provision is intended to ensure configurations that entail inoperability of multiple SSCs that place the plant in an elevated risk condition are identified and appropriately managed. This provision goes beyond the requirements of conventional Technical Specifications by (1) evaluating the impact of the combination of the inoperable Technical Specification SSCs and (2) evaluating this risk in the context of the plant configuration that includes all SSCs within the scope of the plant CRM program. Thus, this provision of RMTS provides a significant enhancement to nuclear safety that is not present in conventional deterministic Technical Specifications. ¶
3.2.5

There are two important configuration risk concepts used in the implementation of a RMTS program to manage risk: instantaneous risk and cumulative risk. Figures 3-2 and 3-3 illustrate these concepts. Figure 3-2 presents an example of an instantaneous core damage frequency (CDF) profile for a calendar week. Figure 3-3 presents an incremental core damage probability (ICDP) profile for the same example week.

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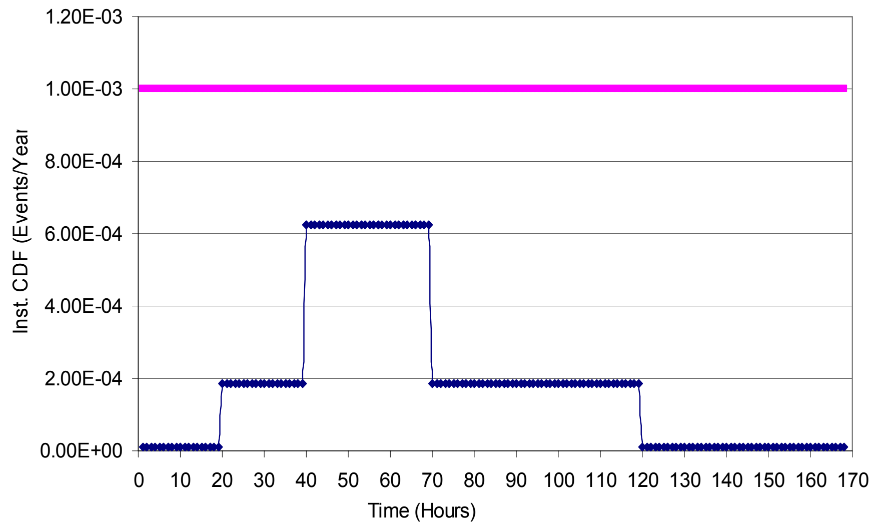

Figure 3-2
Configuration Risk Management – Instantaneous CDF Profile Example

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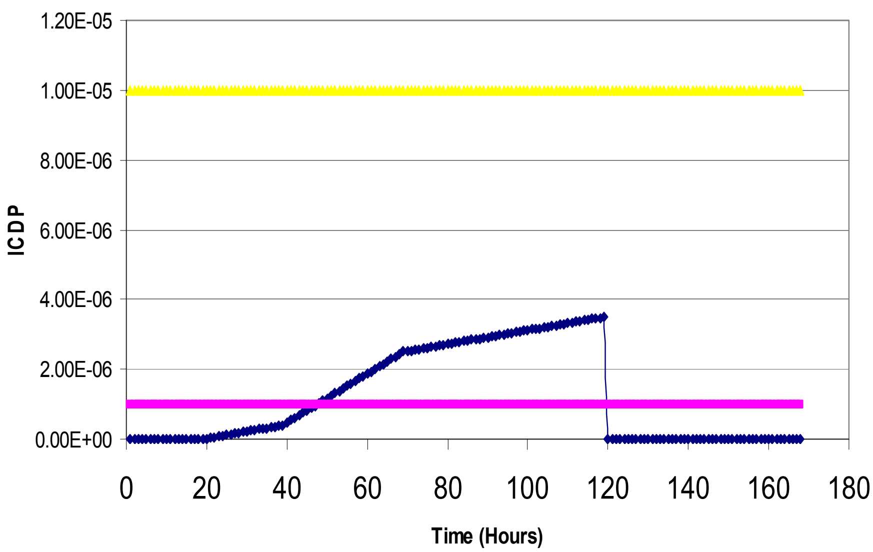

Figure 3-33
Configuration Risk Management – Instantaneous CDP Example

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Figure 3-2 shows an example where the first step increase in instantaneous CDF, from the zero-maintenance state, at time = 20 hours is for a planned maintenance activity, and the second step increase in instantaneous CDF at time = 40 hours is due to an emergent unplanned failure discovered in another system. In this example, the emergent failure function is recovered at time = 70 hours, and the originally planned maintenance continues until time = 120 hours. It is important to note that before time = 20 hours and after time = 120 hours, the instantaneous CDF is not zero (as it may appear in this figure due to size resolution), but is equal to the zero-maintenance CDF for the plant (10^{-5} in this example). The horizontal straight-line upper limit shown in Figure 3-2 is the Instantaneous CDF risk threshold for RMTS (= 10^{-3} events per year). A similar instantaneous LERF risk threshold for RMTS is established at 10^{-4} events per year. It is also important to note that this is an example provided for conceptual purposes only. In general, plant-specific zero-maintenance CDFs and plant configurations will be lower, which will result in less risk accumulation over greater periods of time.

Figure 3-3 shows the same example plant configuration versus time profile for incremental core damage probability (ICDP). ICDP does equal zero whenever the zero-maintenance configuration is in effect, but begins to rise at time = 20 hours when the plant is placed in the originally planned plant configuration. When the plant transitions to the second plant configuration at time = 40 hours (when the emergent condition occurs or is discovered), the slope of the ICDP profile increases until the function of the emergent failure is recovered at time = 70 hours. At this time, the slope of the ICDP curve returns to its original value for the original system being out of service (i.e., the value at time = 20 hours). This profile continues until the plant is returned to the zero-maintenance configuration at time = 120 hours. Within the context of RMTS, plant risk is evaluated with respect to particular plant configurations (either planned or emergent). Thus, at the completion of the evolution for which RMTS is applicable, the ICDP profile is defined to return to zero (as shown in Figure 3-3 at time = 120 hours). Figure 3-3 shows two horizontal lines, the lower for the RMA threshold value (ICDP = 10^{-6}), and the higher for the RICT threshold value (ICDP = 10^{-5}). In this example, the station staff would be required to implement Risk Management Actions (RMAs) once the configuration risk ICDP profile increases above 10^{-6} (at approximately time = 47 hours in this example). In accordance with Section 2.1.3 Item 3, for maintenance activities for which the RMAT is anticipated to be exceeded, RMAs shall be implemented at the earliest appropriate time. The concepts shown in Figures 3-2 and 3-3 are also applied to large early release probability (LERP) thresholds in RMTS.

Figure 3-4 provides a simple example of the RMTS process for inoperability of a SSC followed by an emergent event which modifies the risk profile causing changes in the plant configuration RMAT and RICT values. This example is intended to explicitly demonstrate the application of these values in a RMTS program. At time

= 0, the RMTS SSC becomes inoperable for a duration anticipated to exceed the front-stop CT. In this configuration, a RMAT and RICT are calculated. As evident in the figure, the RMAT would be exceeded at time = 7 days. If the anticipated duration of the activity exceeds this time, appropriate compensatory risk management actions will be developed and implemented prior to reaching the RMAT. Again, in accordance with Section 2.1.3 Item 3, the RMAs shall be implemented at the earliest appropriate time. ince the 10^{-5} ICDP threshold is not reached within the 30 day back-stop CT, the applicable RICT is set at 30 days.

At time = 5 days an emergent event occurs which removes a second SSC from service. At this time, the RMTS program requires recalculation of the RMAT and RICT to apply to the new plant configuration. In this plant configuration the RMAT now occurs very soon after the emergent event occurs, thus necessitating development and rapid implementation of additional compensatory RMAs, Additionally, since the 10^{-5} ICDP threshold is reached at time = 27 days, the RICT is revised to reflect this. The start of the time for this configuration to be exited is taken from the time at which the original SSC was declared inoperable and NOT the time at which the emergent event occurred.

In this condition, the RMTS provision applies separately to each ACTION for which it is entered (i.e., RMTS is applied as an extension of the ACTION statement of the referencing Technical Specification). Although a particular ACTION with the CT extended may be exited when the affected SSC is restored to operable status, the accumulated risk of that configuration will continue to contribute to the configuration risk for the associated entry into RMTS until all affected ACTIONs are exited or within their front-stop CT. Application of the RMTS separately to each ACTION also means that the 30-day back-stop CT limit applies separately to each action.

In the example shown in Figure 3-4, at time = 20 days, the second SSC (i.e., the one which became inoperable due to the emergent event at time = 5 days) is restored to service (i.e., returns to a Technical Specification operable condition). At this time, the RICT may be recalculated to reflect the new plant configuration accounting for the cumulative risk accrued during the evolution from time = 0. In this configuration, the 10^{-5} ICDP is not reached until the after the 30 day back-stop CT. The RICT for System 1 may now be reset to 30 days from the time the first system became inoperable. Also, notice that since the cumulative risk at this point is greater than the 10^{-6} ICDP threshold; implementation of appropriate compensatory risk management actions continue to be required.

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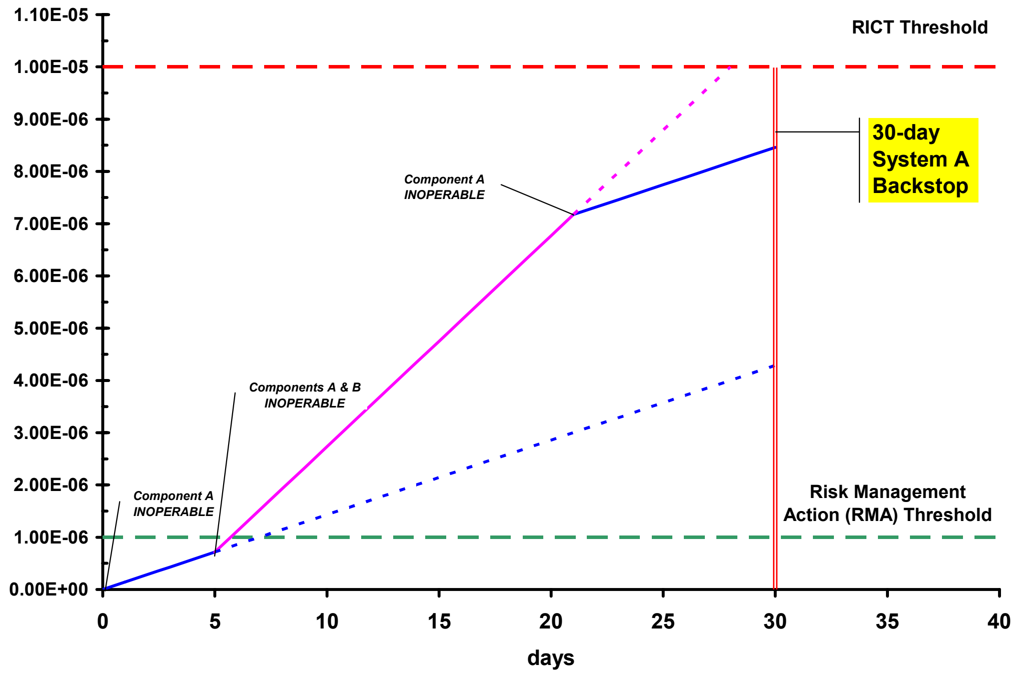

Figure 3-4
Configuration Risk Management – Illustration of Risk Accrual for RICT Calculation

For preventive maintenance conditions which are planned in advance and there is an expectation that the front-stop CT will be exceeded, the RMAT and RICT values should be computed prior to placing the system in an inoperable condition. Furthermore, in the planning of removal of SSCs from service the station should routinely plan to target incremental CDF/LERF values below the Maintenance Rule "normal maintenance level" of 10^{-6} and 10^{-7} respectively. Should preventive maintenance activities be anticipated to exceed the RMAT thresholds, appropriate RMAs should be identified and, as appropriate, implemented before the condition is entered.

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3.3 RMTS Assessment Methods

Sections 3.3.1 and 3.3.2 provide guidance regarding quantitative and qualitative considerations, respectively.

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3.3.1 Quantitative Considerations

The assessment process shall be performed via tools and methods that incorporate quantitative information from the PRA. Acceptable processes for quantitative assessment include direct assessment of configurations via the PRA model, use of on-line safety/risk monitors, or via a comprehensive set of pre-analyzed plant configurations. To properly support the assessment, the PRA must have the attributes specified in Section 2.3.4 unless otherwise justified (also see Section 4.1, PRA Attributes), and it must reflect the actual plant configuration consistent with the RMTS program scope. Additionally, the CRM program / tool must have the attributes specified in Section 2.3.5 unless otherwise justified (also see Section 4.2, CRM Attributes), and must reflect the actual plant configuration consistent with the RMTS program scope.

3.3.2 Qualitative Methods

RMTS programs are fundamentally based on the ability to calculate a RICT, and therefore, are inherently based on quantitative risk analysis. These quantitative analyses can include bounding analyses. Guidance on bounding analyses for PRA applications is provided, for example, in the industry guidance [5] for implementation of 10 CFR 50.69.

Although the calculation of a RICT is quantitative, qualitative assessments are an important part of the RMTS process used, where appropriate, to supplement the quantification and develop appropriate compensatory risk management actions. Qualitative assessments may be applied to confirm that the aspects not comprehensively addressed in the quantitative assessment have negligible effect on the calculated RICT.

3.3.3 Cumulative Risk Tracking

One overall objective of RMTS is to provide plant configuration control consistent with Regulatory Guide 1.174 over long periods of implementation. The purpose of this tracking is to demonstrate the risk accumulated as a result of SSC inoperability beyond the front-stop CT is appropriately managed. To accomplish this goal, the impact of RMTS implementation on the baseline risk metrics should be periodically assessed and managed as appropriate to ensure there is no undue increase. Long-term risk should be managed via an administrative process incorporated within the station RMTS program, and, unlike the RICT implementation described in Table 3-2, would not be directly linked to Technical Specifications required actions. One example of such tracking would be to record all RMTS entries where inoperable SSCs extend beyond their respective front-stop CT and track the associated accumulated risk during those plant configurations. An alternative, more continuous, example of an acceptable general administrative

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cumulative risk management process would be tracking risk via a 52-week rolling average CDF trend that is updated weekly to account for the actual cumulative risk incurred above the zero-maintenance baseline risk. Alternatively, the plant could meet this requirement by documenting the zero-maintenance baseline risk for the plant along with the changes or “deltas” from that baseline, or through quantifying the “deltas” from the baseline on a periodic basis. This administrative process for cumulative risk management should include a requirement to document specific corrective actions and, if necessary, for ensuring operation remains within Regions II or III of Figures 3 and 4 of NRC Regulatory Guide 1.174 [4]. The RMTS program implementing procedure should clearly describe how cumulative risk tracking and associated “triggers” for self-assessment and corrective action will be implemented within the station-specific RMTS program.

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Regardless of the method used**,** the station must track the risk associated with all entries beyond the front-stop CT. This information should be evaluated periodically against the guidance of Regulatory Guide 1.174.

3.3.4 Uncertainty Consideration in a RMTS Program

PRAs applied for RMTS implementation should appropriately consider the issue of uncertainty (see Reference [6] for guidance on treatment of uncertainty in PRAs). This will identify which key base PRA modeling assumptions are important to ensure the RMTS decision-making process is robust. RMTS-implementing stations must have PRAs of acceptable quality and capability yielding zero-maintenance CDF and LERF results that meet established criteria applicable to 10CFR50.65(a)(4) applications. Application of PRA calculated values for configuration risk compared with the PRA quality acceptance guidelines provided herein provides adequate confidence that RICT calculations are safe and appropriate for use in the RMTS decision-making process.

The RMAT and RICT calculations are by definition changes to CDF (i.e., delta-CDF) in that they represent changes from baseline risk values based on equipment out-of-service. In this regard, parameter or aleatory uncertainties are unbiased and tend to cancel since only a change in CDF from equipment out-of-service is being determined.

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In an RMTS program the issue of epistemic uncertainty (or modeling uncertainties) associated with the PRA is addressed by evaluation of PRA base model uncertainties prior to the initial implementation of the RMTS program. The station will perform an assessment of the impact of PRA modeling assumptions on RICT calculations for LCOs within the program scope. This evaluation includes an LCO specific assessment investigating the impact of key PRA assumptions on configuration risk. In support of LCO specific risk assessments, the licensee should:

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1. Identify the key sources of uncertainty in the PRA consistent with the expectations of RG 1.200. An example process for identifying key assumptions is found in EPRI-1009652 [6].

2. For each LCO within the scope of the RMTS program, identify those SSCs or PRA elements (e.g., operator actions, initiating events, etc.) that appear in the same functional core damage sequences as the component for which the LCO is to be determined.

3. Identify key model uncertainties that may impact the SSCs or PRA elements identified in step 2.

4. Perform sensitivity studies on those uncertainties which could potentially impact the result of a RICT calculation. For those sequences in which uncertainty is found to have a potential significant impact on the calculated RICT, identify appropriate compensatory risk management actions and incorporate these into the station RMTS program implementation guidance.

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Although this assessment is not intended to be exhaustive, the general guidance should be that the impact of the key modeling uncertainties and associated key assumptions is limited when reasonable alternate modeling assumptions do not result in significant increases to plant risk. Where the uncertainty impact is identified to result in a significant risk increase, risk management actions are identified to minimize this impact. In instances where assumptions are judged to be overly optimistic (i.e., non-conservative) for this application, use of alternate assumptions should be considered. This assessment is only intended to be performed prior to initial implementation of the RMTS program and after a substantial update of the PRA.

3.3.5 External Events Consideration

When evaluating risks for use in a RMTS program, plant PRA models should include internal floods, fires, and other external events that the PRA would indicate as risk significant and that would impact maintenance decisions. For stations <u>without</u> external events PRAs incorporated into their quantitative CRM Tools, or in cases where the existing external event PRA does not adequately address the situation, the station should apply the following criteria to support maintenance activities beyond the front-stop CT:

1. Provide a reasonable technical argument (to be documented prior to the implementation of the associated RICT) that the configuration risk of interest is dominated by internal events, and that external events, including internal fires, are not a significant contributor to configuration risk (i.e., they are not significant relative to a RICT calculation).

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2. Perform a reasonable bounding analysis of the external events, including internal fires, contribution to configuration risk (to be documented prior to the implementation of the associated RICT) and apply this upper bound external events risk contribution along with the internal events risk contribution in calculating the configuration risk and the associated RICT.

OR

3. For limited scope RMTS applications, a licensee may use pre-analyzed external events and internal fire analyses to restrict RMA thresholds and identify and implement compensatory risk management actions. For the duration of the configuration of interest, these actions should be supported by analyses and provide a reasonable technical argument (to be documented prior to the implementation of the associated RICT) that external events, including internal fires, are adequately controlled so as to be an insignificant contributor to the incremental configuration risk. Any RMAs credited in this manner shall be proceduralized and appropriate training provided.

The "reasonable bounding analyses" identified in Item 2 above must be case-specific and technically verifiable, and they must be shown to be conservative from the perspective of RICT determination (i.e., result in conservative RICT values). An example of a bounding analysis method for screening fire risk in a RMTS program that may be used is presented in Reference [7]. It is the intent of the RMTS process to consider the total plant risk. Stations with full scope PRAs will be able to perform integrated quantitative risk assessments to support their RMTS programs. However, it is expected that many of the stations intending to utilize an RMTS program will have robust Level 1 and LERF PRAs; however, they may need to incorporate additional methods and processes to evaluate the risk impact associated with fire, seismic, and external flooding. When external events PRA is used in the quantitative CRM Tool to address external events applicable to RMTS, the PRA and CRM capability requirements must be commensurate with the guidelines specified in Sections 2.3.4, 2.3.5, 4.1 and 4.2 of this report.

In addition to the evaluation of external events for potential RICT impact, these events should be evaluated for insights which permit development and implementation of applicable risk management actions. The results of these evaluations may be incorporated into plant programmatic controls (e.g., procedures, checklists, etc.).

3.3.6 Common Cause Failure Consideration

Common cause failures are required to be considered for all RICT assessments. For all RICT assessments of planned configurations, the treatment of common cause

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failures in the quantitative CRM Tools may be performed by considering only the removal of the planned equipment and not adjusting common cause failure terms.

For RICT assessments involving unplanned or emergent conditions, the potential for common cause failure is considered during the operability determination process. This assessment is more accurately described as an "extent of condition" assessment. Licensed operators recognize that an emergent condition identified on a Technical Specifications component may have the potential to affect a redundant component or similar components. In addition to a determination of operability on the affected component, the operator should make a judgment with regard to whether the operability of similar or redundant components might be affected. In accordance with the operability determination guidance in Part 9900 of the NRC Inspection Manual (provided in Regulatory Information Summary 2005-20), the determination of operability should be done promptly, commensurate with the safety significance of the affected component. If a common condition affects the operability of multiple components (e.g., that more than one common cause group functional train is affected), action should be taken via the Technical Specifications.

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Based on the information available, the licensed operator is often able to make an immediate determination that there is reasonable assurance that redundant or similar components are not affected. Using judgment with regard to the specific condition, the operator may direct that similar or redundant components be inspected for evidence of the degradation. For conditions where the operator has less information, assistance from other organizations, such as Station Engineering, is typically requested. These support organizations continue to perform the evaluation promptly, as described above. The guidance contained in Part 9900 of the Inspection Manual is used as well as conservative decision-making for extent of condition evaluations. The components are considered functional in the PRA unless the operability evaluation determines otherwise.

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While quantitative changes to the PRA are not required, the PRA should be used as appropriate to provide insights for the qualitative treatment of potential common-cause failures and RMAs that may be applied for the affected configuration. Such information may be used in prioritizing the repair, ensuring proper resource application, and taking other compensatory measures as deemed prudent by station management.

3.4 Managing Risk

Risk Management uses both quantitative and qualitative risk assessment methods in plant decision-making to identify, monitor, and manage risk levels. This process involves coordination with planning, scheduling, monitoring, maintenance, and operations activities.

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The objective of configuration risk management is to manage the planned and emergent risk increases from maintenance activities and equipment failures and to maintain them within acceptable limits. In the context of an RMTS program, this control is accomplished by using RMAT values to identify higher risk evolutions to plan and schedule maintenance such that the risk increases are identified and appropriately managed. For activities in which the RMAT is anticipated to be exceeded, the station staff should take additional actions beyond routine work controls and endeavor to maintain adequate margin between the actual risk level and the RMA threshold. For activities in which the anticipated maintenance duration will exceed the RMAT, organizational controls beyond what are considered normal (i.e. risk management actions) shall be initiated with station priorities directed to returning risk levels to below the ICDP / ILERP threshold. For preplanned maintenance activities for which the RMAT is anticipated to be exceeded, RMAs shall be implemented at the earliest appropriate time including, where appropriate, for the entire duration of the maintenance activity.

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A key risk management activity is assessing the risk impact of planned maintenance. In conjunction with scheduling the sequence of activities, compensatory risk management actions may be taken that reduce the temporary risk increase, if determined to be necessary. Since many of the compensatory risk management actions involve non-quantifiable factors, the risk reduction would not necessarily be quantified. The following sections discuss approaches for the establishment of thresholds for the use of compensatory risk management actions.

3.4.1 Risk Management Action Incorporation in a RMTS Program

Using this framework for risk management, the station staff can calculate RMATs and RICTs. For planned maintenance, target outage times should be established at low risk levels (See Table 3-1) and should be accompanied by normal work controls. The process to manage risk levels assesses the rate of accumulation of risk in specific plant configurations and determines the acceptability of continued plant operation (beyond the front-stop CT) based on the risk assessment, alternative actions, and the impact of compensatory risk management actions. If the target outage time exceeds the RMAT, RMAs must be considered and, where deemed appropriate by station management and operators, implemented. RMAs are specific activities implemented by the plant to monitor and control risk. Section 3.4.3 provides some examples of RMAs. If the target outage time reaches the RICT, action must be taken to implement the applicable Technical Specification action statement(s).

RMAs may be quantified to determine revised RICT values, but this quantification of RMAs is neither expected nor required, as omission of this RMA quantification results in conservative RICT values. For evolutions where compensatory RMAs are planned in support of maintenance (e.g., temporary diesels), it may be beneficial to

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quantify RMAs, to determine realistic RICT values. For a station to be eligible to quantify RMAs and credit them in the RICT determination, it must be able to determine the associated RMA risk impacts on and from the following: SSC functionality, new configurations of existing PRA basic event cut sets, new temporary equipment functions, and new or modified human actions. Actions that will be credited shall be proceduralized with responsible implementing staff trained on application of the procedures. If the station chooses to quantify RMAs, it must apply a documented and approved process that meets the PRA and CRM program requirements described in this guidance document.

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During the time period following the RMAT but before the expiration of the applicable RICT, plants will normally progressively implement risk management compensatory actions commensurate with the projected risk during the plant configuration period. These compensatory actions are identified and implemented by station personnel and approved by station management based on plant conditions. Such compensatory measures may include but are not limited to the following:

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- Reduce the duration of risk sensitive activities.
- Remove risk sensitive activities from the planned work scope.
- Reschedule work activities to avoid high risk-sensitive equipment outages or maintenance states that result in high risk plant configurations.
- Accelerate the restoration of out-of-service equipment.
- Determine and establish the safest plant configuration.

Contingency plans can also be used to reduce the effects of the degradation of the affected components by utilizing the following:

- Specific operator actions.
- Increased awareness of plant configuration concerns and the effects of certain activities and transients on plant stability.
- Administrative controls.
- Ensure availability of functionally redundant equipment.

3.4.2 Qualitative Considerations Supporting Action Thresholds

RMTS risk management action thresholds (i.e., plant conditions and associated configuration risk levels determining when compensatory risk management actions are required) must be established quantitatively, but they can be supported qualitatively, if necessary. Qualitative assessment can be used to support identification and implementation of risk management compensatory actions for specific plant and site conditions present at the time SSCs are out of service, by considering factors outside the scope of the PRA (e.g., weather conditions, grid

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conditions, etc.), the performance of key safety functions, or remaining mitigation capability.

3.4.3 Examples of Risk Management Actions

Determining actions, individually or in combinations, to control risk for maintenance activities is specific to the particular activity, plant configuration, its impact on risk, and the practical means available to control the risk. Normal work controls would be employed for configurations having predicted risk levels below the RMA thresholds. For these configurations, no additional actions to address risk management are necessary.

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Risk management actions, up to and including plant shutdown, should be implemented (and may be required by the RMTS program) for plant configurations whose instantaneous and cumulative risk measures are predicted to approach or exceed the RMTS thresholds. The benefits of these actions may or may not be easy to quantify. These actions are aimed at providing increased risk awareness of appropriate station personnel, providing more rigorous planning and control of the particular maintenance activity, and taking steps to control the duration and magnitude of the increased risk. Examples of risk mitigation / management actions are as follows:

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1. Actions to provide increased risk awareness and control:
   - Discuss the planned maintenance activity and the associated plant configuration risk impact with operations and maintenance shift crews and obtain operator awareness and approval of planned evolutions.
   - Conduct pre-job briefing of maintenance personnel, emphasizing risk aspects of planned plant evolutions.
   - Request/require that system engineer(s) be present for the maintenance activity, or for applicable portions of the activity.
   - Obtain station management approval of the proposed activity.
   - Identify return-to-service priorities.
   - Identify important remain-in-service priorities.
   - Place warning signs or placards in the entry ways to protect other in-service risk significant equipment.
2. Actions to reduce duration of maintenance activity:
   - Pre-stage required parts and materials to be prepared for likely contingencies.

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- Walk-down the anticipated associated system tagout(s) and key equipment associated with the specified maintenance activity(ies) prior to conducting actual system tagout(s) and performing the maintenance.
- Develop critical activity procedures for risk-significant configurations, including identification of the associated risk and contingency plans for approaching/exceeding the RICT.

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- Conduct training on mockups to familiarize maintenance personnel with the activity prior to performing the maintenance.
- Perform maintenance around the clock rather than "day-shift only".
- Establish contingency plans to restore key out-of-service equipment rapidly if and when needed.

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3. Actions to minimize the magnitude of risk increase:
    - Minimize other work in areas that could affect related initiating events (e.g., reactor protection system (RPS) equipment areas, switchyard, diesel generator (D/G) rooms, switchgear rooms) to decrease the frequency of initiating events that are mitigated by the safety function served by the out-of-service SSC.
    - Identify remain-in-service priorities and minimize work in areas that could affect other redundant systems (e.g., HPCI/RCIC rooms, auxiliary feedwater pump rooms), such that there is enhanced likelihood of the availability of the safety functions at issue served by the SSCs in those areas.
    - Establish alternate success paths (provided by either safety or non-safety related equipment) for performing the safety function of the out-of-service SSC.
    - Establish other compensatory measures as appropriate.
    - Monitor RMTS program to ensure application is consistent with station risk-management expectations.

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    - Expedite equipment return to service to reduce risk levels.
    - Postpone plant activities, if appropriate, to maintain or reduce risk levels.

3.5 Documentation

Stations implementing a RMTS program shall provide documentation of the programmatic requirements associated with the RMTS and of the individual RICT evaluations. This documentation shall be of sufficient detail to permit independent evaluation of the assumptions, analyses, calculations, and results associated with the RICT assessments. The specific documentation requirements are provided in Section 2.3.2.

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3.6 Training

Stations implementing a RMTS program shall provide training in the programmatic requirements associated with the RMTS program and of the individual RICT evaluations to personnel responsible for determining Technical Specifications operability decisions or conducting RICT assessments. The specific training requirements are provided in Section 2.3.3.

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4
PRA AND CONFIGURATION RISK MANAGEMENT TOOL ATTRIBUTES

The application of the RMTS program to specific plant configurations requires the determination of a RMAT and RICT. This determination requires a quantitative risk estimate. The basis for these risk estimates is the application of a quantitative configuration risk management (CRM) tool, which is a derivative of the PRA. The scope and quality of the plant PRA and associated CRM tools must be commensurate with the risk impact and scope of the application. Furthermore, the PRA aspects of the CRM tool shall comply with NRC Regulatory Guide 1.200 guidance to the extent appropriate for the specific application. Two documents, Regulatory Guide 1.200 and this guideline, address the requirements for PRA scope and capability for application to the RMTS program. CRM tools applied for RICT calculations also must meet the same quality assurance requirements as their respective underlying PRAs approved for risk-informed applications via Regulatory Guide 1.200. For some operating modes and some initiating events (initiators) detailed below, bounding CRM methods may be used in addition to or instead of the CRM tool. This section describes the attributes of the PRA, the CRM tool, and bounding CRM methods that are necessary to support the RMTS program.

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4.1 PRA Attributes

In general, the quantitative risk assessment (plant PRA for RMTS) should be based on the station Configuration Risk Management Program supported by the PRA calculations. At a minimum, the PRA applied in support of a RMTS program shall include a Level 1 PRA with LERF capability. The scope of this PRA shall include credible internal events, including internal flood and internal fires. Other external events should be considered in the development of the RMTS program to the extent these events impact RMTS decisions. It is preferred that these impacts be modeled such that they are explicitly included in the calculation of a RICT. However, where prior evaluation or alternative methods (e.g., bounding analyses) can demonstrate that one or more of the challenges are not significant to the site or the application, quantitative modeling may be omitted.

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For application to RMTS the scope of the PRA directly addresses plant configurations during Modes 1 and 2 of reactor operation. Where the PRA is to be used to extend CTs that originate in the lower modes described in Section 2.1, the PRA model must directly address lower operating mode configurations, or a

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technically-based argument for application of the Mode 1 and 2 model to these other operating modes must be provided (e.g., it must provide assurance that risk associated with other modes addressed in the RMTS is bounded by the Modes 1 and 2 PRA event sequences).

The PRA must have an update process clearly defined by station procedures or instructions.

The PRA model attributes and technical adequacy requirements for RMTS applications must be consistent and compatible with established ASME standards requirements, as modified by NRC Regulatory Guide 1.200 Rev 0. Plant A and B level Findings and Observations arising from the PRA peer review should be resolved or otherwise dispositioned. It is expected that, in general, the PRA which supports RMTS shall meet Capability Category 2 requirements and any exceptions to meeting those requirements shall be justified. For limited scope applications, the PRA capability shall be appropriate to the Technical Specifications system(s) of concern.

4.2 CRM Tool Attributes

The specific CRM tool and PRA to CRM translation attributes necessary for RMTS implementation are specified in Section 2.3.5. While these CRM attributes may be implemented in various ways at RMTS-implementing stations, these attributes should be verifiable via the approved RMTS program. Guidance and recommendations for each of these attributes is provided as follows:

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1. **Initiating events accurately model external conditions and effects of out-of-service equipment.**

   CRM tools should explicitly model external conditions, such as weather impacts, or a process to adequately address the impact of these external conditions exists. The impacts of out-of-service equipment should be properly reflected in CRM initiating event models as well as system response models. For example, if a certain component being declared inoperable and placed in a maintenance status is modeled in the PRA, the entry of that equipment status into the CRM must accommodate risk quantification to include both initiating event and system response impact.

2. **Model truncation levels are adequate to maintain associated decision-making integrity.**

   Model truncation levels applied in the CRM should be such that they have no significant impact on associated RMTS decisions. In general, this means that the truncation levels are such that, for a specific RICT calculation, the RICT calculated via the truncated model would not vary significantly from that calculated via an associated un-truncated model and that important model elements have not been removed from the PRA through truncation. Reference

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[8] provides a reasonably rigorous set of criteria for managing PRA model truncation that may be applied for adequate decision-making support.

3. **Model translation from the PRA to a separate CRM tool is appropriate; CRM fault trees are traceable to the PRA. Appropriate benchmarking of the CRM tool against the PRA model shall be performed to demonstrate consistency.**

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No time-averaging features of the model that could lead to configuration-specific errors, such as equipment train asymmetries and treatment of possible alternate configurations, should be included in the CRM Tool. Time-averaging features of the basic event data that could lead to configuration-specific errors should be excluded in the CRM Tool database. Conversely, changes to the model and data should correctly reflect configuration-specific risk. In cases where the CRM tool is simply a configuration risk database cataloguing parameters calculated via the approved PRA, then spot checks of these parameters for conformance with the approved PRA should be performed in accordance with approved station procedures. In cases where the CRM tool directly performs PRA logic model reduction and/or risk calculations, quality assurance checks of the model and quantification results translation from the underlying approved PRA should be performed to validate model translation. These technical adequacy checks should show satisfactory traceability from the CRM model to the approved PRA.

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4. **Any modeled recovery actions credited in the calculation of a RICT shall be applicable to the plant configuration.**

RICT calculations should appropriately account for, and quantify, the impacts of human action dependence relative to plant configurations and conditions analyzed. This is particularly important in cases where credit for RMAs implemented within the RMTS program is taken in the RICT calculation. Performance of human recovery actions modeled in the PRA shall be performed via approved station procedures with the implementing personnel trained in their performance for these actions to be credited in the RMTS program.

5. **Configuration of the plant is correctly mapped from systems / components and real time activities to CRM model parameters.**

    a. Any pre-analysis translation tables from plant activities to CRM Tool basic events or model conditions should be accurate and controlled.

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    b. An effective written process should be in place to apply the translation tables and/or generate the CRM Tool inputs corresponding to plant activities.

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    c. Training of personnel who apply or review the CRM tool should be performed.

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6. **Each CRM application tool is verified to adequately reflect the as-built, as-operated plant, including risk contributors which vary by time of**

year or time in fuel cycle or otherwise demonstrated to be conservative or bounding.

CRM tools should reflect as-built, as-operated plant conditions. The CRM tools should be updated in accordance with approved PRA update procedures.

7. **Application specific risk important uncertainties contained in the CRM model (that are identified via PRA model to CRM tool benchmarking) are identified and evaluated prior to use of the CRM tool for RMTS applications.**

   Uncertainty should be addressed in RMTS CRM tools by consideration of the translation from the PRA model to the CRM tool. Note that the uncertainties evaluated in this step are limited to new uncertainties that could be introduced by application of the configuration management tool to provide or calculate configuration specific risk values used in the determination of a RMAT and RICT. These uncertainties may be evaluated using the same four step process described in Section 3.3.4 to evaluate uncertainties in the PRA base model.

8. **CRM application tools and software are accepted and maintained by an appropriate quality program.**

   CRM application tools and associated software applied for RMTS implementation should meet the same level of quality assurance as the underlying approved PRA software and application tools.

9. **The CRM tool shall be maintained and updated in accordance with approved station procedures to ensure it accurately reflects the as-built, as-operated plant.**

   CRM applications tools and associated software are verified to reflect the as-built, as-operated plant. The CRM tool is maintained and updated in accordance with approved station procedures on a periodic basis not to exceed two refueling cycles. A process for evaluation and disposition of proposed facility changes is established for items impacting the CRM tool with criteria established to require CRM model / tool updates concurrent with implementation for facility changes that potentially can significantly impact RICT calculations. Corrective actions are identified and implemented as soon as practicable to address any identified modeling errors that could significantly impact RICT calculations.

It is recommended that RMTS implementation procedures require that confirmatory checks of RICT assessments and associated calculations by appropriately qualified station staff members be part of the RMTS process. Additionally, station personnel applying CRM tools to perform and approve RICT assessments must be adequately trained and qualified in accordance with station Technical Specifications implementation procedures and the provisions of this guidance.

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5 REFERENCES

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2. Nuclear Energy Institute, “Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants,” NUMARC 93-01, Revision 3, July 2000.

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6. “Guideline for the Treatment of Uncertainty in Risk-Informed Applications: Technical Basis Document,” EPRI 1009652, Palo Alto, CA, December 2004.

7. “Methodology for Fire Configuration Risk Management,” EPRI Report 1012948, December 2005.

8. Cepin, Marko, “Method for Setting up the Truncation Limit of Probabilistic Safety Assessment,” International Conference on Probabilistic Safety Assessment and Management (PSAM 7 – ESREL ’04) paper 0602, June 2004.

9. Regulatory Issue Summary 2005-20 and NRC Inspection Manual, Part 9900: Technical Guidance, "Operability Determinations and Functionality Assessments for Resolution of Degraded or Nonconforming Conditions Adverse to Quality or Safety," issued 9/26/05.

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GLOSSARY OF TERMS

Key terms used in this guide are defined in this appendix. These definitions are intended to be consistent with existing plant Technical Specifications and associated regulatory and industry guidance. In any case where a plant's Technical Specifications definitions differ from those provided herein, the plant Technical Specifications definitions take precedence.

allowed outage time (AOT) – Same as completion time (CT).

back-stop completion time (back-stop CT) – the ultimate LCO completion time or allowed outage time limit permitted by the RMTS. The back-stop completion time limit for licensee action takes precedence over any risk-informed completion time calculated to be greater than 30 days.

baseline risk – the "no-maintenance" or "zero-maintenance" risk calculated via the plant PRA. This is different from (i.e., less than) the average annual risk calculated via the PRA.

completion time (CT) – as defined in the improved standard Technical Specifications (NUREG-1430 through -1434), the completion time is the amount of time allowed by the Technical Specifications for completing an action. Limiting Conditions for Operation (LCOs) specify minimum requirements for ensuring safe operation of the unit. The actions associated with an LCO state conditions that typically describe the ways in which the requirements of the LCO can fail to be met. Specified with each stated condition are action(s) and completion time(s). The completion time is the amount of time allowed for completing an action. It is referenced to the time of discovery of a situation (e.g., inoperable equipment or variable not within limits) that requires entering a condition unless otherwise specified in the Technical Specifications.

configuration risk management (CRM) program – the plant program designed to apply the approved PRA to support prudent risk management over the plant life cycle. This program is designed to support the planning and execution of plant maintenance, testing, and inspection activities, as well as other risk-impacting evolutions.

core damage probability (CDP) – the integral of CDF over time; the classical cumulative probability of core damage (i.e., instantaneous core or fuel damage

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frequency integrated over a specified duration), over a given period of time. CDP is unit-less. Weekly risk is calculated for the 168-hour time period over each calendar week. Configuration risk is calculated for the anticipated and/or actual duration of a plant configuration. Annual risk is a 52-week rolling average, calculated week by week.

cumulative risk – the accumulated risk integrated over time accounting for variations in instantaneous risk.

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emergent event or emergent condition – any event or condition, which is NOT in the planned work schedule, which renders station equipment non-functional or extends non-functional equipment scheduled outage time beyond its planned duration. The term "any event or condition" includes the impacts of mode changes and external conditions which adversely impact the risk associated with the evolution.

front-stop completion time (front-stop CT) – the completion time or allowed outage time for plant equipment specified in the conventional plant Technical Specifications.

high-risk configuration – a plant configuration yielding a plant instantaneous CDF > 1.00E-03 or LERF > 1.00E-4 per year.

incremental core damage frequency (ICDF) – the frequency above a "no-maintenance" baseline CDF (expressed in terms of events per calendar year) that one can expect a reactor fuel core-damaging event to occur for a nuclear power plant of interest.

incremental core damage probability (ICDP) – the integral of ICDF over time; the classical cumulative probability of incremental core damage over a given period of time. ICDP is unit-less. Weekly risk is calculated for the 168-hour time period over each calendar week. Configuration risk is calculated for the anticipated and/or actual duration of a plant configuration. Annual risk is a 52-week rolling average, calculated week by week.

incremental large early release frequency (ILERF) – the frequency above a "no-maintenance" baseline LERF (expressed in terms of events per calendar year) that one can expect a large early release of radioactivity [3] from a reactor core-damaging event to occur for a nuclear power plant of interest.

incremental large early release probability (ILERP) – the classical cumulative probability of incremental large early release of radioactivity over a given period of time. ILERP is unit-less. Weekly risk is calculated for the 168-hour time period over each calendar week. Configuration risk is calculated for the anticipated and/or

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actual duration of a plant configuration. Annual risk is a 52-week rolling average, calculated week by week.

instantaneous core damage frequency (CDF) – the instantaneous expected core damage frequency resulting from continued operation in a specific plant mode and a given plant configuration (generally presented with units of events/year). This term is very similar to the conventional use of the term "core damage frequency" applied in probabilistic risk assessments. However, for application to RMTS programs, the focus here is on a single point in time, and not on longer term averages typically applied.

instantaneous large early release frequency (LERF) – the instantaneous expected large early release frequency resulting from continued operation in a specific plant mode and a given plant configuration (generally presented with units of events/year). This term is very similar to the conventional use of the term "larger early release frequency" applied in probabilistic risk assessments. However, for application to RMTS programs, the focus here is on a single point in time, and not on longer term averages typically applied.

large early release probability (LERP) – the classical cumulative probability of large early release of radioactivity (i.e., instantaneous large early release frequency integrated over a specified duration), over a given period of time. LERP is unit-less. Weekly risk is calculated for the 168-hour time period over each calendar week. Configuration risk is calculated for the anticipated and/or actual duration of a plant configuration. Annual risk is a 52-week rolling average, calculated week by week.

limiting condition for operation (LCO) – as defined in 10 CFR 50.36 (c)(2), limiting conditions for operation are the lowest operable capability or performance levels of equipment required for safe operation of the facility. When a limiting condition for operation of a nuclear reactor is not met, the licensee shall shut down the reactor or follow any remedial action permitted by the Technical Specifications until the condition can be met.

operable and operability – as defined in the improved standard Technical Specifications (NUREG-1430 through -1434) a system, subsystem, train, component or device shall be operable or have operability when it is capable of performing its specified function(s), and when all necessary attendant instrumentation, controls, electrical power, cooling and seal water, lubrication and other auxiliary equipment that are required for the system, subsystem, train, component, or device to perform its function(s) are also capable of performing their related support function(s).

operational mode or mode – as defined in the improved standard Technical Specifications (NUREG-1430 through -1434), an operational mode (i.e., mode) shall correspond to any one inclusive combination of core reactivity condition, power

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level, and average reactor coolant temperature specified in plant Technical Specifications.

plant configuration – the consolidated state of all plant SSCs with their associated individual states of functionality (i.e., either functional or non-functional) and alignment (including surveillance inspections and testing alignments) identified. Consistent with the Maintenance Rule and associated NEI guidance [2], the concept of "plant configuration" encompasses the existence of activities or conditions (including maintenance) that can materially affect plant risk.

In the context of this guide, there are two major types of plant configurations, planned and unplanned. A planned configuration is one that is intentionally and deliberately pre-scheduled (e.g., in a weekly maintenance plan). An unplanned configuration includes an unintentional, emergent situation (i.e., discovery of failure or significant degradation of an SSC with the provision to utilize a RICT or a forced, unscheduled extension of previously-planned maintenance).

PRA-calculated mean value: the mean value of a probability distribution for a key risk measure, such as CDP or LERP, calculated via the PRA.

probabilistic risk assessment (PRA) – a quantitative assessment of the risk associated with plant operation and maintenance that is measured in terms of frequency of occurrence of risk metrics, such as core damage or a radioactive material release and its effects on the health of the public (also referred to as a probabilistic safety assessment, PSA).

PRA functionality - functionality that can be explicitly credited in a RICT calculation of a Technical Specification inoperable SSC.

recovery – restoration of a function lost as a result of a failed SSC by overcoming or compensating for its failure.

repair - restoration of a failed SSC by correcting the cause of failure and returning the failed SSC to its modeled functionality.

risk-informed completion time (RICT) – a plant-specific SSC plant configuration CT calculated based on maintaining plant operation within allowed risk thresholds or limits and applying a formally approved configuration risk management program and associated probabilistic risk assessment. The RICT is the time interval from discovery of a condition requiring entry into a Technical Specifications action for a SSC with the provision to utilize a RICT until the 10^{-5} ICDP or 10^{-6} ILERP threshold is reached, or 30 days, whichever is shorter. The maximum RICT of 30 days is referred to as the "back-stop CT." For the purposes of RMTS implementation, a SSC is considered to be in a RICT when it (1) is Technical Specification inoperable and (2) is beyond its front-stop CT.

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risk-management action time (RMAT) - the time interval at which the risk management action threshold is exceeded. Stated formally, the RMAT is the time interval from discovery of a condition requiring entry into a Technical Specifications action for a SSC with the provision to utilize a RICT until the 10^{-6} ICDP or 10^{-7} ILERP RMA threshold is reached, whichever is the shorter duration. This guidance requires risk management actions to be taken no later than the calculated RMAT.

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risk-management technical specifications (RMTS) – a plant-specific set of configuration-based Technical Specifications, based on a formally approved configuration risk management program and associated probabilistic risk assessment, designed to supplement previous conventional plant Technical Specifications.

zero-maintenance CDF – the calculated CDF for the zero-maintenance configuration.

zero-maintenance configuration – the plant configuration where no planned or emergent maintenance is being performed (including any risk-impacting testing or inspection actions) and PRA components remain functional.

zero-maintenance LERF – the calculated LERF for the zero-maintenance configuration.

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REPORT SUMMARY

EPRI has assessed the role of probabilistic risk assessment (PRA) in the regulation of nuclear power station Technical Specifications. This report presents nuclear utilities with a framework and associated general guidance for implementing risk managed Technical Specifications (RMTS) as a partial replacement of existing Technical Specifications. This report was prepared for EPRI with extensive technical input and review by the Nuclear Energy Institute (NEI) Risk-Informed Technical Specifications Task Force (RITSTF), which includes input from the Westinghouse Owner's Group. This report is a substantial Technical Update to EPRI Report 1011758, which was published in December 2005. A draft of the revision provided in this report was submitted to the Nuclear Regulatory Commission (NRC) staff to support pilot applications of RITSTF Initiative 4B. This revision incorporates modifications to address comments provided by NRC staff.