Issued 04/18/07

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
MINUTES OF THE MEETING OF THE SUBCOMMITTEE ON RELIABILITY AND PROBABILISTIC RISK ASSESSMENT REGARDING RISK MANAGED TECHNICAL SPECIFICATIONS, INITIATIVE 4b
MARCH 23, 2007
ROCKVILLE, MARYLAND

On March 23, 2007, the Subcommittee on Reliability and Probabilistic Risk Assessment (PRA) held a meeting in Room T-2B3, 11545 Rockville Pike, Rockville, Maryland. The purpose of the meeting was to discuss the NRC staff's review of the industry guidance document NEI 06-09 titled, "Risk-Informed Technical Specifications Initiative 4b, Risk-Managed Technical Specifications (RMTS) Guidelines," with representatives of the Office of Nuclear Reactor Regulation (NRR) and the industry. In addition to NRR, representatives from Electric Power Research Institute (EPRI) and the South Texas Project Nuclear Operating Company (STPNOC) made presentations to the Committee.

The meeting was open to the public. No written comments or requests to make oral statements were received from members of the public related to this meeting. A telephone bridge line was made available for NRC staff from Region I and certain members of the press to listen into the meeting. Ms. Maitri Banerjee was the Designated Federal Official for this meeting. The meeting was convened at 8:30 a.m. and adjourned at 12:00 p.m. on March 23, 2007.

ATTENDEES:

ACRS MEMBERS
George Apostolakis, Chairman
Tom Kress, Member
Otto Maynard, Member
William Shack, Member
Said Abdel-Khalik, Member
Mario Bonaca, Member

NRC STAFF/PRESENTERS
R. Tjader, NRR/DRIS/ITSB
A. Howe, NRR/DRA
K. Canavan, EPRI
S. Hess, EPRI
J. Phelps, STPNOC

OTHER ATTENDEES
S. Head, STPNOC
W. Harrison, STPNOC
R. Grantom, STPNOC
B. Bradley, NEI
Z, Edwar, APS/CRMF
M. Banerjee, ACRS Staff
C. Holden, NRR/DRA
D. Terao, NRR/DORL
M. Marshall, NRR/DORL
D. Harrison, NRR/DRA
G. Parry, NRR/DRA
M. Thadani, NRR/DORL
C. Schulten, NRR/DIRS

The presentation slides, handouts used during the meeting, and a complete list of attendees are attached to the Office Copy of the meeting minutes. The presentations to the Subcommittees are summarized below.

Opening Remarks

Dr. Apostolakis, Chairman of the Subcommittee on Reliability and PRA convened the meeting and mentioned the previous ACRS meting with the staff and the industry in his introductory remarks. NEI 06-09 proposes to rely on PRA and risk monitors to extend the technical specification completion times for returning structures, systems, and components to operable

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

MEMORANDUM TO: Maitri Banerjee, Senior Staff Engineer, ACRS

FROM: G. Apostolakis, Chairman, Reliability and PRA Subcommittee

SUBJECT: CERTIFICATION OF THE MINUTES OF THE MEETING OF THE SUBCOMMITTEE ON RELIABILITY AND PROBABILISTIC RISK ASSESSMENT REGARDING RISK MANAGED TECHNICAL SPECIFICATIONS, INITIATIVE 4b, ON MARCH 23, 2007, IN ROCKVILLE, MARYLAND

I hereby certify, to the best of my knowledge and belief, that the minutes of the subject meeting on March 23, 2007, are an accurate record of the proceedings for that meeting.

4/18/07

George Apostolakis, Date
Reliability and PRA Subcommittee Chairman

The Subcommittee will review the staff's plans for evaluating the agency's human reliability analysis models in an effort to propose either a single model for the agency to use or guidance on which model(s) should be used in specific circumstances. The Subcommittee will hear presentations by and hold discussions with representatives of the NRC staff and industry regarding this matter. The Subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions, as appropriate, for deliberation by the full Committee.

Members of the public desiring to provide oral statements and/or written comments should notify the Designated Federal Official, Dr. Hossein P. Nourbakhsh, (Telephone: 301–415–5622) five days prior to the meeting, if possible, so that appropriate arrangements can be made. Electronic recordings will be permitted.

Further information regarding this meeting can be obtained by contacting the Designated Federal Official between 7:30 a.m. and 4:15 p.m. (ET). Persons planning to attend this meeting are urged to contact the above named individual at least two working days prior to the meeting to be advised of any potential changes to the agency.

Dated: February 23, 2007.

Cayetano Santos,

Acting Branch Chief, ACRS.

[FR Doc. E7–3824 Filed 3–2–07; 8:45 am]

BILLING CODE 7590–01–P

NUCLEAR REGULATORY COMMISSION

Advisory Committee on Reactor Safeguards (ACRS); Meeting of the ACRS Subcommittee on Reliability and Probabilistic Risk Assessment; Notice of Meeting

The ACRS Subcommittee on Reliability and Probabilistic Risk Assessment (PRA) will hold a meeting on March 23, 2007, Room T–2B3, 11545 Rockville Pike, Rockville, Maryland.

The entire meeting will be open to public attendance.

The agenda for the subject meeting shall be as follows:

Friday, March 23, 2007—8:30 a.m. until the conclusion of business

The Subcommittee will review the Risk Management Technical Specification Initiative 4b and the Risk Informed Completion Times. The Subcommittee will hear presentations by and hold discussions with representatives of the NRC staff and industry regarding this matter. The Subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions, as appropriate, for deliberation by the full Committee.

Members of the public desiring to provide oral statements and/or written comments should notify the Designated Federal Official, Ms. Maitri Banerjee (Telephone: 301–415–6973) five days prior to the meeting, if possible, so that appropriate arrangements can be made. Electronic recordings will be permitted.

Further information regarding this meeting can be obtained by contacting the Designated Federal Official between 7:30 a.m. and 4:15 p.m. (ET). Persons planning to attend this meeting are urged to contact the above named individual at least two working days prior to the meeting to be advised of any potential changes to the agenda.

Dated: February 26, 2007.

Cayetano Santos,

Acting Branch Chief, ACRS.

[FR Doc. E7–3825 Filed 3–2–07; 8:45 am]

BILLING CODE 7590–01–P

NUCLEAR REGULATORY COMMISSION

Sunshine Act Meeting Notice

AGENCY HOLDING THE MEETINGS: Nuclear Regulatory Commission.

DATE: Week of February 26, 2007.

PLACE: Commissioners' Conference Room, 11555 Rockville Pike, Rockville, Maryland.

STATUS: Public and Closed.

ADDITIONAL MATTERS TO BE CONSIDERED:

Week of February 26, 2007—Tentative

Monday, February 26, 2007

1:05 p.m. Affirmation Session (Public Meeting) (Tentative)

a. AmerGen Energy Company, LLC (License Renewal for Oyster Creek Nuclear Generating Station) Docket No. 50–0219, Remaining Legal challenges to LBP–06–07 (Tentative)

b. Nuclear Management Co., LLC (Palisades Nuclear Plant, license renewal application); response to "Notice" relating to San Louis Obispo Mothers for Peace (Tentative)

c. System Energy Resources, Inc. (Early Site Permit for Grand Gulf ESP Site); response to NEPA/terrorism issue (Tentative)

d. Pacific Gas & Electric Co. (Diablo Canyon ISFSI), Docket No. 72–26–ISFSI (Tentative)

* * * * *

*The schedule for Commission meetings is subject to change on short notice. To verify the status of meetings call (recording)—(301) 415–1292. Contact person for more information: Michelle Schroll, (301) 415–1662.

* * * * *

ADDITIONAL INFORMATION: By a vote of 5–0 on February 23, 2007, the Commission determined pursuant to U.S.C. 552b(e) and § 9.107(a) of the Commission's rules that "Affirmation of a. AmerGen Energy Company, LLC (License Renewal for Oyster Creek Nuclear Generating Station) Docket No. 50–0219, Remaining Legal challenges to LBP–06–07 (Tentative); b. Nuclear Management Co., LLC (Palisades Nuclear Plant, license renewal application); response to "Notice" relating to San Louis Obispo Mothers for Peace (Tentative); c. System Energy Resources, Inc. (Early Site Permit for Grand Gulf ESP Site); response to NEPA/terrorism issue (Tentative); d. Pacific Gas & Electric Co. (Diablo Canyon ISFSI), Docket No. 72–26–ISFSI (Tentative)" be held February 26, 2007, and on less than one week's notice to the public.

Affirmation of "Exelon Generation Company, LLC (Early Site Permit for Clinton ESP)" tentatively scheduled on February 26, 2007, has been postponed and will be rescheduled.

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The NRC Commission Meeting Schedule can be found on the Internet at: *www.nrc.gov/what-we-do/policy-making/schedule.html.*

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The NRC provides reasonable accommodation to individuals with disabilities where appropriate. If you need a reasonable accommodation to participate in these public meetings, or need this meeting notice or the transcript or other information from the public meetings in another format (*e.g.*, braille, large print), please notify the NRC's Disability Program Coordinator, Deborah Chan, at 301–415–7041, TDD: 301–415–2100, or by e-mail at *DLC@nrc.gov.* Determinations on requests for reasonable accommodation will be made on a case-by-case basis.

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This notice is distributed by mail to several hundred subscribers; if you no longer wish to receive it, or would like to be added to the distribution, please contact the Office of the Secretary, Washington, DC 20555 (301–415–1969). In addition, distribution of this meeting notice over the Internet system is available. If you are interested in receiving this Commission meeting schedule electronically, please send an electronic message to *dkw@nrc.gov.*

status. A pilot plant application was submitted for NRC approval on August 2, 2004 (later resubmitted on June 6, 2006) by the Nuclear Operating Company for the South Texas project (STP). The last staff briefing was for the joint ACRS Subcommittee on Reliability and PRA and Plant Operations that took place on April 28, 2006. At that time, the staff's safety evaluation (SE) was not developed and the staff was planning to perform an audit of the applicant's implementation of the program at the plant site. The Subcommittee requested another meeting after the staff's planned site visits. Dr. Apostolakis also wanted the benefit of the staff's SE before bringing this to the Full Committee. Dr. Apostolakis called upon Mr. Tjader of the Office of Nuclear Reactor Regulation (NRR) to begin the discussion.

Staff Introduction and Overview of RMTS Initiative 4b

Mr. Bob Tjader and Mr. Andrew Howe with the Technical Specifications Branch and PRA Branch of NRR respectively, made the staff presentation. The staff was seeking a letter from the ACRS supporting the staff's approval of the risk-informed completion time process in NEI 06-09. The staff discussed their review documented in the draft SE. The staff plans to finalize the SE after ACRS review.

The RMTS initiative aligns technical specifications with the Commission Policy Statement on use of PRA. It is consistent with the established NRC guidance and the maintenance rule, particularly rule (a)(4) which requires assessing and managing risk prior to maintenance activities. The staff discussed the benefits of the program in that it affects integrated plant risk considerations based on a broader scope of systems, equipment and components than just those considered in the technical specifications. It also forces a heightened plant operator's awareness of risk contributors and the existing risk profile of the plant, and avoids unnecessary plant transients and shutdowns, while taking TS actions based on risk that is involved in the configuration of the plant at the time.

Risk-informed completion times in Initiative 4b, calculates real time quantitative risk associated with the plant configuration and provides a risk-justified extended completion time for the required actions of the technical specifications. This time will not exceed 30 days which gives the licensee time to restore the system to operable status.

The risk management guidance document program requirements will be included in the plant's technical specifications, under the administrative controls section, after the NRC approves a licensee's amendment request. The program includes: (1) an approved decision-making process and methodology based on risk thresholds for determining TS required action and completion times; (2) requirements for technical adequacy and quality of the supporting PRA; (3) configuration risk management (CRM) tool attributes and fidelity; and (4) implementation guidance. The requirements for quantitative configuration and cumulative risk metrics, and periodic assessment to comply with Regulatory Guide (RG) 1.174, Rev. 1 ("An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," November 2002), in addition to documentation and training requirements are also specified.

In order to apply the program to the TS, the functions addressed by the TS need to be modeled in the plant's PRA, and the PRA needs to be maintained to reflect the as-built and as-operated plant. Although no peer review process is applied for the CRM tool, the staff discussed the attributes the CRM tools must have to meet the program. Application of RG 1.200 ("An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for

Risk Informed Activities," February 2004) for the required technical adequacy of the PRA, the requirements for translation of the PRA into the CRM tool (configuration impact, truncation levels, benchmarking, etc.), conservative treatment of time of the year or operating cycle specific variables, relative ease of user interface, and appropriate administrative controls (software QA, model configuration control, procedures, training and corrective action program) were discussed. Upon members' questions, the staff indicated that an appropriate bounding analysis (e.g., for fire) may be acceptable in leu of specific PRA modeling. EPRI prepared a guidance document on methodology for fire configuration risk management, but staff has not reviewed the document.

The staff discussed the credit allowed for functionality of inoperable components, although the Initiative 4b program cannot be used when all trains of a system become inoperable or upon loss of safety function. The methodology will allow the licensee to reflect the actual capability of systems against the required action if it is modeled in the PRA. The staff provided to the Subcommittee two revised pages of their draft SE relating to this discussion (recorded as a part of the presentation slides).

Mr. Bonaca wanted to know if licensing actions to permanently extend the deterministic TS front-stop completion times using PRA has any merit, particularly after the Initiative 4b is implemented at a site. Although the licensees may still want to apply for TS amendments to extend very short front-stop values based on PRA (Initiative 4a), the consensus was that the merit of Initiative 4b was in the enhanced ability to address emerging conditions and not the planned single system outages.

The staff indicated that the program does not require modifying the risk-informed completion time assuming emergent common-cause failures, as the staff considers the existing requirement for operability determination and assessment for extent-of-condition to be adequate for safety. However, the program requires assessment of additional risk management actions while still evaluating the extent-of-condition while in the extended completion time.

The staff indicated that they expect to do an on-site audit for each licensee applying for the TS amendment to implement 4b, like they did at STP. Quality of the PRA, its application in the 4b program, key assumptions and uncertainties, and implementation of the program including the compensatory measures are the prime areas for review.

Discussion on periodic evaluation of cumulative risk, required by the program, resulted in a question from Chairman Apostolakis as to its consistency with the RG 1.174 risk monitoring guidance. The RG guidance addresses cumulative risk (delta CDF or delta LERF) due to plant changes over the baseline PRA risk number, whereas the RMTS program tracks risk accumulated due to each extension of the TS completion time. Dr. Apostolakis asked the staff to address this aspect of risk trending in their briefing of the Full Committee on April 5, 2007, and if the staff's safety evaluation needed any change.

Staff Audit of STP on Readiness to Implement Initiative 4b

The staff stated that the purpose of the audit was to ensure that the applicant's PRA model, CRM program and supporting activities were adequate for implementation of the RMTS. The scope of the audit included a review of the PRA models not addressed by standards (fire, seismic, external events); development, implementation and updating of CRM program;

training; procedures and overall safety culture of the licensee's organization related to PRA. The staff indicated that the result of this review showed an overall adequate implementation of the program at STP, although individual discrepancies, that needed to be resolved, were identified. The audit team identified plant TS applications where the scope of the PRA model was incomplete. As a result, these TSs could not be added to the program until further enhancement of the plant PRA. The licensee maintains approximately 20,000 pre-solved configurations for program implementation. The staff found that the licensee made conservative assumptions in general, although the licensee needed to enhance the justification for applying the CRM program to some plant TS. At the time of the audit, the results of the licensee's uncertainty analyses were not available, the audit team reviewed the licensee's plan on how to identify the key uncertainties and found some areas of improvements.

Dr. Apostolakis noted that in its SE, the staff made a statement regarding the document titled EPRI 1009652, "Guidelines for the Treatment of Uncertainty in Risk-Informed Applications: Technical Basis Document," December 2004, which provides a method for determining key uncertainties. The SE noted that staff had not reviewed this document, and that the NRC neither endorsed nor disapproved its methods. The staff stated that they were in the process of reviewing the EPRI document, and the EPRI representative at the meeting, Mr. Canavan, agreed to provide a courtesy copy to the ACRS.

Upon Dr. Apostolakis' questions, Mr. Grantom from STP discussed their current process for handling large areas of uncertainties in PRA modeling by assuming conservative approaches through new initiating events.

Industry Presentation

Messrs. Ken Canavan and Stephen Hess of EPRI briefly discussed the human error probability treatment in Initiative 4b (human reliability analysis was the subject of the Subcommittee's meeting the day before), PRA transition into the CRM tool, and consideration of uncertainties. In his presentation, Mr. Canavan pointed out that the treatment of uncertainty in the program is expected to be conservative as in reality the plant operators will have an even better understanding of actual plant configuration and associated risk management actions once the program is implemented. Two EPRI guidance documents on uncertainty are currently available. The staff has been reviewing one, and although the concept is found to be acceptable, the staff has some issues with the details. The Subcommittee would like to review these documents, and EPRI and the staff agreed to make them available. Mr. Canavan mentioned that STP application of uncertainty was consistent with the EPRI guidance, with worst case assumptions for elements of uncertainty that cannot be accurately modeled.
In his presentation on the CRM tool, Mr. Hess pointed out that the industry program is mature and is effectively controlling risk while supporting compliance with the maintenance rule. Risk-informed methods used for the (4)(a) requirement of the rule is enhanced with more rigorous methods for Initiative 4b. The plant CRM tools are supporting management decision-making to effectively manage plant configuration risk and any needed compensatory risk management actions. In addition to the tools available for pre-solved risk results for plant configurations (RASCal, Sentinel), on-demand configuration risk solvers (EOOS, Safety Monitor) are also available. Upon Dr. Shack's question, Mr. Hess pointed out that the current program is geared toward completion time extensions while at power, although an industry standards committee is working on a PRA standard for low-power and shutdown conditions.

STP Implementation of Risk-Informed Technical Specifications

Mr. Phelps of NOC discussed implementation of the program at STP, and pointed out that a computer database of 20,000 pre-solved maintenance states and configuration-specific completion time calculations is available for the plant operators and maintenance planners in an easy ACCESS format. Mr. Phelps also presented an example of the use of the tool to show how initial entry, risk assessment, and subsequent emergent non-quantified conditions are addressed. Upon Dr. Abdel-Khalik's questions, Mr. Phelps stated that at STP they did not find any existing TS completion time (front-stop) to be inadequate (i.e., not restrictive enough), although some very short front-stop completion times are subject to future evaluation for possible permanent extension. The staff pointed out that once Initiative 4b is implemented, such extension may become unnecessary. Also, the staff stated that they had thought about the idea of using a 4b type of process to do away with the TS front-stops. The staff has come to a position against it at this time because of the practical problems it poses. One of the problems may involve finding of a degradation in the tool itself, and determining what process to use to cope with that finding on an immediate online basis.

Dr. Abdel-Khalik wanted to know how changes in plant equipment states that impact the risk-informed completion times, are handled, communicated and documented. Mr. Phelps stated that in case of identification of non-quantified maintenance states, the plant PRA Engineer, available 24 hours on duty or call, would be contacted to calculate the revise completion times. Existing plant procedures will be used to obtain management approval, communication to the plant operators and repair crew, and for documenting the change.

At the end of the presentation, Mr. Tjader pointed out the subject of allowing credit for functionality of inoperable components had received some opposition from the staff and revisions to some parts of the staff's SE (as noted in the two revised pages addressed before). Dr. Apostolakis asked that the staff include this subject in their presentation at the Full Committee meeting on April 5.

Staff/Industry Follow-up Actions

The staff/EPRI agreed to provide the Subcommittee chairman with copies of two EPRI Technical reports related to guidance on treatment of uncertainty (EPRI 1009652, and EPRI 1013491).

Subcommittee Decisions and Follow-up Actions

The Subcommittee acknowledged the benefit of the program and requested the staff to address the following at the Full Committee meeting on April 5, 2007:

- Overview of Initiative 4b
- Incremental risk considerations in configuration risk management
- Operability vs. functionality considerations
- PRA adequacy and uncertainty considerations with examples
- Cumulative risk considerations vs. RG 1.174 guidance
- Benefits to the industry and NRC processes.

Background Materials Provided to the Committee

1. NEI 06-09 Rev. 0, "Risk-Informed Technical Specifications Initiative 4b, Risk-Managed Technical Specifications (RMTS) Guidelines," November 2006, (ADAMS Accession No. ML063390639).

2. Letter from D. W. Rencurrel, STP to U.S. Nuclear Regulatory Commission, "South Texas Project Units 1 and 2 Docket Nos. STN 50-498, STN 50-499, Revised Broad Scope Risk-Informed Technical Specification Amendment Request," June 6, 2006, NOC-AE-06002005 (ADAMS Accession No. ML061630315).

3. Memo from L. A. Mrowca, Chief, Probabilistic Risk Assessment Licensing Branch B, NRR, to D. Terao, Chief, Plant Licensing Branch IV, NRR, "Audit Report Regarding South Texas Project, Units 1 and 2, Risk-Managed Technical Specifications Application," October 5, 2006, (ADAMS Accession No. ML062860170)

4. Memo from Timothy J. Kobetz, Chief, Technical Specifications Branch, NRR, to Stacey L. Rosenberg, Chief, Special Projects Branch, NRR, "Draft Safety Evaluation Relating to NEI 06-09, Risk-Managed Technical Specifications Guidelines, for Risk Management Technical Specifications Initiative 4B, Risk-Informed Completion Times," undated.

5. Draft Revisions to NRR SE (2 pages) provided at the Subcommittee meeting, untitled, undated.

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NOTE:
Additional details of this meeting can be obtained from a transcript of this meeting available in the NRC Public Document Room, One White Flint North, 11555 Rockville Pike, Rockville, MD, (301) 415-7000, downloading or view on the Internet at http://www.nrc.gov/reading-rm/doc-collections/acrs/ can be purchased from Neal R. Gross and Co., 1323 Rhode Island Avenue, NW, Washington, D.C. 20005, (202) 234-4433 (voice), (202) 387-7330 (fax), nrgross@nealgross.com (e-mail).

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
MEETING OF THE SUBCOMMITTEE ON RELIABILITY AND PRA
ROCKVILLE, MARYLAND
MARCH 23, 2007

ACRS Contact: Maitri Banerjee (301) 415-6973, E-mail: mxb@nrc.gov

	TOPICS	PRESENTERS	TIME
I.	Opening Remarks	G. Apostolakis, ACRS	8:30 -8:40 a.m. 10 minutes
II.	General Overview of RMTS Initiative 4b, Guidelines Document, NEI 06-09	R. Tjader, NRR	8:40 -9:30 a.m. 50 minutes
III.	PRA, CRMP, & License Amendment Requirements for RMTS	A. Howe, NRR	9:30 -10:20 a.m. 50 minutes
	Break		10:20-10:35 a.m.
IV.	STP Audit Results of PRA & CRMP for capability to Implement I4b	A. Howe, NRR	10:35-11:05 a.m. 30 minutes
V.	HRA Models for use in PRA/PRA transition into the CRM tool	K. Canavan, EPRI	11:05-11:25 a.m. 20 minutes
VI.	Consideration of Uncertainties in Initiative 4b Process	K. Canavan, EPRI	11:25-11:45 a.m. 20 minutes
VII.	CRM tool/STP perspective of I4b Process	Steve Hess, EPRI Jay Phelps, STP	11:45-12:15 p.m. 30 minutes
VIII.	General Discussion and Adjourn	G. Apostolakis, ACRS	12:15-12:30 p.m. 15 minutes

NOTE:

- Presentation time should not exceed 50 percent of the total time allocated for a specific item. The remaining 50 percent of the time is reserved for discussion.
- STP is the South Texas Project Nuclear Operating Company.
- EPRI is the Electric Power Research Institute.

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

SUBCOMMITTEE MEETING ON RELIABILITY AND PROBABILISTIC RISK ASSESSMENT

March 23, 2007
Date

PLEASE SIGN IN BELOW

PLEASE PRINT

	NAME	ORGANIZATION
1	CARL SCHULTEN	NRR/DIRS/ITSB
2	Scott Head	STP Nuclear Operating Co
3	Rick Grantom	
4	Wayne Harrison	
5	Jay Phelps	↓
6	STEPHEN HESS	EPRI
7	KEN CANAVAN	↓
8	Biff Bradley	NEI
9	Zouhair Elawar	APS / CRMF
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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

SUBCOMMITTEE MEETING ON RELIABILITY AND PROBABILISTIC RISK ASSESSMENT

March 23, 2007
Date

PLEASE SIGN IN BELOW

PLEASE PRINT

	NAME	NRC ORGANIZATION
1	Bob Tjader	NRR / ITSB
2	Mohan Thadani	NRC / NRR
3	Gareth Parry	NRC /NRR /DRA
4	Donnie Harrison	NRC/NRR/DRA/APLA
5	David Terao	NRC/NRR/DORL/LPL4
6	C. Hoblen	NRC/NRR/DRA
7	Michael Marshall	NRO/DCIP/~~[illegible]~~ CTSB
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From: Maitri Banerjee
To: ACRS-Members
Date: 03/02/2007 1:16:20 PM
Subject: Risk Managed technical Specification Initiative 4b - SPT Application

I attached a copy of the STP pilot plant application (dated 8/2/04) to my previous e-mail to allow you to see the implementation of the proposed guideline (that you are reviewing) in a licensing application. STP revised its application in entirety on 6/6/06 to incorporate changes made to the draft NEI guideline and staff RAI on its application. I attached a copy of this revised STP application, incase you would like to see it. (ML061630315)

Please let me know if you have any questions, or have trouble opening the documents.

Regards.

Maitri

CC: Carol Brown; Cayetano Santos

Risk Management Technical Specifications Guidelines for Initiative 4b, Risk-Informed Completion Times

Presentation to ACRS

Reliability & PRA Sub-Committee
March 23, 2007
Technical Specifications & PRA Branches
Bob Tjader Andrew Howe
415-1187 415-3078

ACRS Meeting Goals

- Discuss and obtain feedback on RMTS Initiative 4b, Risk Management Guidance Document: Requirements and Guidance, and associated Safety Evaluation.
- Provide Related Requested Information
- Seek letter to Commission supporting the NEI 06-09 Risk-Informed Completion Time (RICT) Process.

Purpose of Risk Management Technical Specifications Initiatives

- Align Tech Specs with Commission's Policy Statement on use of PRA
- Consistent with: Maintenance Rule, Established guidance (RG 1.174, RG 1.177, NUMARC 93-01)
- Enhance Safety/Improve Effectiveness
  - Focus on Operability, versus on shutdown, and
  - Avoid unnecessary plant transients/shutdowns
  - Integrated plant risk considered
- Enhance Operator Safety Focus
  - Heightened awareness of risk contributors & profile
  - Actions & times in Tech Specs perceived as appropriate for risk

Initiative 4 – Risk-Informed Completion Times

- Description: Use configuration risk management
  - "Real-Time" calculation of completion time (CT) based upon current plant configuration and associated risk
  - Extend CT from a nominal value up to a predetermined "backstop" maximum of 30 days
- Implementation: Risk Management Guidance includes:
  - Approved decision-making process
  - Implementation requirements and guidance
  - Requirements for PRA technical adequacy, and configuration risk monitoring
  - Quantitative configuration and cumulative risk metrics
  - Documentation requirements
  - Training requirements
- Status: STP pilot plant site visit & PRA audit complete; expect to issue license amendment this summer. FCS pilot approval shortly thereafter.

Benefits of RMTS RICT

- Risk Informed
- Integrate Plant Risk
  - Manage Multiple SSC Outages
  - Manage Broader Scope of SSCs (TS + non-TS)
- Flexible Configuration Management
  - Base Decisions on Real-Time Insights
  - Focus on Repair, Not Necessarily Shutdown
  - Licensee Control
- Ongoing Risk Awareness

Risk Management Guidance Document Implementation

- NEI 06-09 RICT Program Requirements in Technical Specifications Administrative Controls
  - Methodology/Guidance Document (NEI 06-09) referenced in Tech Specs Administrative Controls by revision number & date
  - Requires License Amendment to change NEI 06-09 methodology and requirements

- NEI 06-09 Organization
  - RMTS Initiative 4b Program Requirements
    - Including Risk Thresholds, TS, Process, PRA, CRM Tool, Documentation, and Training Requirements
  - RMTS Implementation Guidance, Requirements & Methodology
  - PRA Quality & Configuration Risk Management Tool Attributes

Completion Time (CT) Approach

- CT Features
  - Front Stop; current CT
  - CRMP-based CT (RICT)
  - Back Stop (30 Days)
  - Risk Assessment Tools Must Provide Timely Reliable Result
  - Decision Making Process Reliable/Scrutable
- Proposed 4b Tech Spec

Generic RICT TS

CONDITION	Required Action	Completion Time
B. Subsystem Inoperable	**B.1** Restore subsytem to OPERABLE Status.	72 hours
	<u>OR</u>	
	B.2.1 Determine that CT extension beyond 72 hours is acceptable IAW RMTS Thresholds.	72 hours
	<u>AND</u>	
	B.2.2 Verify CT extension beyond 72 hours remains acceptable.	IAW RMTS Program
	<u>AND</u>	
	B2.3 Restore subsystem to OPERABLE Status.	30 days or acceptable RICT, whichever is less.

RICT Flowchart (see Figure 3-1)

<table>
<tr><td colspan="2">Has TS been entered that allows use of RICT?</td></tr>
<tr><td>Yes, proceed</td><td>No, Apply current TS CT</td></tr>
<tr><td colspan="2">Is Front Stop CT expected to be exceeded?</td></tr>
<tr><td>Yes, Calc RMAT & RICT</td><td>No, Apply current TS CT</td></tr>
<tr><td colspan="2">Has RICT or Backstop CT been reached?</td></tr>
<tr><td>Yes, Take TS Actions</td><td>No, Proceed</td></tr>
<tr><td colspan="2">Have associated RICT TS Actions been exited?</td></tr>
<tr><td>Yes, Apply current TS</td><td>No, as applicable take RMAs & recalculate RICT upon emergent conditions</td></tr>
<tr><td colspan="2">Continue until TS exited.</td></tr>
</table>

RITS 4B - RMTS

- Risk assessed and managed:
  - Implement risk management actions at 1E-6 ICDP or 1E-7 ILERP
  - CT based on 1E-5 ICDP or 1E-6 ILERP with 30-day backstop; not to exceed 1E-3 CDF or 1E-4 LERF
  - Consistent with NUMARC 93-01 guidance
- Periodic assessment to comply with RG 1.174 ΔCDF and ΔLERF guidance.

Backup Slides

RMTS Quantitative Thresholds

CRITERION		MR Risk Guidance	RMTS I4b Guidance
CDF	LERF		
≥ 10E-3	≥ 10E-4	Careful consideration prior to enter configuration	RMAs, No Voluntary entry
ICDP	ILERP		
≥ 10E-5	≥ 10E-6	No Voluntary entry	Follow TS Required Actions
≥ 10E-6	≥ 10E-7	RMAs, Assess non-quant factors	RMAT & RICT req RMAs, Assess non-quant factors
< 10E-6	< 10E-7	Normal work controls	Normal work controls

PRA QUALITY MUST BE ADEQUATE TO SUPPORT 4b

- Internal events PRA:
  - Use ASME standard & RG 1.200
  - Establish Basis for PRA Technical Adequacy Sufficient to Meet Adequacy Requirements (e.g., generally ASME capability cat 2)
  - Use PRA Peer Review Findings & Observations
  - Use results of Self Assessments to identify where PRA does not meet the prescribed basis (ASME Capability Category 2)
  - Assess the impact of ASME Supporting Requirements that are met on I4b process; upgrade PRA
- External Events, Transients, & Shutdown Risk
  - Staff will need to reviews licensees' PRAs

RITS 4B – RMTS (cont)

- High PRA quality expectations:
  - ASME Capability Category II
  - Quantitative capability for internal fires and other significant external event contributors
  - Programs/procedures to assure PRA model is current with as-built/as-operated plant
  - PRA training and capability of staff
  - Staff intends to perform more extensive audit of PRA and supporting programs and training

RICT Documentation

- Date & Time entry into RICT
- Date & Time exiting RICT
- PRA Functionality Assessment when applicable
- Configuration specific risk data (more than one may be required; i.e., for configuration changes)
- Risk Management Actions implemented
- Emergent condition assessment
- Total accumulated ICDP & ILERP

RMTS I4b Training

- Required training for organizational personnel with CRMP functional responsibilities, including:
  - Licensed operators
  - Work control personnel
  - PRA personnel
  - Station Management

Status of Initiatives

- Reliance on existing (a)(4) Program
  - Initiative 2: Missed Surveillances (NRC Approved)
  - Initiative 3: Mode Change Flexibility (NRC Approved)
- Analysis of Specific Plant Configurations
  - Initiative 1: Modified End States (CE & BWR Approved)
  - Initiative 6: LCO 3.0.3 Action Times
  - Initiative 7: Non-TS Support System Operability;
    - Snubber Unavailability (NRC Approved)
    - Barrier Unavailability (NRC Approved)
- Quantitative Risk Assessment
  - Initiative 4: Flexible Completion Times
  - Initiative 5: Surveillance Frequency Program (Pilot Approved)
- Rulemaking
  - Initiative 8: Relocate non-risk significant systems from TS

Applying Credit for the Risk Significance of Inoperable SSCs. In determining the configuration-specific risk impact, an inoperable SSC is normally considered to be completely unavailable with respect to the calculation of risk using the PRA model. Depending upon the specific inoperable SSC which causes the TS LCO to be not met, the level of risk calculated may vary, and so different RICTs may be calculated for the same TS action for different inoperable SSCs. For example, an inoperable valve in one of two or more redundant flowpaths may make a system inoperable, but the impact is less and the associated RICT would be longer than with a pump which cannot feed multiple flowpaths. Thus the calculated CT is risk-informed, and varies based on the PRA functional impact of the actual SSC inoperability. The RMTS Guidelines define "PRA functionality" as that which can be explicitly credited in a RICT calculation of a TS inoperable SSC, and is not to be confused with the use of the term, "functionality," in RIS 2005-20, Operability Determination Process, that only applies to non-TS SSCs capability to perform their safety function. A RICT only applies to a TS Condition, and associated Required Action and CT.

If the unique effect of the SSC inoperability on its particular TS function is discernible by the CRMP and supporting PRA models, then the remaining capability of the affected inoperable SSC may be credited when calculating the RICT. For example, if a valve has TS required functions in both the open and closed positions, then an inoperable valve may be credited in the RICT calculation based on its actual open or close status, if the PRA model can account for failure modes which are based on the actual valve position. This allows the RICT to accurately reflect the risk of the specific plant configuration in terms of the available mitigating capability of inoperable SSCs. In any case, where credit is given in the RICT calculation to inoperable SSCs performing a required TS function, appropriate justification must be provided and documented.

Emergent Failures. During the time when an RICT is in effect and risk is being assessed and managed, it is possible that emergent failures of SSCs may occur, and these must be assessed to determine the impact on the RICT. If a failed component is one of two or more redundant components in separate trains of a system, then there is potential for a common cause failure mechanism. Licensees must immediately assess the remaining redundant components to determine there is reasonable assurance of their continued operability, and this is not changed by implementation of RMTS. If a licensee concludes that the redundant components remain operable, then these components are functional for purposes of the RICT. However, the licensee is required to consider and implement additional risk management actions (RMAs), due to the potential for increased risks from common cause failure of similar equipment. The staff interprets NEI 06-09 as requiring consideration of such RMAs whenever the redundant components are considered to remain operable, but the licensee has not completed the extent of condition evaluations, required by a followup prompt operability determination.

If an emergent failure, or degraded or non-conforming condition is discovered for a redundant SSC that results in a total loss of TS specified safety function while the RMTS are in effect, then the RICT is exited and the associated applicable TS Required Actions are considered not met, and subsequent TS Required Actions are required to be implemented. Voluntary use of the RMTS for a configuration which represents a loss of TS specified safety function, or inoperability of all required safety trains, is not permitted. The total loss of a TS specified safety function requires exiting the RICT and entering the associated TS Required Actions.

As discussed above with regards to the PRA functionality of SSCs, it is possible that all trains of a TS system may be inoperable, but the impact of the inoperability may be discerned by the

PRA model in the CRMP. In such cases involving emergent (unplanned) conditions, the RMTS may be applied to calculate a RICT, provided that the inoperability does not result in the inability of the system as a whole to perform the TS required specified safety function. A RICT can only apply to (restorative) TS Required Actions that are not Mode changes or unit shutdown (i.e., TS 3.0.3 actions and CTs), and that a total loss of TS specified safety function requires exiting the RICT. For example, all trains of ECCS (e.g., NUREG-1431, TS 3.5.2) are declared inoperable due to a common test line being unisolated, but the combined ECCS flow meets the minimum flowrate required by analyses assumptions (i.e., 10 CFR 50.46). In this case, the ECCS still meets its design basis analysis requirements even though all trains are inoperable, because the minimum required flow equivalent to one train is available. A RICT is appropriate if the PRA model can correctly assess the degraded condition and establish a CT based on the actual capacity of the ECCS.

For example, if a degraded seismic support is discovered on a common line which renders all trains of the affected system inoperable, the system will still function for all initiating events except an earthquake. If the PRA model has the capability to calculate the seismic risk impact of this condition, then the RMTS could be applied. As a further example, if during planned maintenance of one train of a two train TS system, an emergent failure of a low pressure pump trip interlock required to protect the pump in the event of a failed traveling screen system may render the pump inoperable, but the pump can still function if the screen is operable. In such a case, the RMTS could be applied even though both trains of the TS system are inoperable, since one of the two trains remains PRA functional.

These example cases involve SSC inoperabilities which, while degraded, do not involve a potential for further degrading component performance. In most cases, degrading SSCs may not be considered to be PRA functional while inoperable. For example, a pump which fails its surveillance test for required discharge pressure is declared inoperable. It cannot be considered functional for calculation of a RICT, since the cause of the degradation may be unknown, further degradation may occur, and since the safety margin established by the pump's operability requirements may no longer met. As a counter example, a valve with a degrading stroke time may be considered PRA functional if the stroke time is not relevant to the performance of the safety function of the valve; for example, if the valve is required to close and is secured in the closed position, then the degradation of stroke time would not impact the capability of the valve to be closed.

Presentation to ACRS Subcommittee on Reliability and Probabilistic Risk Assessment

Risk Management Technical Specification Initiative 4b
and Risk Informed Completion Times

PRA, CRMP, and License Amendment Requirements

Andrew Howe – NRR/Division of Risk Assessment

ACRS Presentation of RITS 4B - Overview

- PRA Technical Adequacy
- Implementation of CRMP
- License Amendment Submittal and Review

ACRS Presentation of RITS 4B – PRA Technical Adequacy

- Full scope of significant contributors
  - – Internal events
  - – Fires
  - – Other external events unless justified by licensee as insignificant to configuration risk assessment
- CDF and LERF
- Shutdown risk not in scope

ACRS Presentation of RITS 4B – PRA Technical Adequacy

- Internal Events PRA Models:
  - RG 1.200 Rev. 1 and ASME-RA-Sb-2005
  - Conform to capability category II of standard
  - Match PRA system success criteria with design basis
- Fire:
  - RG 1.200 Rev. 1 high level requirements
  - Must treat quantitatively, but can use conservative, bounding evaluations, etc.
- Other External Events:
  - May justify exclusion based on insignificant contribution to configuration risk
  - Otherwise RG 1.200 Rev. 1 high level requirements

ACRS Presentation of RITS 4B – CRMP

- Translation of PRA to CRMP
  - Configuration impact on initiating events
  - Truncation levels
  - Benchmarking: consistency, new uncertainties
  - Time-of-year or time-in-cycle risk contributors
  - Recovery actions applicable to configuration
  - User interface – RMTS scope
- Appropriate administrative controls
  - Software QA
  - Model configuration control (plant changes)
  - User training
  - Procedures
  - Corrective action program

ACRS Presentation of RITS 4B – License Amendment Review

- Scope of TS to which RMTS apply
  - TS functions addressed by PRA modeled functions
  - Success criteria match between design basis and PRA
  - Exceptions justified or restricted
- RG 1.200 assessment
  - Results of peer reviews/self assessments
  - Comparison to capability category II of standards
  - Scope, level of detail, technical adequacy, methods used for PRA models without endorsed standards
- Exclusion of external events
  - Justify insignificant impact on configuration risk metrics
  - Identify and justify use of conservative/bounding methods

ACRS Presentation of RITS 4B – License Amendment Review

- Use of at-power PRA models for transition modes
  - Power and startup operation acceptable without further basis
  - Hot standby/shutdown must be justified
  - Cold shutdown out of scope
- Model reflects as-built, as-operated plant
  - Describe programs/procedures to assess and disposition plant changes
- CRMP
  - Translation of PRA models into CRMP tool
  - Administrative controls and training
  - SSC scope of CRMP
  - Ease of use for RMTS scope of SSCs

ACRS Presentation of RITS 4B – License Amendment Review

- Key assumptions/sources of uncertainty
  - Discussion of method(s) used to identify
  - Disposition of impact on RMTS program
  - Cold shutdown out of scope
- Implementation
  - Programs and procedures
  - Plant staff responsibilities under RMTS program
  - Decision process for risk management actions

Presentation to ACRS Subcommittee on Reliability and Probabilistic Risk Assessment

Risk Management Technical Specification Initiative 4b and Risk Informed Completion Times

South Texas Project Audit of PRA Readiness to Implement RITS 4B

Andrew Howe – NRR/Division of Risk Assessment

ACRS Presentation of RITS 4B - Overview

- Audit Purpose
- Findings from Audit

ACRS Presentation of RITS 4B – Purpose of Audit

- Logistics
  - 4 experienced PRA analysts, SRA from region, TS expertise, and STP PM
  - 3-1/2 days of review June 19 -22, 2006
  - Written audit and review plan developed prior to visit
  - Licensee personnel aware of review scope prior to visit
- Purpose:

  "Provide assurance that the PRA model, CRMP, and supporting activities are adequate to conclude that the implementation of the proposed RMTS amendment request will not challenge public health and safety."

ACRS Presentation of RITS 4B – Purpose of Audit

- Scope:
  - Establish technical adequacy of licensee PRA models not addressed by standards (fire, seismic, external events)
  - Review development and implementation of CRMP
  - Review status of licensee's training and procedures to support RMTS implementation
  - Overall plant safety and risk culture in the licensee's organization

ACRS Presentation of RITS 4B – Findings of Audit

- Overall Conclusion:
  - The STP PRA models, the CRMP, and supporting procedures and training appear sufficient in scope and detail to support the RMTS license amendment request.

ACRS Presentation of RITS 4B – Findings of Audit

- Details – Fire PRA
  - SNL review in NUREG/Cr-5606
  - Updated 1994 for fire barrier issues
  - Successive screening approach found to be reasonable
  - Suppression credit adjusted based on availability of fire pumps in CRMP
- Details – Seismic PRA
  - Low seismicity zone
  - Seismic failures assumed 100% correlated

ACRS Presentation of RITS 4B – Findings of Audit

- Details – Internal Events
  - Meets capability category II of standard
  - Documentation detail needed
  - Identified TS where PRA model scope incomplete

ACRS Presentation of RITS 4B – Findings of Audit

- Details – CRMP
  - Database lookup of pre-solved configurations
  - QA requirements for generation of results
  - No credit for repairs of OOS equipment
  - No time-dependent variables, or assume conservative
  - Some issues with knowing which CRMP function associated with TS

ACRS Presentation of RITS 4B – Findings of Audit

- Details – Uncertainty Analysis
  - Presentation and discussion of licensee plans:
    - Identify key uncertainties per industry guidance
    - Assess key uncertainties impact on configurations with <30 days CT for potential impact
    - Perform sensitivity studies
    - Per NEI 06-09, implement program restrictions or compensatory measures as necessary.
  - NRC team made recommendations for additional areas to be considered.

ACRS Presentation of RITS 4B – Findings of Audit

- Details – Human Reliability Analysis
  - Updating to use EPRI calculation
  - Update to use more robust methods (CBDT or HCR/ORE) instead of existing FLIM.
  - Peer review required by ASME standard due to methodology changes.
  - Staff made observations regarding methods used and supporting t/h analyses bases.

ACRS Presentation of RITS 4B – Findings of Audit

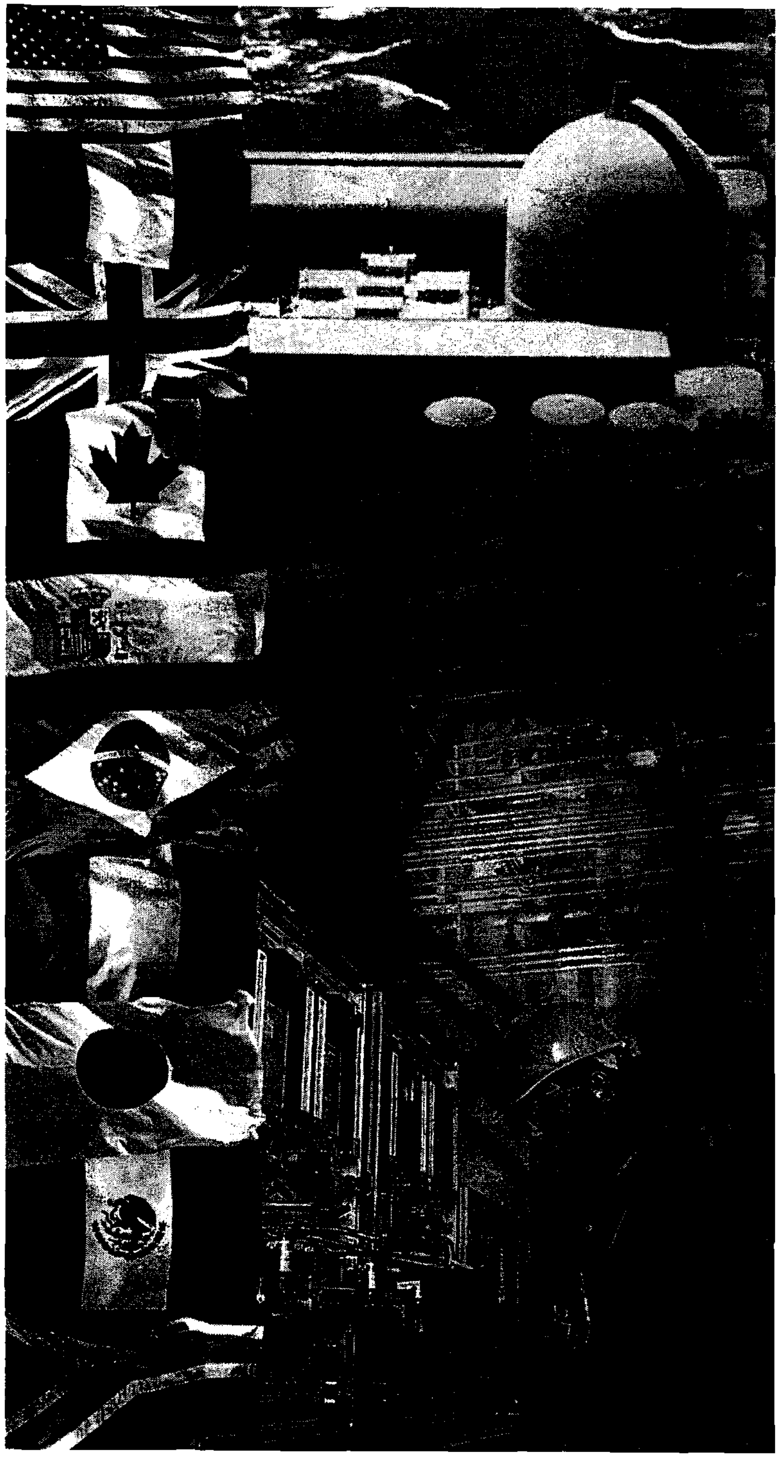
- Details – CRMP Implementation
  - Implementing procedures found consistent with RMTS guidance document
    - OPGP03-ZA-0091 "Configuration Risk Management Program"
    - OPGP03-ZO-0039 "Operations Configuration management"
    - OPOP01-ZO-0006 "Risk Management Actions"
    - OPGP07-ZA-0014 "Software QA Program"
  - Staff attended ongoing operator training for RMTS

ACRS Presentation of RITS 4B – Findings of Audit

- Details – Risk and Safety Culture
  - Assessed areas:
    - Use of risk management in conduct of plant operations
    - Use of risk management as an element of plant safety culture
    - Overall plant risk/safety culture
  - Conducted interviews:
    - I&C Technician
    - Shift Supervisor
    - CAP Manager
    - Assistant Maintenance Manager
    - Employee Concerns Manager
  - Overall Finding: Risk assessment and management is integral to daily operation and maintenance of STP
    - Risk included in daily operations focus meetin, daily monitor reports, daily maintenance planning, performance goals, daily information newsletters.
    - Awareness by management and other personnel

ACRS Presentation of RITS 4B – Findings of Audit

- Conclusions
  - Overall STP appears on right track to implement RMTS
  - Some areas to be considered for RAI to support LAR:
    - Licensee to justify fire scenarios screened
    - Licensee to evaluate fire PRA data in uncertainty analysis
    - Licensee to update RG 1.200 assessment
    - Licensee to justify each TS can be assessed by CRMP



ELECTRIC POWER
RESEARCH INSTITUTE

ACRS Meeting
Tech Spec Initiative 4B

March 2007

Ken Canavan
Risk and Asset Program Manager

Human Error Probability Treatment in 4B

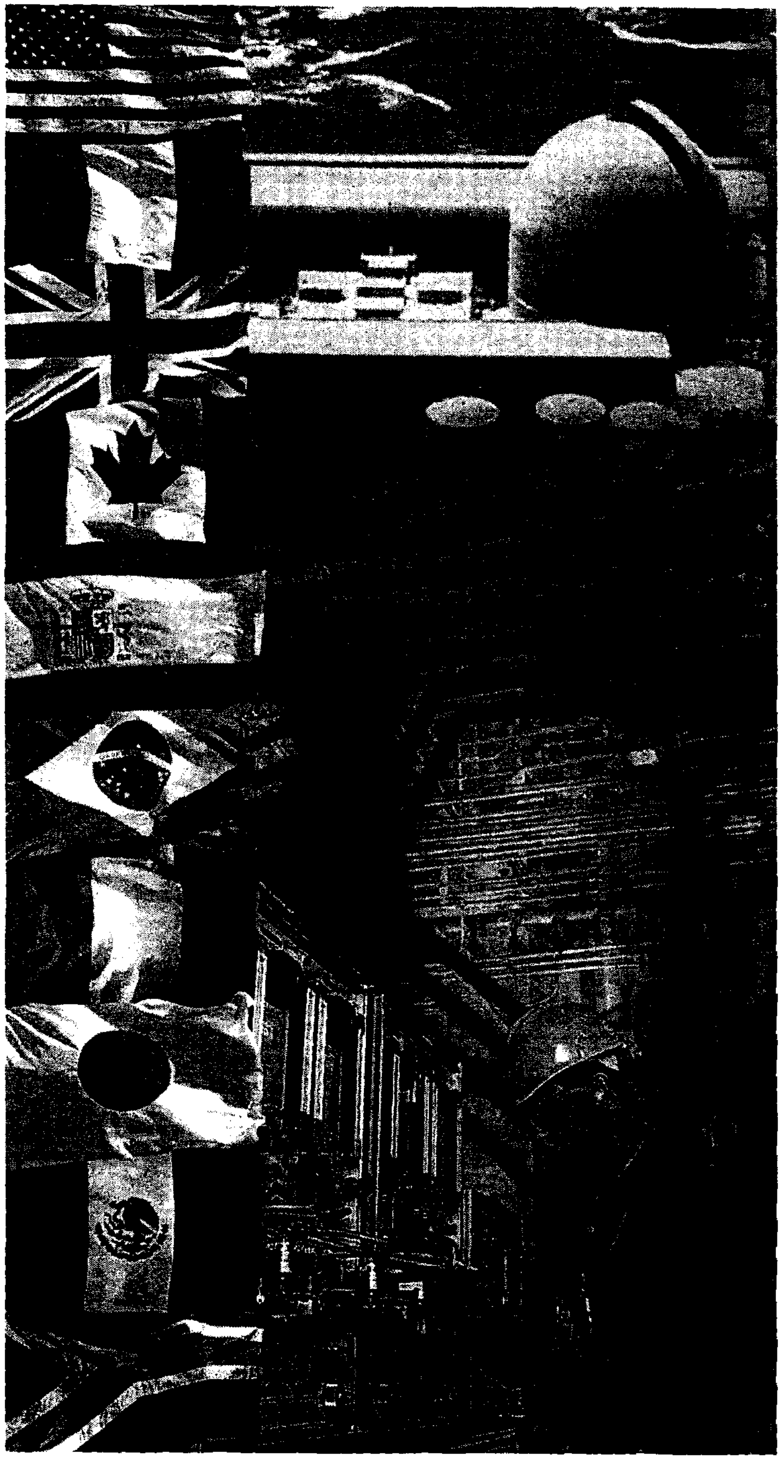
- General HEP Treatment in TS 4B
  - No changes are made to HEPs
  - Generally, treatment is slightly conservative since plant configuration known by operators
  - Specific risk management actions for certain configurations

- STP uses EPRI HRA Calculator (THERP methodology)

Treatment of Uncertainty in TS 4B

- Parametric Uncertainty
  - Performed for base model
  - Delta risk calc – generally no significant change
- Modeling Uncertainty
  - Uncertainty on base case - sensitivity studies
    - Standard sensitivity cases (HRA, CCF, etc)
    - Specific sensitivity case where RAW > 2
    - No new sequences as a result of 4B

- STP consistent with EPRI Uncertainty Guide (not initially used due to timing of activities)



EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Configuration Risk Management Tools

USNRC ACRS RITS 4B Presentation
23 March 2007

Dr. Stephen M. Hess
Project Manager - Configuration Risk Management Program

STP Nuclear Operating Company

STP Implementation of Risk-Informed Technical Specifications

ACRS Subcommittee on Reliability and PRA

March 23, 2007

Jay Phelps, STP Operations Manager

Desired Outcomes

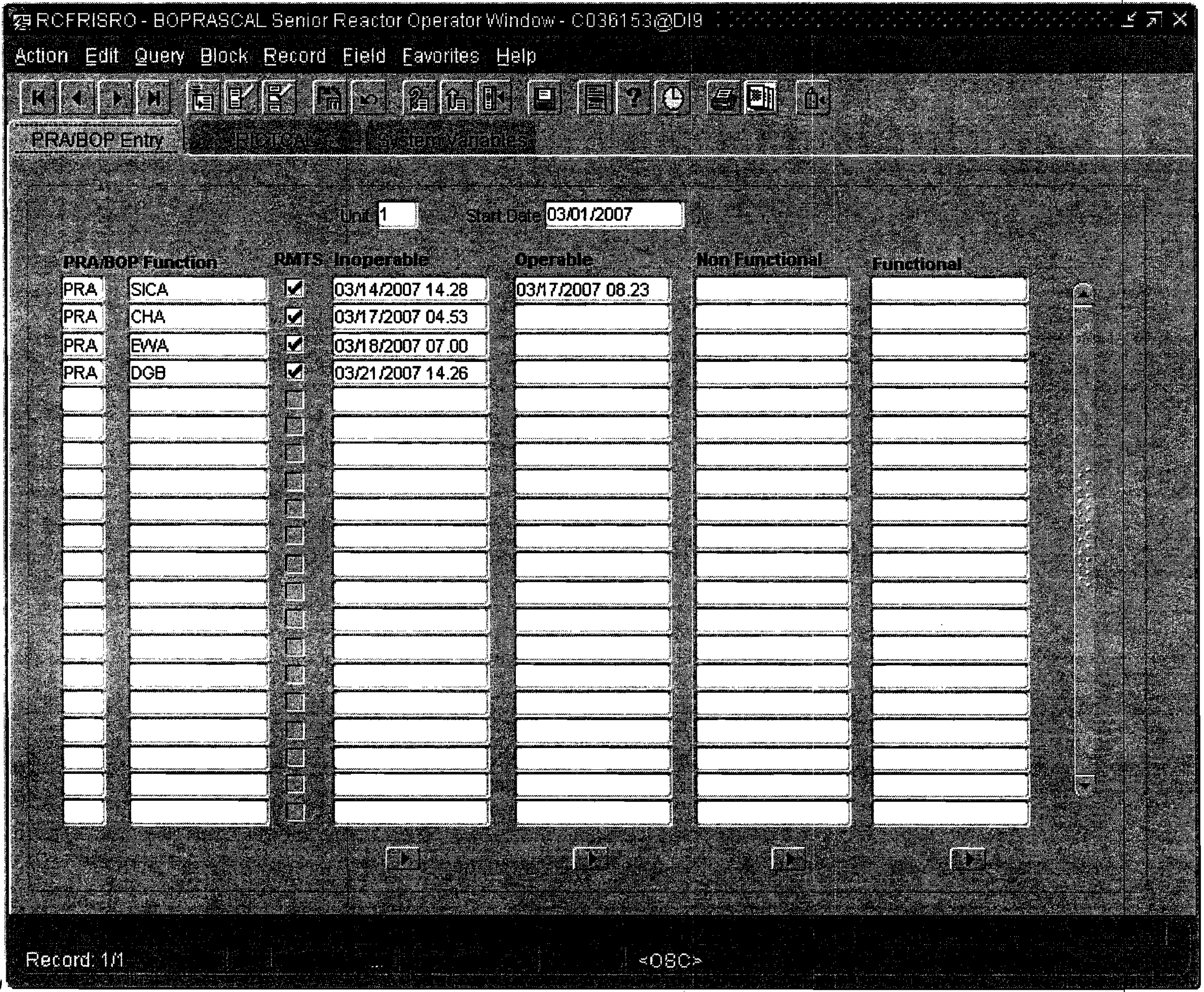
- Overview of STP's On-line risk assessment tools
- RICTCal Attributes and Applications at STP
- RMTS Implementation at STP

RICTCal Overview

- Based on STPNOC's existing configuration risk management tool
- Meets NEI 06-09 RMTS Guideline requirements
- Database of >20,000 maintenance states quantified by the STP PRA
  - CDF and LERF pre-quantified
- User friendly interface developed in cooperation with STP users

Application of RICTCal

- RICTCal will be used by Operations and Maintenance Planners to calculate RICTs
- Risk Management Group may be called to quantify a configuration that is not in RICTCal



Unit 1 Start Date 03/01/2007

PRA/BOP Function		RMTS	Inoperable	Operable	Non Functional	Functional
PRA	SICA	☑	03/14/2007 14.28	03/17/2007 08.23		
PRA	CHA	☑	03/17/2007 04.53			
PRA	EWA	☑	03/18/2007 07.00			
PRA	DGB	☑	03/21/2007 14.26			
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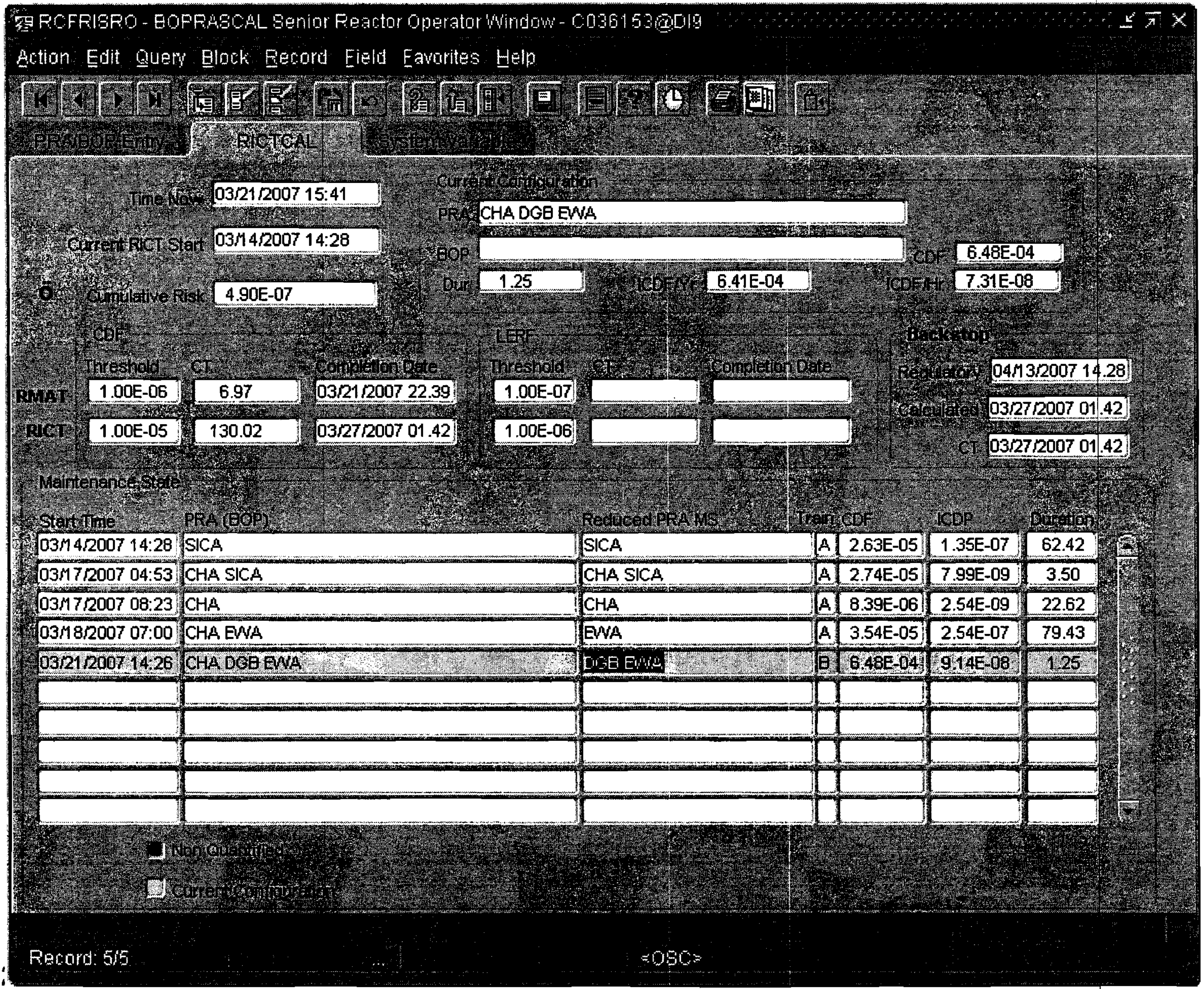

Time Now 03/21/2007 15:41

Current RICT Start 03/14/2007 14:28

Cumulative Risk 4.90E-07

Current Configuration

PRA CHA DGB EWA

BOP

Dur 1.25

ICDF/Yr 6.41E-04

CDF 6.48E-04

ICDF/Hr 7.31E-08

	CDF			LERF		
	Threshold	CT	Completion Date	Threshold	CT	Completion Date
RMAT	1.00E-06	6.97	03/21/2007 22.39	1.00E-07		
RICT	1.00E-05	130.02	03/27/2007 01.42	1.00E-06		

Backstop

Regulatory 04/13/2007 14.28

Calculated 03/27/2007 01.42

CT 03/27/2007 01.42

Maintenance State

Start Time	PRA (BOP)	Reduced PRA MS	Train	CDF	ICDP	Duration
03/14/2007 14:28	SICA	SICA	A	2.63E-05	1.35E-07	62.42
03/17/2007 04:53	CHA SICA	CHA SICA	A	2.74E-05	7.99E-09	3.50
03/17/2007 08:23	CHA	CHA	A	8.39E-06	2.54E-09	22.62
03/18/2007 07:00	CHA EWA	EWA	A	3.54E-05	2.54E-07	79.43
03/21/2007 14:26	CHA DGB EWA	DGB EWA	B	6.48E-04	9.14E-08	1.25

■ Non Quantified

▨ Current Configuration

Record: 5/5 <OSC>

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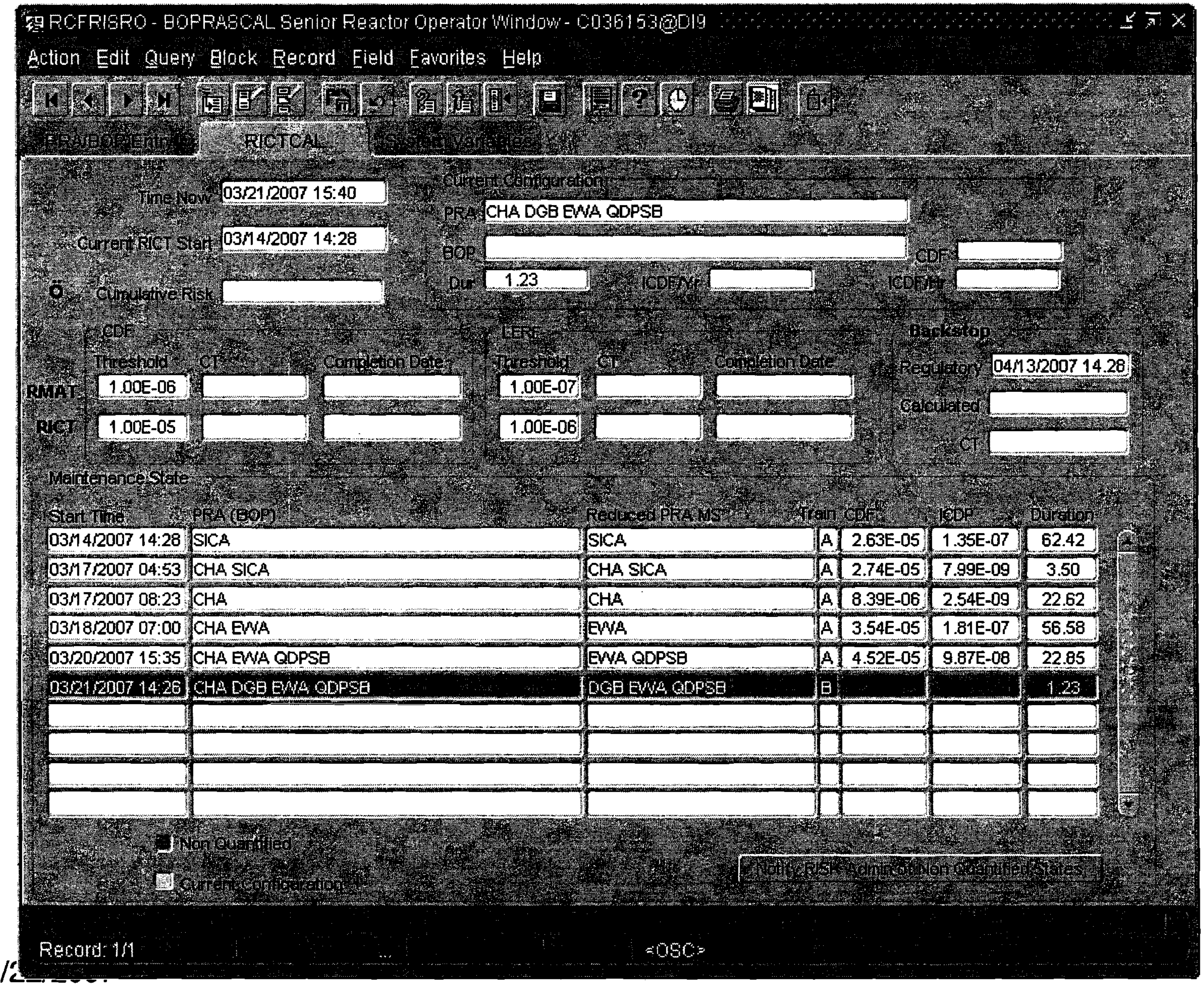

Time Now 03/21/2007 15:40

Current RICT Start 03/14/2007 14:28

Cumulative Risk

Current Configuration

PRA CHA DGB EWA QDPSB

BOP

Dur 1.23

ICDF/Yr

CDF

ICDF/Hr

	CDF Threshold	CDF CT	CDF Completion Date	LERF Threshold	LERF CT	LERF Completion Date
RMAT	1.00E-06			1.00E-07		
RICT	1.00E-05			1.00E-06		

Backstop

Regulatory 04/13/2007 14.28

Calculated

CT

Maintenance State

Start Time	PRA (BOP)	Reduced PRA MS	Train	CDF	ICDP	Duration
03/14/2007 14:28	SICA	SICA	A	2.63E-05	1.35E-07	62.42
03/17/2007 04:53	CHA SICA	CHA SICA	A	2.74E-05	7.99E-09	3.50
03/17/2007 08:23	CHA	CHA	A	8.39E-06	2.54E-09	22.62
03/18/2007 07:00	CHA EWA	EWA	A	3.54E-05	1.81E-07	56.58
03/20/2007 15:35	CHA EWA QDPSB	EWA QDPSB	A	4.52E-05	9.87E-08	22.85
03/21/2007 14:26	CHA DGB EWA QDPSB	DGB EWA QDPSB	B			1.23

■ Non Quantified

■ Current Configuration

Record: 1/1 ... <OSC>

03/2

7

March 1, 2007

MEMORANDUM TO: George Apostolakis, Chairman
Reliability and Probabilistic Risk Assessment Subcommittee

FROM: Maitri Banerjee, Senior Staff Engineer
Technical Support Branch, ACRS

SUBJECT: REVIEW MATERIALS FOR THE ACRS SUBCOMMITTEE MEETING ON MARCH 23, 2007, RELATED TO THE REVIEW OF THE RMTS INITIATIVE 4B

The purpose of this memorandum is to forward written materials for your use in preparing for the meeting of the ACRS Subcommittee on Reliability and Probabilistic Risk Assessment, March 23, 2007, concerning the risk managed technical specification (RMTS) initiative 4b. Initiative 4b, titled "Use of Configuration Management for Determining Technical Specification Completion Times, related to the use of Probabilistic Risk Assessment (PRA) and Risk Monitoring Tools," attempts to extend the TS allowed outage times or completion times with the help of PRA tools and configuration risk management.

The last presentation staff made to the Subcommittee was on April 28, 2006. The Subcommittee wanted to understand how the PRA model would be translated to the configuration risk management tool before endorsing the RMTS guidelines. The staff was asked to have another meeting with the Subcommittee after the staff's planned site visit to the pilot plants last summer and completion of the safety evaluation report on the RMTS guidance document. A Full Committee briefing is scheduled during the April meeting.

To prepare for the meeting, the following documents are attached:

1) Industry guidance document, NEI 06-09, Rev 0, "Risk-Managed Technical Specification (RMTS) Guidelines," dated November 2006;

2) RMTS Guidance Document Draft Safety Evaluation (not yet final, but staff does not expect major changes);

3) South Texas Project PRA Audit Report;

4) Pilot plant application from South Texas project dated August 2, 2004; (ML042190366)

5) Minutes of the last Subcommittee meeting on the subject;

6) EPRI document, "Methodology for Fire Configuration Risk Management," December 2005. This document was requested by Dr. Apostolakis at the last meeting.

NEI 06-09 (Revision 0)

Risk-Informed Technical Specifications Initiative 4b

Risk-Managed Technical Specifications (RMTS) Guidelines

Industry Guidance Document

November 2006

ML063390639

ACKNOWLEDGMENTS

This document was originally developed by EPRI as:

Risk-Managed Technical Specifications (RMTS) Guidelines

EPRI Report 1013495

The development of the requirements for Risk-Managed Technical Specifications was supported by the RITS 4B development team. NEI wishes to acknowledge the efforts of the following individuals who contributed to this effort:

Steve Hess	Electric Power Research Institute
John Gaertner	Electric Power Research Institute
Ray Schneider	Westinghouse
Gary Chung	Southern California Edison
Rick Grantom	South Texas Project Nuclear Operating Company
Alan Hackerott	Omaha Public Power District
Wayne Harrison	South Texas Project Nuclear Operating Company
Scott Head	South Texas Project Nuclear Operating Company
Dave Musick	South Texas Project Nuclear Operating Company

NOTICE

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.

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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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.

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.

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.

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.

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.

2
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.

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 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.

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

* 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.

2.2 RMTS Thresholds

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.

Table 2-2
RMTS Quantitative Risk Management Thresholds

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

* 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”

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.

    - 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.

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.

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.

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).

- 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.
- 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.

  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.

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

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.

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.

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.

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

    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:

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

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

    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.

    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.

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

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.

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.

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).

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.

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.

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

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

   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.

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.

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).

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.

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.

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.

    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

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:

  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.

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.

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 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).

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.

Table 3-1
RMTS Quantitative Risk Management Thresholds

Criterion*		**Maintenance Rule Risk Management Guidance**	**RMTS Risk Management Guidance**
CDF	LERF		
$\geq 10^{-3}$ events/year	$\geq 10^{-4}$ 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		
$\geq 10^{-5}$	$\geq 10^{-6}$	– Configuration should not normally be entered voluntarily	- Follow the Technical Specification requirements for required action not met.
$\geq 10^{-6}$	$\geq 10^{-7}$	– 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

* 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 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.

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.

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.

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
		<u>OR</u>		
		B.2.1	Determine that the completion time extension beyond 72 hours is acceptable in accordance with established RMTS thresholds.	72 hours
		<u>AND</u>		
		B.2.2	Verify completion time extension beyond 72 hours remains acceptable.	In accordance with the RMTS Program.
		<u>AND</u>		
		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.

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.

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 or (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).

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:

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.

RMTS PROCESS FLOWCHART

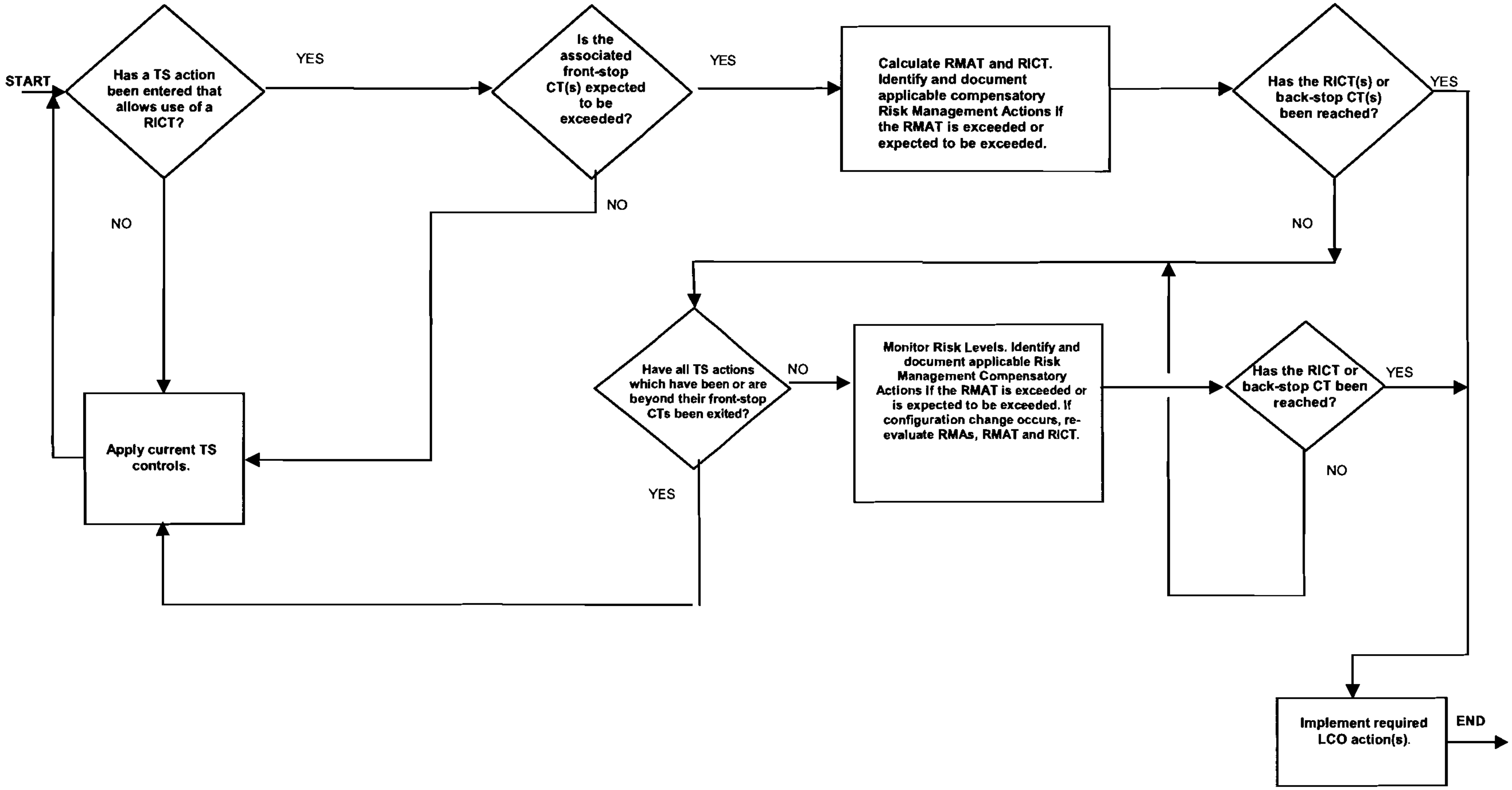

Figure 3-1
Process Flowchart for RMTS RICT Assessment and Implementation

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.
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.
   - 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

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.

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.)

> 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.

- 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 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.

3.2.4 Examples Demonstrating Application of RMAT and RICT in RMTS Programs

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.

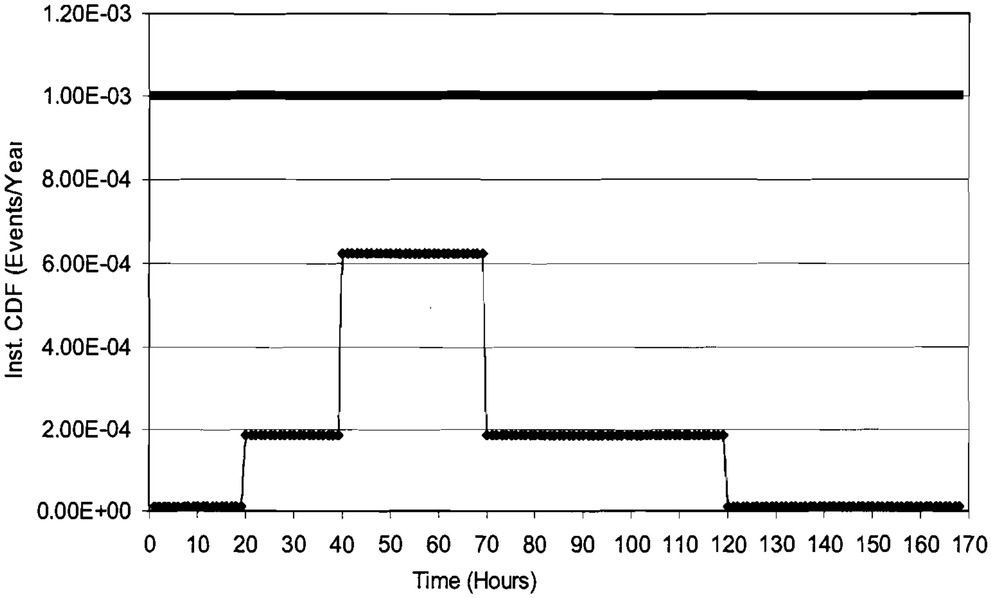

Figure 3-2
Configuration Risk Management – Instantaneous CDF Profile Example

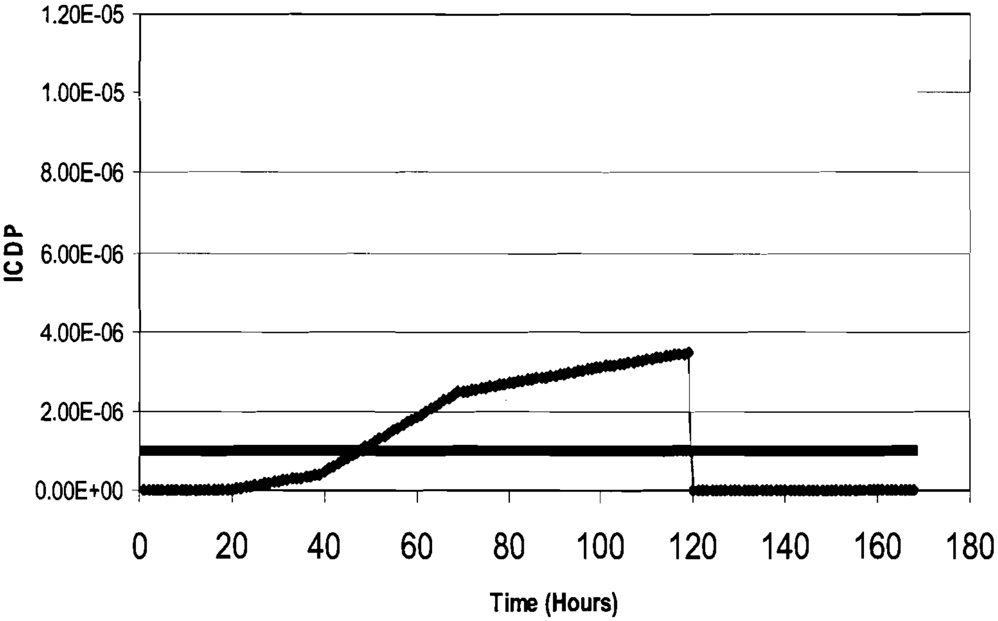

Figure 3-3
Configuration Risk Management – Instantaneous CDP Example

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.

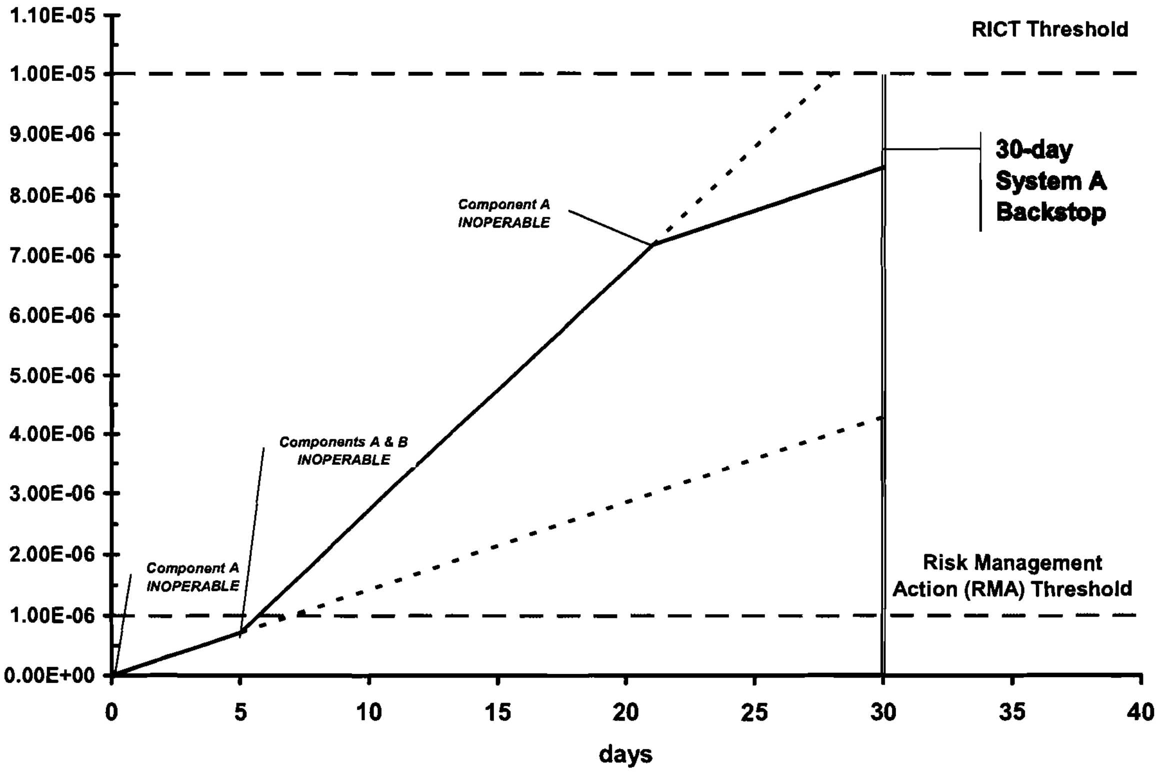

Figure 3-3
Configuration Risk Management – Illustration of Risk Accrual for RICT Calculation

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.

3.3 RMTS Assessment Methods

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

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 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.

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.

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:

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.

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).

OR

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 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.

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.

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.

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.

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 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.

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:

- 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 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.

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:

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.

- 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.
- 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.

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.
    - 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.

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.

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.

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.

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 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:

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

[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.**

   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.

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.

   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.

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

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.

5
REFERENCES

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4. USNRC, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," Regulatory Guide 1.174, Revision 1, November 2002.
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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.

A
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 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.

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 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 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.

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.

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.

MEMORANDUM TO: Stacey L. Rosenberg, Chief
Special Projects Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

FROM: Timothy J. Kobetz, Chief
Technical Specifications Branch
Division of Inspection and Regional Support
Office of Nuclear Reactor Regulation

SUBJECT: DRAFT SAFETY EVALUATION RELATING TO NEI 06-09, RISK-MANAGED TECHNICAL SPECIFICATIONS GUIDELINES, FOR RISK MANAGEMENT TECHNICAL SPECIFICATIONS INITIATIVE 4B, RISK-INFORMED COMPLETION TIMES (TAC NO. MB3541)

On December 16, 2003, the Nuclear Energy Institute (NEI) provided document EPRI 1002965, "Risk-Managed Technical Specifications (RMTS) Guidelines," Interim Report, October 2003, for U.S. Nuclear Regulatory Commission staff review. Since that date, several supplemental communications have been received, and a revised version was received on November 13, 2006, entitled "NEI 06-09 Rev. 0, Risk-Informed Technical Specifications Initiative 4B, Risk-Managed Technical Specifications (RMTS) Guidelines," November 2006.

This generic guidance document provides a methodology for licensee implementation of industry Risk Management Technical Specifications Initiative 4B, Risk-Informed Completion Times. This initiative allows for exceeding the completion times of selected limiting conditions for operation, provided risk is assessed and managed. Detailed requirements for the risk assessment and supporting program are provided by NEI 06-09, which would be added to the administrative controls of technical specifications.

The attached safety evaluation confirms the acceptability of the proposed industry methodology of NEI 06-09. The safety evaluation will be reviewed by the Advisory Committee on Reactor Safeguards (ACRS) as part of an overall review of Risk Management Technical Specifications Initiative 4B. Prior to the ACRS review, your assistance in providing this draft safety evaluation to NEI will be appreciated.

Enclosure:
As stated

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SAFETY EVALUATION OF NEI 06-09
RISK-MANAGED TECHNICAL SPECIFICATIONS GUIDELINES

1.0 INTRODUCTION

On December 16, 2003, the Nuclear Energy Institute (NEI) provided document EPRI 1002965, "Risk-Managed Technical Specifications (RMTS) Guidelines," Interim Report, October 2003, for U.S. Nuclear Regulatory Commission (NRC) staff review. Since that date, several supplemental communications have been received, and a revised version was received on November 13, 2006, entitled "NEI 06-09 Rev. 0, Risk-Informed Technical Specifications Initiative 4B, Risk-Managed Technical Specifications (RMTS) Guidelines," November 2006 (Ref. 1)(ADAMS Accession No. ML063390639).

1.1 Proposed Action

The document provides a risk-informed methodology which would permit a licensee to implement RMTS Guidelines (RMTS hereafter refers to the RMTS Guidelines), to permit the completion times (CT), also referred to as the allowed outage times (AOT), associated with actions of technical specifications (TS) to be extended, provided risk is assessed and managed within a configuration risk management program (CRMP). NEI 06-09 supports industry initiative 4B of the Risk-Management Technical Specifications risk-informed CT (RICT) TS program. These initiatives are intended to maintain and improve safety through the incorporation of risk assessment and management techniques in TS, while reducing unnecessary burden and making TS requirements consistent with the Commission's other risk-informed regulatory requirements.

For those limiting conditions for operation (LCO) within the proposed plant-specific scope of the RMTS, a new action requirement is provided to permit continued operation beyond the existing CTs of applicable action requirements of the LCOs. This new action requirement tracks risk as measured by the configuration-specific core damage frequency (CDF) and large early release frequency (LERF), and assesses this risk using processes and limits specified in NEI 06-09. Additional requirements for compensatory measures or risk management actions (RMA), requirements for scope and quality of the probabilistic risk assessment (PRA) models used in the CRMP, and for quantitative evaluation of risk sources for which PRA models may not be available are also specified.

1.2 Related NRC Actions

The document is referenced in two pilot plant submittals. Omaha Public Power District submitted a license amendment request (LAR) for Fort Calhoun Station on May 14, 2004 (Ref. 12), and South Texas Project Nuclear Operating Company submitted a LAR for the two unit South Texas Project plants on August 2, 2004 (Ref. 13). The South Texas request was resubmitted on June 6, 2006 to incorporate revisions made to the report. The Ft. Calhoun request was withdrawn on August 25, 2006, and is planned to be resubmitted in the first quarter of 2007 pending approval of the report.

2.0 REGULATORY EVALUATION

2.1 Applicable Regulations

In Title 10 of the *Code of Federal Regulations* Part 50.36 (10 CFR 50.36), the Commission established its regulatory requirements related to the content of TS. Pursuant to 10 CFR 50.36, TS is required to include items in the following five specific categories related to station operation: (1) safety limits, limiting safety system settings, and limiting control settings; (2) LCOs; (3) surveillance requirements; (4) design features; and (5) administrative controls. The rule does not specify the particular requirements to be included in a plant's TS. As stated in 10 CFR 50.36(c)(2), "Limiting conditions for operation are the lowest functional 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 will shut down the reactor or follow any remedial action permitted by the technical specifications until the condition can be met."

Most TS LCOs provide a fixed time interval, referred to as the AOT or CT, during which the LCO may not be met, to permit a licensee to perform required testing or maintenance activities, or to conduct repairs. Upon expiration of the CT, the requirement to shut down the reactor or follow remedial action is imposed. The RMTS provide a means for the licensee to extend the CT and thereby delay reactor shutdown or remedial actions, if risk is assessed and managed within specified limits and programmatic requirements established by the CRMP. The regulatory requirements for the content of LCOs continue to be met, since only the CT is changed by RMTS. The specific functional capabilities or performance levels of equipment are unchanged, and the remedial actions, including the requirement to shut down the reactor, are also unchanged; only the specific time limits for initiating actions are extended by RMTS.

The maintenance rule, 10 CFR 50.65, "Requirements for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," requires licensees to monitor the performance or condition of structures, systems and components (SSC) against licensee-established goals, in a manner sufficient to provide reasonable assurance that these SSCs are capable of fulfilling their intended functions. In addition,10 CFR 50.65(a)(4) requires the assessment and management of the increase in risk that may result from a proposed maintenance activity. NEI 06-09 uses processes which are consistent with and complementary to the requirements of 10CFR50.65(a)(4).

2.2 Applicable Regulatory Criteria/Guidelines

A CT extension may increase the unavailability of a component due to the increased time the component is permitted to be out-of-service for maintenance or repair. There are two components to the risk impact: (1) the single event risk when the CT is invoked and the component is out-of-service, and (2) the yearly risk contribution based on the expected frequency that the CT will be implemented.

The yearly risk impact is represented by the ΔCDF and ΔLERF metrics referenced in Regulatory Guide (RG) 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," (Ref. 2). The single event risk is represented by the incremental conditional core damage probability (ICCDP) and the incremental conditional large early release probability (ICLERP) metrics referenced in RG 1.177, "An Approach for Plant-Specific, Risk-Informed Decisionmaking: Technical Specifications," (Ref. 3).

General guidance for evaluating the technical basis for proposed risk-informed changes is provided in Chapter 19.0, "Use of Probabilistic Risk Assessment in Plant-Specific, Risk-Informed Decisionmaking: General Guidance," of the NRC Standard Review Plan (SRP), NUREG-0800 (Ref. 9). More specific guidance related to risk-informed TS changes, including changes to TS CTs, is provided in SRP Section 16.1, "Risk-Informed Decisionmaking: Technical Specifications," (Ref. 10).

Specific methods and guidelines acceptable to the staff are also outlined in RG 1.177 for assessing risk-informed TS changes. Specifically, RG 1.177 provides recommendations for utilizing risk information to evaluate changes to TS CTs with respect to the impact of the proposed change on the risk associated with plant operation. RG 1.174 and RG 1.177 also describe acceptable implementation strategies and performance monitoring plans to help ensure that the assumptions and analysis used to support the proposed TS changes will remain valid. Finally, RG 1.200 establishes requirements for PRA technical adequacy.

3.0 TECHNICAL EVALUATION

3.1 Background

This section discusses how RMTS are implemented at a plant, and provides the specific detailed requirements identified in NEI 06-09 for RMTS programs.

NEI 06-09 provides a risk-informed method to assess and manage the extension of CTs of TS action requirements. PRA methods are used to calculate the configuration-specific risk in terms of CDF and LERF. These risk metrics are applied to determine an acceptable extended duration for the CT, referred to as a risk-informed completion time (RICT), based on the accumulation of risk from the point in time when the LCO was not met.

The existing CTs of the TS actions are retained in the TS, and referred to as the frontstop CTs. When a TS LCO is not met but the frontstop CT of the required action has not yet been reached, there is no change to TS action requirements, and the provisions of 10CFR50.65(a)(4) address the requirement to assess and manage configuration-specific risk. If the TS LCO is not restored prior to exceeding the frontstop CT, then under the existing TS requirements, a plant shutdown, or other specified remedial action(s), would be required.

As an alternative TS action, the RMTS may be voluntarily applied, if applicable to the TS action requirement, and subject to program limitations. A RICT may be calculated to determine an appropriate extension of the CT to defer the plant shutdown or specified remedial action. The RICT is based on the configuration-specific CDF and LERF, and the time to reach specified limits for integrated core damage probability (ICDP) or integrated large early release probability (ILERP). The RICT is further limited to a deterministic maximum of 30 days (referred to as the backstop CT) from the time the TS action was first entered. The RICT is based on the configuration-specific accumulation of risk from the time the TS action was first entered, and is required to be recalculated whenever the plant configuration changes. If the TS LCO is not restored prior to reaching the calculated RICT, then the TS requirements for plant shutdown or other remedial action become applicable.

Risk Metrics. For RICT calculations, the configuration-specific risk is determined and the time to reach an ICDP of 10^{-5}, or an ILERP of 10^{-6}, is calculated. The more limiting time becomes applicable as the RICT, subject to an upper limit (backstop CT) of 30 days. The use of core damage and large early release metrics is consistent with the guidance of RG 1.177 and RG 1.174. The ICDP and ILERP limits are consistent with the guidance of Section 11 of NUMARC 93-01, "Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants", dated February 22, 2000 (Ref. 7), which was endorsed by RG 1.182, "Assessing and Managing Risk Before Maintenance Activities at Nuclear Power Plants," (Ref. 8) for control of risk during maintenance activities. The 30-day backstop CT assures that TS equipment is not out of service for extended periods, and is a reasonable upper limit to permit repairs and restoration of equipment to an operable status.

In addition to the integrated risk limits for calculating the RICT, NEI 06-09 also imposes a restriction which prohibits voluntary entry into a plant configuration which exceeds a risk level equivalent to 10^{-3}/year CDF, or 10^{-4}/year LERF. These limits provide a control to prevent entry into potential high risk configurations, and are consistent with the guidance of NUMARC 93-01. Consistent with RG 1.182, the staff neither endorses nor disapproves of the 10^{-3}/year CDF value, nor the 10^{-4}/year LERF value. The NRC has not developed guidance on acceptable levels of configuration risk, but instead uses metrics based on the accumulation of risk over time. The industry imposed limits of 10^{-3}/year CDF and 10^{-4}/year LERF would only permit a few days of operation until the ICDP limit of 10^{-5}, or the ILERP limit of 10^{-6}, upon which the RICT is based, were reached, and so extended operation in such configurations would not be permitted under a RMTS program. Such configurations are not expected to occur frequently, and therefore the staff does not find it necessary to provide any further restrictions on configuration risk beyond what is proposed in NEI 06-09.

A periodic assessment of the risk incurred due to the extension of CTs is also required. This is an evaluation of the calculated change in risk after implementation of RMTS to assure that the guidance of RG 1.174 for ΔCDF (1E-5 per year) and ΔLERF (1E-6 per year) are met. If the RG 1.174 limits are exceeded, then corrective actions must be implemented.

Applicability. The use of the RMTS is voluntary, and applies only to a plant-specific set of TS LCOs and associated action requirements. The RMTS are applicable whenever any current TS CT (referred to as the frontstop CT) is exceeded and the TS required plant shutdown or other remedial action is to be deferred based on the RMTS. Under the existing TS, when the CT is reached, the plant would be required to shut down, or to implement other remedial actions allowed by the particular TS action. Under the RMTS, the RICT determined based on ICDP or ILERP, up to a limit of 30 days, becomes the CT in effect for the LCO. The RMTS cannot be voluntarily entered if 1) the configuration-specific risk exceeds the instantaneous limits of 10^{-3}/year CDF, or 10^{-4}/year LERF, 2) the ICDP or ILERP limit has been reached prior to exceeding the frontstop CT, or 3) a total loss of function for the affected TS system occurs.

Until a RICT is calculated, the frontstop CT, and any associated actions, remain the TS control in effect. The RICT must be established prior to any time limit associated with a TS action requirement of the frontstop CT. The RICT is based on the time to accumulate the allowable risk limit from the time the LCO was not met; that is, the RICT accounts for risk accumulated while the TS action was in effect prior to reaching the frontstop CT.

While an RICT is in effect, any configuration change requires a reassessment of the configuration-specific risk and the resulting impact on the RICT. This includes changes in status of any SSC within the scope of the plant-specific CRMP, including those SSCs not subject to TS controls. For planned changes, the revised RICT would be determined prior to implementation of the change in a configuration. For emergent conditions, the revised configuration risk is required to be assessed within the time limits of any required TS action, not to exceed 12 hours, and used to determine the new RICT.

The accumulation of risk and comparison to the ICDP and ILERP limits to determine an RICT continues until there are no LCOs exceeding their front-stop CTs. At that time, the current TS CTs become the CTs in effect, and the risk accumulation for a RICT is reset.

If the ICDP or ILERP limits are reached (i.e., the RICT is reached) and any TS LCO action requirement is beyond its frontstop CT, then the actions required by the TS LCOs are implemented. In addition, a 30-day backstop CT is also applicable to each individual LCO action requirement, applicable from the time the LCO became not met, after which the actions required by the TS LCOs must be implemented.

Functionality of SSCs. In determining the configuration-specific risk impact, an inoperable SSC is normally considered to be nonfunctional with respect to the calculation of risk using the PRA model. Depending upon the specific inoperable SSC which causes the TS LCO to be not met, the level of risk calculated may vary, and so different RICTs may be calculated for the same TS action for different inoperable SSCs, based on the functional impact on the PRA model of the nonfunctional SSCs. For example, an inoperable valve which only affects one redundant flowpath renders the affected system or train inoperable, but may cause a lesser risk impact compared to that resulting from the unavailability of the pump which supplies all flowpaths, and therefore would result in a longer RICT. Thus the calculated CT is risk-informed, and varies based on the functional impact of the actual SSC inoperability.

If the unique effect of the SSC inoperability on its particular TS functions is discernible by the CRMP and underlying PRA models, then the functional capability of the affected inoperable SSC may be credited when calculating the RICT. For example, if a valve has TS required functions in both the open and closed positions, then an inoperable valve may be credited in the RICT calculation based on its actual open or close status, if the PRA model can account for failure modes which are based on the actual valve position. This allows the RICT to accurately reflect the risk of the specific plant configuration in terms of the available mitigating capability of inoperable SSCs.

In any case, where credit is given in the RICT calculation to inoperable SSCs performing a required TS function, appropriate justification must be provided and documented.

Emergent Failures. During the time when an RICT is in effect and risk is being assessed and managed, it is possible that emergent failures of components may occur, and these must be assessed to determine the impact on the RICT. If a failed component is one of two or more redundant components in separate trains of a system, then there is potential for a common cause failure mechanism. Licensees already assess the remaining redundant components to verify reasonable assurance of their continued operability, and this is not changed by implementation of RMTS. If a licensee concludes that the redundant components remain operable, then these components may be considered functional for purposes of the RICT. However, the licensee is required to consider and implement additional RMAs, due to the potential for increased risks from common cause failure of similar equipment. The staff interprets NEI 06-09 as requiring consideration of such RMAs whenever the redundant components are considered to remain operable, but the licensee has not completed the extent of condition evaluations.

If an emergent failure of a redundant component results in a total loss of function while the RMTS are in effect, then the RICT is exited and the applicable TS action is required to be implemented. Voluntary use of the RMTS for a configuration which represents a loss of function, or inoperability of all safety trains, is not permitted.

As discussed above with regards to the functionality of SSCs, it is possible that all trains of a TS system may be inoperable, but the functional impact of the inoperability may be discerned by the PRA model in the CRMP. In such cases involving emergent (unplanned) conditions, the RMTS may be applied to calculate a RICT.

For example, if a degraded seismic support is discovered on a common line which renders all trains of the affected system inoperable, the system will still function for all initiating events except an earthquake. If the PRA model has the capability to calculate the seismic risk impact of this condition, then the RMTS could be applied. As a further example, if during planned maintenance of one train of a two train TS system, an emergent failure of a low pressure pump trip interlock required to protect the pump in the event of a failed traveling screen system may render the pump inoperable, but the pump can still function if the screen is operable. In such a case, the RMTS could be applied even though both trains of the TS system are inoperable, since one of the two trains remains functional.

These example cases involve SSC inoperabilities which do not involve degrading component performance. In most cases, degrading SSCs may not be considered to be functional while inoperable. For example, a pump which fails its surveillance test for required discharge pressure is declared inoperable. It cannot be considered functional for calculation of a RICT, since the cause of the degradation may be unknown, further degradation may occur, and since the safety margin established by the pump's operability requirements may no longer met. As a counter example, a valve with a degrading stroke time may be considered functional if the stroke time is not relevant to the performance of the safety function of the valve; for example, if the valve is required to close and is secured in the closed position, then the degradation of stroke time would not impact the capability of the valve to be closed.

Risk Management. An important element of RMTS is the programmatic requirement to manage risk and to implement reasonable compensatory measures to reduce risk. Thresholds are established at a factor ten below the RICT limits for ICDP and ILERP, and used to calculate a risk management action time (RMAT). If the equipment out-of-service time exceeds the RMAT, or if the planned outage duration is projected to result in exceeding the RMAT, then RMAs must be considered and applied as appropriate to the specific configuration and plant conditions. These limits are consistent with the guidance of NUMARC 93-01 endorsed by RG 1.182. NEI 06-09 provides guidance on typical RMAs which may be considered, but is not prescriptive in requiring specific actions. RMAs are based on the configuration-specific risk, and determined in accordance with plant-specific procedures and programs.

PRA Quality. In order to support RMTS, the plant-specific CRMP must include the capability to assess LERF, and must include a quantified assessment of all significant sources of risk (i.e., external events and fires) which can be impacted by changes to the plant configuration. Where PRA models are not available, conservative or bounding analyses may be performed to quantify the risk impact and support the calculation of the RICT. Sources of risk shown to be insignificant or unaffected by changes in plant configurations may be neglected in the RICT calculations. This assures that the RICT is calculated with appropriate consideration of all potentially significant sources of risk.

The technical adequacy of the underlying PRA models is required to be assessed against the requirements of RG 1.200 Rev. 0, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities" (Ref. 4). For the internal events PRA models, the assessment is required to consider capability Category II of American Society of Mechanical Engineers (ASME) RA-Sa-2003, "Addendum to ASME RA-S-2002, Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications," (Ref. 5). Any departure from these requirements must be assessed and determined not to impact the RMTS. Where NRC-endorsed standards do not exist for specific PRA models (i.e., fire risk), the licensee must justify the technical adequacy of these models to support RMTS.

The staff notes that an addendum to the ASME standard was issued in 2005, ASME RA-Sb-2005, "Addenda to ASME RA-S-2002, Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications," (Ref. 11). An imminent revision to RG 1.200 will endorse the updated standard applicable for internal events PRA models. The staff takes exception to NEI 06-09 and will require assessment of PRA technical adequacy using the revised RG 1.200 and the updated PRA standard.

Scope of TS Applicability. Only TS LCOs governing SSCs which can be assessed using the CRMP and underlying PRA models may be subject to RMTS. The PRA model and CRMP must address the TS required functions of the SSCs to assure that the risk significance of the unavailability of the SSC is properly assessed to determine an RICT.

Documentation. Each entry into the RMTS is required to be properly documented to permit proper review and oversight to determine compliance with the TS requirements. The minimum requirements include:

- date/time an LCO(s) is not met and date/time restored;
- assessment of functionality of the inoperable components, and the basis for such determinations;
- configuration-specific risk over the duration of the RICT, identifying inoperable or non-functional equipment and associated plant alignments;
- RMAs implemented;
- extent of condition assessments for emergent failures involving redundant components;
- total accumulated ICDP and ILERP; and
- use of quantified bounding assessments or other conservative quantitative approaches.

Periodically, an assessment of the RMTS program implementation is performed, which is required to include:

- accumulated annual risk above the zero-maintenance baseline due to equipment out-of-service beyond the frontstop CT;
- associated process used to monitor the accumulated risk; and
- associated insights and lessons learned.

3.2 Evaluation

The staff reviewed industry methodology document NEI 06-09, Risk-Managed Technical Specifications (RMTS) Guidelines, using SRP Chapters 19 and 16.1, and the three-tiered approach and the five key principles of risk-informed decisionmaking presented in RG 1.174 and RG 1.177, as discussed below.

SRP 19.0, consistent with RG 1.177, identifies five key safety principles to be met for risk-informed applications, including changes to TS. Each of these principles is addressed by the industry methodology document NEI 06-09 as discussed below.

1. The proposed change meets the current regulations unless it is explicitly related to a requested exemption or rule change.

   10 CFR 50.36(c) provides that TSs will include limiting conditions for operations which are "the lowest functional 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 will shut down the reactor or follow any remedial action permitted by the technical specifications until the condition can be met." NEI 06-09 supports a risk-informed determination of the CT applicable to the actions of the LCO by providing a NRC-approved methodology for assessing and managing the configuration-specific risk. The LCOs themselves would remain unchanged, as would the required remedial actions or shut down requirements, as per 10 CFR 50.36(c). Therefore, the proposed industry methodology for determining CTs is consistent with current regulations, and satisfies the first key safety principle of RG 1.177.

2. The proposed change is consistent with the defense-in-depth philosophy.

   Consistency with the defense-in-depth philosophy is maintained if:

   - A reasonable balance is preserved among prevention of core damage, prevention of containment failure, and consequence mitigation.

   - Over-reliance on programmatic activities to compensate for weaknesses in plant design is avoided.

   - System redundancy, independence and diversity are preserved commensurate with the expected frequency, consequences of challenges to the system, and uncertainties (e.g., no risk outliers).

   - Defenses against potential common cause failures are preserved, and the potential for the introduction of new common cause failure mechanisms is assessed.

- Independence of barriers is not degraded.
- Defenses against human errors are preserved.
- The intent of the general design criteria in 10 CFR Part 50, Appendix A, are maintained.

NEI 06-09 uses both the CDF and the LERF metrics to assess and establish CTs, which addresses maintaining a balance between core damage prevention and containment failure prevention. Compliance with the guidance of RG 1.174 and RG 1.177 for changes to CDF and LERF is achieved by evaluation using a comprehensive risk analysis, which assesses the configuration-specific risk by including contributions from human errors and common cause failures. The use of extended CTs is restricted to conditions which do not involve a total loss of function, which assures preservation of redundancy and diversity. Both the quantitative risk analysis and the qualitative considerations assure a reasonable balance of defense-in-depth is maintained to ensure protection of public health and safety, satisfying the second key safety principle of RG 1.177.

Use of Compensatory Measures to Retain Defense-In-Depth

The guidance found in NEI 06-09 addresses potential compensatory actions and risk management action measures by stating, in generic terms, that compensatory measures may include but are not limited to the following:

-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.

The guidance requires compensatory measures be initiated when the PRA calculated risk managed action time (RMAT) is exceeded, or for preplanned maintenance for which the RMAT is expected to be exceeded, RMAs shall be implemented at the earliest appropriate time. In order to maintain defense-in depth, compensatory actions for significant components should be predefined to the extent practicable in plant procedures and implemented at the earliest appropriate time.

Examples of compensatory measures that can be established for systems and components in technical specifications are provided in items A and B below.

A. Examples of compensatory measures that should be considered during the extended period that a diesel generator (DG) is inoperable, so that the increased risk is reduced and to ensure adequate Defense-in-Depth, are:

(1) The condition of the offsite power supply, switchyard and the grid should be evaluated prior to entering the extended AOT for elective maintenance, and RMAs considered, particularly during times of high grid stress conditions, such as during high demand conditions;

(2) Deferral of switchyard maintenance should be considered, such as deferral of discretionary maintenance on the main, auxiliary or startup transformers associated with the unit;

(3) Deferral of maintenance that affects the reliability of the trains associated with the Operable DGs should be considered.

(4) Deferral of planned maintenance activities on station blackout mitigating systems should be considered, and consideration given to treating those systems as protected equipment.

(5) Consider contacting the dispatcher on a periodic basis to provide information on the DG status and the power needs of the facility.

B. Examples of compensatory measures that should be considered during the extended period that a safety related battery is inoperable for elective maintenance, so that the increased risk is reduced and to ensure adequate Defense-in-Depth, are:

(1) Consider limiting the immediate discharge of the affected battery.

(2) Consider recharging the affected battery to float voltage conditions using a spare battery charger.

(3) Evaluate the remaining battery capacity and its ability to perform its safety function.

(4) Periodically verify battery float voltage is equal to or greater than the minimum required float voltage.

3. <u>The proposed change maintains sufficient safety margins.</u>

The design, operation, testing methods and acceptance criteria for SSCs, specified in applicable codes and standards (or alternatives approved for use by the NRC) will continue to be met as described in the plant licensing basis (including the final safety analysis report and bases to TSs), since these are not affected by risk-informed changes to the CTs. Similarly, there is no impact to safety analysis acceptance criteria as described in the plant licensing basis. Thus, safety margins are maintained by the proposed methodology, and the third key safety principle of RG 1.177 is satisfied.

4. <u>When proposed changes result in an increase in CDF or risk, the increases should be small and consistent with the intent of the Commission's Safety Goal Policy Statement.</u>

NEI 06-09 is a methodology for a licensee to evaluate and manage the risk impact of extensions to TS CTs. Permanent changes to the fixed TS CTs are typically evaluated by using the three-tiered approach described in Chapter 16.1 of the Standard Review Plan, and RG 1.177 and RG 1.174. This approach addresses the calculated change in risk as measured by the change in CDF and LERF, as well as the ICCDP and ICLERP; the use of compensatory measures to reduce risk; and, the implementation of a CRMP to identify risk-significant plant configurations.

Because NEI 06-09 is a methodology rather than a specific proposed change to an existing TS CT, it does not provide a specific implementation of the three-tiered approach for a particular change to a TS CT. Rather, it establishes the quality and scope requirements of the PRA model or bounding assessments which support such calculations, and establishes numerical criteria on which a licensee is to base the determination of acceptable extensions of the existing TS CTs, to establish a bases for compliance with the three-tiered approach each time the RMTS program is used to extend a CT. The existing TS CTs (i.e., the frontstop CTs) are not changed by implementation of RMTS; rather, the subsequent action requirement upon expiration of the frontstop CT is revised to permit continued operation for up to 30 days provided risk is assessed and managed by the CRMP within specified limits. The TS CT is not permanently changed, and the three-tiered process for risk assessment and management is required each time the TS CT is to be exceeded.

The three-tiered approach implemented by NEI 06-09 is summarized as follows:

Tier 1: The licensee should assess the impact on CDF, ICCDP, and, when appropriate, LERF and ICLERP. NEI 06-09 requires an assessment of the accumulated risk in terms of the ICDP and ILERP against program limits while a RICT is in effect. The assessment is ongoing, in that any changes to the plant configuration which would impact the RICT are required to be assessed and their impacts to the RICT accounted for. The RICT therefore accounts for the actual plant risk based not just on the inoperable TS system, but on the availability and alignment status of all plant systems which are important to safety and modeled in the CRMP. The limits established for a RICT are consistent with the guidance of NUMARC 93-01 endorsed by RG 1.182 as applicable to plant maintenance activities. Thus, the NEI 06-09 program requirements effectively establish a TS CT limit which is consistent with the principle of Tier 1 that the risk increase should be small.

A periodic assessment of the risk incurred during RMTS extended CTs is required to evaluate the overall risk impact of the program in terms of annual ΔCDF and ΔLERF. Any risk increases are evaluated against the criteria of RG 1.174 to assure such increases are small, consistent with the principle of Tier 1.

Tier 2: The licensee should provide reasonable assurance that risk-significant plant equipment outage configurations will not occur. NEI 06-09 does not permit high risk configurations which would exceed instantaneous CDF and LERF limits. It further requires implementation of RMAs when the actual or anticipated risk accumulation during a RICT will exceed 10% of the ICDP or ILERP limit. Such RMAs may include rescheduling planned activities to lower risk periods or implementing risk reduction measures. The limits established for entry into a RICT and for RMA implementation are consistent with the guidance of NUMARC 93-01 endorsed by RG 1.182 as applicable to plant maintenance activities. These NEI 06-09 program requirements are consistent with the principle of Tier 2 to avoid risk-significant configurations.

Tier 3: The licensee should ensure that the risk impact of out-of-service equipment is appropriately evaluated. NEI 06-09 establishes requirements for a CRMP and the underlying PRA models in terms of scope and technical adequacy. The CRMP is then used to evaluate configuration-specific risk for planned activities associated with the RMTS extended CT, as well as emergent conditions which may arise during an extended CT. This required assessment of configuration risk, along with the implementation of compensatory measures and RMAs, is consistent with the principle of Tier 3 for assessing and managing the risk impact of out-of-service equipment.

RG 1.177 includes consideration of various technical and quality aspects of the PRA models used for risk evaluations in support of changes to TS. These items are discussed for the CRMP supporting the RMTS as described in NEI 06-09, and are evaluated below.

Quality of the PRA. RG 1.174 and RG 1.200 define the quality of the PRA in terms of its scope, level of detail, and technical adequacy. The quality must be compatible with the safety implications of the proposed TS change and the role the PRA plays in justifying the change.

The NRC has developed regulatory guidance to address PRA technical adequacy. RG 1.200 addresses the use of the ASME RA-Sb-2005 and the NEI peer review process NEI 00-02, "PRA Peer Review Process Guidance" (Ref. 6), to address the technical adequacy of internal events PRA models. External events and internal fires are also addressed, but as there are currently no endorsed standards, RG 1.200 provides high level attributes and submittal guidance only.

NEI 06-09 requires an evaluation of the PRA model used to support the RMTS against the requirements of RG 1.200 Rev. 0 and AMSE RA-S-2002 for capability Category II. This assures that the PRA model is technically adequate for use in the assessment of configuration risk. This capability category of PRA is sufficient to support the evaluation of risk associated with out-of-service SSCs and establishing risk-informed CTs.

For external events and internal fires, submittal of the information identified by RG 1.200 assures that the staff has an adequate basis to determine the technical adequacy of these models to support the assessment of configuration risk.

The staff notes that an addendum to the ASME standard was issued in 2005, ASME RA-Sb-2005, "Addenda to ASME RA-S-2002, Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications," (Ref. 11). An imminent revision to RG 1.200 will endorse the updated standard applicable for internal events PRA models. The staff takes exception to NEI 06-09 and will require assessment of PRA technical adequacy using the revised RG 1.200 and the updated PRA standard.

The staff further interprets the guidance to evaluate the PRA using RG 1.200 and the ASME standard for capability Category II as a requirement that the licensee's PRA for internal events must satisfy all requirements of the ASME standard, and achieve at least capability Category II where the standard provides unique requirements. Because of the significant role of the PRA models in this application, exceptions to the requirements of the standard are not acceptable.

There are currently no RG 1.200 endorsed standards for external events, fires, or low power and shutdown conditions. NEI 06-09 permits the use of either PRA or non-PRA type quantitative evaluations, including conservative or bounding methods, to assess risk of these events and conditions. The specific method to be utilized in the RMTS program would be identified and technically justified by the licensee in their plant-specific application to implement RMTS, and would be reviewed and approved by the staff in a license amendment implementing RMTS.

Industry standards have been or are being prepared for external events, internal fires, and low-power and shutdown PRAs. For RMTS submittals received after a standard is developed by the industry, endorsed by the NRC via revisions to RG 1.200, and is beyond any staff-approved implementation period, the staff will use that standard to assess the technical adequacy of the corresponding aspect of the PRA, if used to support the RMTS program. This is consistent with the Commission's phased approach to PRA quality. The staff notes that if sources of risk can be shown to be insignificant contributors to configuration risk, then they may be excluded from the RMTS program, as discussed under "Scope of the PRA", below; the approval of industry standards would not impose any requirement for such sources of risk to be included in the RMTS calculations.

As part of its review and approval of a licensee's application requesting to implement RMTS, the staff intends to impose a license condition that will explicitly address the scope of the PRA and non-PRA methods approved by the staff for use in the plant-specific RMTS program. If a licensee wishes to change its methods, and the change is outside the bounds of the license condition, the licensee will need NRC approval, via a license amendment, of the implementation of the new method in their RMTS program. The focus of the staff's review and approval will be on the technical adequacy of the methodology and analyses relied upon for the RMTS application.

Therefore, these requirements of NEI 06-09, as modified, are consistent with Section 2.3.1 of RG 1.177.

Scope of the PRA. NEI 06-09 requires a quantitative assessment of potential impact on risk due to impacts from internal events, including internal fires. Other sources of risk (i.e., seismic, other external events) must be quantitatively assessed if they contribute significantly to configuration-specific risk. Transition risk is conservatively not considered in establishing RICTs, and as RMTS are not applicable to cold shutdown and refueling modes, shutdown risk for these conditions need not be evaluated. Consideration is made of both CDF and LERF metrics. Bounding analyses or other conservative quantitative evaluations are permitted where realistic PRA models are unavailable. The guidance provided in NEI 06-09 is sufficient to ensure the scope of the risk analysis supporting the RMTS evaluations are adequate to assess configuration risk, and is consistent with Section 2.3.2 of RG 1.177.

PRA Modeling. NEI 06-09 specifically applies the RMTS only to those SSCs which mitigate core damage or large early releases. Where the SSC is not modeled in the PRA, and its impact cannot otherwise be quantified using conservative or bounding approaches, the RMTS are not applicable, and the existing frontstop CT would apply.

Potential impacts on the risk analyses due to screening criteria and truncation levels are adequately addressed by the requirements for PRA quality in RG 1.200.

NEI 06-09 also provides additional requirements for the CRMP PRA model to assure a conservative calculation of the risk impact of unavailable SSCs:

- quantitative credit for repair or recovery of inoperable equipment is not permitted;
- quantitative credit for compensatory measures or RMAs is permitted only when such actions are included in the baseline PRA model, and are contained in plant procedures;
- the impact of SSC unavailability on the likelihood of initiating events must be quantitatively assessed; and
- seasonal or time-in-operating cycle variations must be either conservatively assessed or properly quantified for the particular conditions.

Therefore, based on the above considerations, the guidance of NEI 06-09 for PRA modeling is sufficient to ensure an acceptable evaluation of risk due to the SSC unavailability, and is consistent with Section 2.3.3 of RG 1.177.

Assumptions. NEI 06-09 applies the PRA model to evaluate configuration-specific risk in order to set the required TS CT. No specific assumptions of the PRA model are unique to this application. When key assumptions introduce a source of uncertainty to the risk calculations (identified in accordance with the requirements of the ASME standard (Ref. 5)), NEI 06-09 requires analysis of the assumptions and accounting for their impact to the RMTS calculated RICTs. Thus, the guidance of NEI 06-09 appropriately identifies the requirement to identify and address assumptions with regard to configuration risk analyses in support of TS CTs, and is consistent with Section 2.3.4 of RG 1.177.

Sensitivity and Uncertainty Analyses. NEI 06-09 requires sensitivity studies to assess the impact of key sources of uncertainties of the PRA on the RMTS. Where the sensitivity analyses identify a potential impact on the calculated RICT, programmatic changes must be identified and implemented, such as additional RMAs or program restrictions which would address the impact of the uncertainties, or the use of bounding analyses which address the impact of the uncertainty. Thus, the guidance of NEI 06-09 appropriately identifies the requirement to consider the possible impacts of PRA model uncertainty and sensitivity to key assumptions and model limitations, consistent with Section 2.3.5 of RG 1.177.

The staff notes that NEI 06-09 references EPRI 1009652, "Guidelines for the Treatment of Uncertainty in Risk-Informed Applications: Technical Basis Document," December 2004, as a method for determining key uncertainties. The staff has not reviewed this document, and the NRC neither endorses nor disapproves its methods with regards to identifying key uncertainties. The staff will review each individual licensee's process for identifying and assessing key uncertainties as part of the review of the RMTS license amendment request.

Use of Compensatory Measures in TS Change Evaluations. NEI 06-09 requires consideration and implementation of appropriate compensatory measures, or RMAs, when the risk associated with an extended TS CT exceeds the thresholds of 10^{-6} ICDP or 10^{-7} ILERP. These thresholds are consistent with NUMARC 93-01. Such actions are not typically credited in the risk assessment. Where credit for such RMAs is to be applied, the action must be incorporated into the underlying PRA model of the CRMP. Thus, NEI 06-09 appropriately identifies the requirement to provide consideration for compensatory measures, consistent with Section 2.3.6 of RG 1.177.

Contemporaneous Configuration Control. NEI 06-09 uses a CRMP to assess the configuration-specific risk and determine the acceptability of extending the TS CT. The document specifically requires reanalysis of the risk, and reverification that the extended CT remains acceptable for any change to the plant configuration which occurs during the extended CT. NEI 06-09 provides numerical limits on configuration risk, consistent with the requirements of NUMARC 93-01, for implementation of compensatory measures to mitigate higher risk configurations. It further implements specific limits on configuration risk above which extended CTs are prohibited. These limits are verified at the time the extended CT are first entered, and whenever a configuration change occurs. NEI 06-09, which includes the requirement for the CRMP, will be required to be included in the TS administrative controls for any licensee implementing RMTS. These requirements are consistent with Section 2.3.7.1 of RG 1.177.

RG 1.177 also identifies four key components of a CRMP: 1) Implementation of the CRMP, including the scope of SSCs, form of the assessment, and timing of the assessment; 2) Control and use of the CRMP Assessment Tool, including update provisions and procedures governing its use; 3) Level 1 Risk-Informed Assessment; and 4) Level 2 Issues and External Events. NEI 06-09 addresses all four key components, and a CRMP applied to support an RMTS program must meet or exceed the key components identified in RG 1.177, as described below.

1) **CRMP Implementation**. The scope of SSCs subject to the CRMP includes all PRA model components in addition to the components subject to the TS for which the RMTS is applicable, and the assessment tool must include a direct PRA assessment of the configuration. The CRMP must be used prior to entering an extended CT, and emergent conditions must be assessed within the time limits of any applicable TS actions up to a maximum allowed time of 12 hours. Compensatory measures or RMAs are required to be in place for planned activities, and must be implemented upon reaching specified risk thresholds for either planned or unplanned activities.

2) **Control of CRMP Assessment Tool.** A process must be in place to monitor plant modifications and other changes which may impact the PRA model to assure that the CRMP correctly reflects the as-built, as-operated plant. The CRMP must be governed by plant procedures, and extended CTs must be exited immediately if the configuration is outside the scope of the CRMP.

3) **Level 1 Assessment**. Quantitative assessment of CDF risk for internal events is required to support the RMTS. The assessment must use a PRA model which satisfies capability Category II of ASME RA-Sb-2005.

4) **Level 2 and External Events**. Quantitative assessment of LERF risk is required to support the RMTS. Fire risk must be treated quantitatively as well, although the use of conservative or bounding analyses may be employed. Other external events are also treated quantitatively, unless it is demonstrated that these risk sources are insignificant contributors to configuration-specific risk.

   The staff notes that NEI 06-09 references EPRI 1012948, "Methodology for Fire Configuration Risk Management," December 2005, as an example of a bounding analysis method applicable to RMTS for screening fire risk. The staff has not reviewed this document, and the NRC neither endorses nor disapproves its methods with regards to analyzing fire risk to support RMTS. The staff will review each individual licensee's method for assessing the fire risk contribution within the RMTS program as part of the review of the RMTS license amendment request.

Thus, NEI 06-09 requirements for the CRMP are consistent with Section 2.3.7.2 of RG 1.177.

Acceptance Guidelines. NEI 06-09 requires a licensee to quantitatively evaluate the change in total risk for CDF and LERF for each instance of an extended TS CT, using the configuration specific risk applicable at the time the TS LCO is not met. Each individual instance is limited to a risk impact of 10^{-5} for ICDP, and 10^{-6} for ILERP. These limits were chosen to be consistent with the guidance of NUMARC 93-01, as endorsed by the staff in RG 1.182, for control of risk during maintenance activities.

A limit for configuration-specific CDF of 10^{-3}/year (consistent with Ref. 7), and for LERF of 10^{-4}/year, are also established by NEI 06-09. If the configuration-specific risk is above these limits, an extended CT may not be entered, and the existing TS frontstop CTs would apply. These limits provide a control to prevent entry into potential high risk configurations. Consistent with its endorsement of RG 1.182, the staff neither endorses nor disapproves of the 10^{-3}/year CDF value, nor the 10^{-4}/year LERF value. The NRC has not developed guidance on acceptable levels of configuration risk, but instead uses metrics based on the accumulation of risk over time. The industry imposed limits of 10^{-3}/year CDF and 10^{-4}/year LERF would only provide for a maximum of about 3.5 days of operation until the ICDP limit of 10^{-5}, or the ILERP limit of 10^{-6}, upon which the RICT is based, were reached, and so extended operation in such configurations would not be permitted under a RMTS program. Such configurations are not expected to occur frequently, and therefore the staff does not find it necessary to provide any further restrictions on configuration risk beyond what is proposed in NEI 06-09.

Further, the staff interprets NEI 06-09 guidance as not permitting a RICT to be entered (i.e., to exceed the frontstop CT) when the configuration-specific risk exceeds the 10^{-3} CDF or 10^{-4} LERF limits, since use of a RICT is a voluntary decision to extend a CT. However, NEI 06-09 does not require exiting a RICT if the limits of either 10^{-3} CDF or 10^{-4} LERF are subsequently exceeded due to emergent conditions which arise after a RICT is in effect. This is consistent with the guidance of NUMARC 93-01 (Ref.7). The RICT, once in effect, is solely governed by the ICDP and ILERP limits described above, and emergent configurations whose risk level exceeds the 10^{-3} CDF or 10^{-4} LERF limits are managed using RMAs.

RG 1.177 provides criteria for changes in risk applicable to permanent changes to TS CTs, of 5 x 10^{-7} ICCDP, and 5 x 10^{-8} ICLERP. The staff considered this guidance and its applicability to RMTS, and specifically considered that the allowable risk accumulation proposed in NEI 06-09 exceeds the RG 1.177 guidance, and instead applies 10^{-5} ICDP and 10^{-6} ILERP from NUMARC 93-01. The more restrictive limits of RG 1.177 are based on a calculation which assumes that only the particular TS SSC of the LCO is inoperable, and that all other plant SSCs are at their nominal unavailability level. The intent of these limits is to provide assurance that a proposed TS change, by itself, has no more than a small quantitative impact on plant risk. However, the licensee is not limited by the assumptions of this risk calculation, and any particular application of the TS change may result in risk which exceeds RG 1.177 guidance, depending upon the status of other SSCs when the LCO action is entered. The risk during implementation is determined and managed in accordance with a licensee's program for 10CFR50.65 (a) (4). The risk calculations applicable to an RMTS program are more similar to the risk management activities and calculations performed for actual application of a TS change, which assesses the actual plant configuration, considering the status of all SSCs which are included in the scope of the CRMP. Therefore, the staff concludes that the guidance of NUMARC 93-01 endorsed by RG 1.182 is appropriate guidance for establishing an acceptable RICT.

The methodology for extending CTs does not impact the existing frontstop CTs of the TS. Further, there is no permanent change to the CT of any TS LCO, since configuration-specific risk must always be assessed each time the frontstop CT is to be exceeded, based on the actual status of all SSCs. The staff considers extensions of TS CTs using NEI 06-09 to be temporary changes in plant risk, and the RG 1.177 ICCDP and ICLERP guidelines for AOT changes should not be applied. Therefore, these CT extensions may be assessed and managed using the criteria consistent with NUMARC 93-01.

Implementation of RMTS avoids unnecessary unplanned shutdowns, and the transition risks associated with such evolutions. RMAs which reduce the actual risk incurred while TS equipment is out-of-service are required to be considered and implemented when appropriate as part of the NEI 06-09 program guidance. The RMTS allow a licensee to consolidate planned maintenance and testing activities into single equipment outages, rather than performing such activities over several smaller outages in order to comply with the existing TS CTs. This consolidation may reduce the total unavailability of safety-related SSCs by eliminating the recurrence of restoration alignment and testing, and displace and reduce the risk associated with more frequent, shorter equipment outages. These improvements to operational safety are not quantified or credited by the RMTS program.

Implementation of NEI 06-09 is therefore consistent with the three-tiered approach of RG 1.177 and SRP 19.0 by providing for:

1) a comprehensive risk assessment addressing configuration-specific risk of core damage and large early release, applying limits consistent with NUMARC 93-01 applicable for equipment maintenance, and assessing the total risk associated with all significant sources of risk, including fire risk and any plant-specific

significant external events;

2) consideration and implementation of risk management actions for those equipment outages which exceed specified risk thresholds; and

3) ongoing risk assessment within a CRMP for all changes to plant status occurring during implementation of the TS extended CT.

Therefore, the proposed methodology satisfies the fourth key safety principle of RG 1.177 by assuring any increase in risk is small consistent with the intent of the Commission's Safety Goal Policy Statement.

5. The impact of the proposed change should be monitored using performance measurement strategies.

The cumulative impact of extensions to TS CTs is periodically assessed as required by NEI 06-09, and must be shown to result in a total risk impact below 10^{-5}/year for change to CDF, and below 10^{-6}/year for change to LERF, and the total CDF and total LERF must be reasonably shown to be less than 10^{-4}/year and 10^{-5}/year, respectively. These criteria are consistent with the guidance of RG 1.174 for acceptable small changes in risk.

The staff anticipates that the use of extended CTs within an RMTS program is unlikely to be a routine practice, since licensees already accomplish planned maintenance activities within the existing TS CTs. Although the RMTS are permitted to be applied to planned maintenance activities, other requirements, such as 10CFR50.65 performance monitoring, and regulatory oversight of equipment performance, are disincentives to a licensee for incurring significant additional unavailability of plant equipment, even when allowed by an RMTS program. This provides a further control on the use of RMTS which could result in a significant increase in equipment unavailability and the commensurate risk.

The staff notes that the cumulative risk guidance is the same as is applied to each individual application of the RMTS; that is, it is possible for a single RICT to result in accumulation of risk which is equivalent to the annual guidance in RG 1.174. This could occur, for example, if a 10^{-4} CDF configuration were entered for a 30-day period as permitted by the RMTS. While allowable, such configurations are not routinely encountered during plant maintenance activities, and are not the anticipated application of RMTS. More typically, the actual risk of a configuration involving an extended CT would be a low risk evolution, and the RICT provides an effective method for a licensee to manage and reduce the total risk associated with all plant maintenance activities.
If implementation of RMTS results in a cumulative annual calculated risk increase above the RG 1.174 guidance, NEI 06-09 requires the licensee to assess the cause and implement appropriate corrective actions. These assessments are required to be documented and available for NRC staff review. The performance monitoring and feedback specified in NEI 06-09 is sufficient to reasonably assure changes in risk due to implementation of RMTS are small, and are consistent with Section 3.2 of RG 1.177. Thus, the fifth key safety principle of RG 1.177 is satisfied.

4.0 SUMMARY AND CONCLUSIONS

The staff has reviewed NEI 06-09, a risk-informed methodology using plant-specific PRA models within a CRMP to assess and manage risk and permit extensions of TS CTs. This methodology would support a proposed change to a licensee's TS to implement RMTS , and would be required to be referenced in the Administrative Controls of the TS.

The staff applied the review guidance of SRP 19.0 and SRP 16.1, and finds that the proposed implementing methodology satisfies the key principles of risk-informed decision making applied to changes to TS, as delineated in RG 1.177 and RG 1.174, in that:

- The proposed change meets current regulations;
- The proposed change is consistent with defense-in-depth philosophy;
- The proposed change maintains sufficient safety margins;
- Increases in risk resulting from the proposed change are controlled to be small and consistent with the Commission's Safety Goal Policy Statement; and
- The impact of the proposed change is monitored with performance measurement strategies.

The staff therefore finds that the program requirements of NEI 06-09 are acceptable for referencing by licensees proposing to amend their TS to implement RMTS,

Licensees should provide the following plant-specific information in support of their amendment request:

1. The request will include proposed changes to the Administrative Controls of TS to add a CRMP in accordance with the guidance of NEI 06-09 Rev. 0.

2. The request will provide identification of the TS LCOs and action requirements to which the RMTS will apply, with a comparison of the TS functions to the PRA modeled functions of the SSCs subject to those LCO actions. The comparison should justify that the scope of the PRA model, including applicable success criteria, are consistent with each of the TS requirements, or an appropriate disposition or programmatic restriction will be provided.

3. The request will provide a discussion of the results of peer reviews and self assessments conducted for the plant-specific PRA models which support the RMTS, including the resolution or disposition of any identified deficiencies (i.e., findings and observations from peer reviews). This will include a comparison of the requirements of RG 1.200 using the elements of ASME RA-Sb-2005 for capability Category II for internal events PRA models, and for other models for which RG 1.200 endorsed standards exist. If additional standards have been endorsed by revision to RG 1.200, the request will also provide similar information for those PRA models used to support the RMTS program.

4. The request will provide a description, in terms of scope, level of detail, technical adequacy, and methods applied, for all PRA models used in calculations of risk used to support the RMTS for risk sources for which NRC endorsed standards are not available.

5. The request will provide a justification for excluding any risk sources determined to be insignificant to the calculation of configuration-specific risk, and will provide a discussion of any conservative or bounding analyses to be applied to the calculation of RICTs for sources of risk not addressed by the PRA models.

6. The request will provide the plant-specific total CDF and total LERF to confirm that these are less than 10^{-4}/year and 10^{-5}/year, respectively. This assures that the potential risk increases allowed under the RMTS program are consistent with RG 1.174.

7. The request will provide appropriate plant-specific justification for using the at-power PRA models in shutdown modes to which the RMTS applies.

8. The request will provide a discussion of the licensee's programs and procedures which assure the PRA models which support the RMTS are maintained consistent with the as-built, as-operated plant.

9. The request will provide a description of the PRA models and tools used to support the RMTS, including identification of how the baseline PRA model is modified for use in the CRMP tools, quality requirements applied to the PRA models and CRMP tools, consistency of calculated results from the PRA model and the CRMP tools, and training and qualification programs applicable to personnel responsible for development and use of the CRMP tools. The scope of SSCs within the CRMP will be provided. This item should also confirm that the CRMP tools can be readily applied for each TS LCO within the scope of the plant-specific RMTS submittal.

10. The request will provide a discussion of how the key assumptions and sources of uncertainty were identified, and how their impact on the RMTS was assessed and dispositioned.

11. The request will provide a description of the implementing programs and procedures with regards to the plant staff responsibilities for RMTS implementation, and specifically discuss the decision process for RMA implementation during a RICT.

5.0 REFERENCES

1. NEI 06-09 Rev. 0, "Risk-Informed Technical Specifications Initiative 4B, Risk-Managed Technical Specifications (RMTS) Guidelines," November 2006.

2. Regulatory Guide 1.174 Rev. 1, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," USNRC, November 2002.

3. Regulatory Guide 1.177, "An Approach for Plant-Specific, Risk-Informed Decisionmaking: Technical Specifications," USNRC, August 1998.

4. Regulatory Guide 1.200 for Trial Use, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," February 2004.

5. ASME RA-Sa-2003, "Addendum to ASME RA-S-2002, Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications," December 2003.

6. NEI 00-02, "Probabilistic Risk Assessment (PRA) Peer Review Process Guidance," 2000.

7. Section 11 of NUMARC 93-01, "Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," February 22, 2000.

8. Regulatory Guide 1.182, "Assessing and Managing Risk Before Maintenance Activities at Nuclear Power Plants," May 2000.

9. NUREG-0800, Standard Review Plan 19.0, "Use of Probabilistic Risk Assessment in Plant-Specific, Risk-Informed Decisionmaking: General Guidance," November 2002.

10. NUREG-0800, Standard Review Plan 16.1, "Risk-Informed Decisionmaking: Technical Specifications," August 1998.

11. ASME RA-Sb-2005, "Addenda to ASME RA-S-2002, Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications," December 2005.

12. Letter, R. T. Ridenoure to U. S. NRC, "Fort Calhoun Station Unit No. 1 License Amendment Request, Application for Technical Specification Improvement to Implement a Risk-Informed Alternative to the Existing Restoration Period for the High Pressure Safety Injection System," May 14, 2004.

13. Letter, T. J. Jordan to U. S. NRC, "South Texas Project Units 1 and 2 Docket Nos. STN 50-498, STN 50-499, Broad-Scope Risk-Informed Technical Specification Amendment Request," August 2, 2004.

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October 5, 2006

MEMORANDUM TO: David Terao, Chief
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Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

FROM: Lynn A. Mrowca, Chief ***/RA/***
Probabilistic Risk Assessment Licensing Branch B
Division of Risk Assessment
Office of Nuclear Reactor Regulation

SUBJECT: AUDIT REPORT REGARDING SOUTH TEXAS PROJECT, UNITS 1 AND 2, RISK-MANAGED TECHNICAL SPECIFICATIONS APPLICATION (TAC NOS. MD2341 AND MD2342)

The probabilistic risk assessment (PRA) Licensing Branch B coordinated an onsite audit of the South Texas Project Risk-Managed Technical Specifications (RMTS) license amendment request from June 19 - 22, 2006. The purpose of the audit was to provide assurance that the PRA model, configuration risk management program, and other supporting activities are adequate to conclude that the implementation of the proposed RMTS amendment request will not challenge public health and safety. The scope of the audit was to address several issues, including:

1. The technical adequacy of licensee PRA models for which U.S. Nuclear Regulatory Commission (NRC)-endorsed standards are unavailable (i.e., fire, seismic, and other external events), and review of the licensee's assessment of technical adequacy of their internal events PRA model.

2. The development and implementation of the licensee's configuration risk management program computer-based tool used to identify configuration-specific risk in support of the RMTS program.

3. The status of the licensee's training and procedure development supporting implementation of the RMTS license amendment.

4. The overall plant safety and risk culture in the licensee's organization.

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The results of the audit are documented as an enclosure to this memorandum. The NRC audit team found that, in general, the licensee's PRA models appear to be sufficient in scope and detail to support the RMTS license amendment request. A few items related to the technical adequacy of the PRA models were identified and will need to be resolved within the license amendment request process. The licensee's configuration risk management program, procedures and training to support RMTS appear sufficient to support the RMTS license amendment, although these elements are still in draft form and not yet completed.

Enclosure:
As stated

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AUDIT REPORT REGARDING SOUTH TEXAS PROJECT, UNITS 1 AND 2 RISK-MANAGED TECHNICAL SPECIFICATIONS APPLICATION (TAC NOS. MD2341 AND MD2342)

1. INTRODUCTION

The Nuclear Regulatory Commission (NRC) staff performed an onsite review of the South Texas Project (STP), Units 1 and 2, probabilistic risk assessment (PRA) models and configuration risk management program (CRMP) tool, procedures, programs, and training which support the licensee's application for Risk-Managed Technical Specifications (RMTS).

The audit was conducted by Clifford K. Doutt, Andrew J. Howe, Steven A. Laur, Gareth W. Parry, and Jacqwan S. Walker of the Division of Risk Assessment; Theodore R. Tjader of the Division of Inspection and Regional Support; Mohan C. Thadani of the Division of Operating Reactor Licensing; and Michael F. Runyan of Region IV. The audit took place June 19 - 26, 2006, at the licensee's offices located at the plant site. An entrance meeting was held the afternoon of the first day and licensee personnel were debriefed during an exit meeting on the final day. The audit team found the licensee PRA and licensing staffs and plant management to be cooperative and forthcoming in their support of this audit.

The purpose of the audit was to provide assurance that the PRA model, CRMP, and other supporting activities are adequate to conclude that the implementation of the proposed RMTS amendment request will not challenge public health and safety. The scope of the audit was to address several issues, including:

1. The technical adequacy of licensee PRA models for which NRC-endorsed standards are unavailable (i.e., fire, seismic, and other external events), and review of the licensee's assessment of technical adequacy of their internal events PRA model.

2. The development and implementation of the licensee's CRMP computer-based tool used to identify configuration-specific risk in support of the RMTS program.

3. The status of the licensee's training and procedure development supporting implementation of the RMTS license amendment.

4. The overall plant safety and risk culture in the licensee's organization.

The basis for the audit is to support the review of the licensee's amendment request to revise STP Units 1 and 2 technical specifications (TSs). Because the amendment request is a pilot for the industry Risk-Informed TS initiative 4B, and a first-of-a-kind application, a more direct review and assessment was appropriate.

2. AUDIT SCOPE

The audit was specifically related to the RMTS application and was not intended to be an assessment of the overall PRA model quality. A major focus of the audit was to determine whether the scope and level of detail of the STP PRA models, CRMP and associated procedures and training, are sufficient to support the RMTS risk assessment processes.

ENCLOSURE

In order to support this audit, and to provide a structured review of future RMTS submittals, a draft audit procedure was developed which identified specific tasks to focus the review:

Task 1: Fire and External Events PRA
Audit Plan Elements: 3.2.a.2, 3.2.b.1 (in part), 3.2.b.2
Request for Additional Information (RAI): 24

Summary: This task reviewed the scope and quality of the PRA models which assess non-internal events. Specific attention was paid to fire risk, and the screening processes employed and their potential impact on configuration-specific risk assessments. Model maintenance and the age of the current models were also be reviewed.

Task 2: Internal Events PRA and Low Power/Shutdown
Audit Plan Elements: 3.2.a.1, 3.2.a.3, 3.2.a.4, 3.2.a.5, 3.2.b.1 (part)
RAIs: 8b, 27, 28, 31

Summary: This task reviewed the open RAIs on regulatory guide (RG) 1.200 scope and quality. Additional tasks are the site-specific justification for use of at-power PRA to address modes 3 and 4, handling of model uncertainty, and the comparison of TS functions to modeled PRA functions to assure PRA scope is adequate for 4B application.

Task 3: CRMP Tool Development
Audit Plan Elements: 3.2.c.1 (in part), 3.2.c.2, 3.2.c.3 (in part)
RAI: 30

Summary: This task reviewed the translation of the average annual model to the configuration risk management (CRM) dynamic model. Specific attention was paid to each of the elements identified in the Electric Power Research Institute (EPRI) guide.

Task 4: CRMP Implementation
Audit Plan Elements: 3.2.c.1 (in part), 3.2.c.3 (in part), 3.2.e.1, 3.2.e.2
RAIs: 3, 7, 8c

Summary: This task reviewed the program procedures, training and qualification of personnel, and implementation of the RMTS. Specific attention was paid to the ease of use of the tools and other elements, and of their compliance with the EPRI guidance document.

Task 5: Risk Culture
Audit Plan Elements: 3.2.d.1, 3.2.d.2, 3.2.d.3
RAIs: None

Summary: This task reviewed the overall risk culture at the site, and the update and maintenance of the PRA and CRMP models.

3. AUDIT RESULTS

The STP PRA models, the CRMP, and supporting procedures and training appear sufficient in scope and detail to support the RMTS license amendment request. The detailed evaluations for each audit task is provided below. The audit identified several issues which need to be resolved prior to issuance of the amendment. These were discussed with the licensee's PRA staff and management during the audit and at the exit meeting.

Task 1: Fire and External Events PRA

Internal Fires

The staff reviewed the 1992 STP individual plant examination (IPE)/individual plant examination of external events (IPEEE) submittal, the 1994 fire update of selected Thermolag areas, and the contribution of fires in the current PRA model. The STP fire PRA was developed as part of the 1988 PRA. The motivation for performing the PRA was to enable STP to derive plant-specific technical specifications appropriate to the three-train design, since standard TSs were developed for two-train plants.

The PRA was reviewed by Sandia National Laboratory (SNL) in NUREG/CR-5606, and revisions were made to respond to the SNL review comments, and the revised model results reported in the IPEEE submittal. Since then the only change to the fire PRA was to revisit the screening in 1994 to address issues identified with the use of Thermolag (reported in PLG-1015). This resulted in an additional five scenarios being retained post screening to add to the three retained in the IPEEE. It is unclear whether the extra scenarios are due to a refinement of the screening process, or due to not taking credit for Thermolag. The latter seems to be more consistent with PLG-1015 which presents as sensitivity studies cases which assess the 'worth' of Thermolag for the various fire zones.

The STP fire PRA used a successive screening methodology to reduce the amount of effort required to complete the study. For areas where detailed fire modeling was done, the analysis included open circuits, momentary hot shorts, and longer-term hot shorts. The screening value was 1.7E-7 per year, because this represented 0.1 percent of the internal core damage frequency at the time the fire PRA was developed. The successive screening approach appeared to be reasonable. The first step was to assume the worst possible combination of induced failure modes of affected equipment, and the frequency of any fire in a zone, and screen if this is less that the equivalent frequency from the internal events analysis. At a second level, various plant damage vectors were developed using a fire event tree that identified specific failure impacts of that subset of equipment failure modes that would have an impact on the resulting scenarios IPEEE. At this point, the probabilities of the various failure modes, e.g., spurious actuations, were introduced. This had an impact on the frequencies of the fire scenarios that were screened. SNL was satisfied with the screening approach.

A comprehensive database of cable routing was available when the study was performed to facilitate identification of PRA basic events impacted by each postulated fire. Licensee personnel stated that this database is being re-constituted from hard copy printouts to facilitate a future planned update of the fire PRA.

The STP PRA originally screened all but three fires, all in the control room: Fires FR10, FR18, and FR23. The 1994 Thermolag a re-analysis resulted in five additional fires being added to the PRA: Z047B, Z047X, Z047BC, Z071X, and Z147O. The screening was performed using the "average" maintenance model to calculate the conditional core damage probability (CCDP), so that there is the possibility that some scenarios were screened that could affect the risk informed completion time (RICT) calculations. For any scenario screened out just below the screening criterion, the effect of one of the structure, system, and component (SSCs) taken credit for in the CCDP being out of service could affect the incremental core damage probability (ICDP). This was acknowledged by STP staff, and a fire PRA update is contemplated for the future, but not on a schedule that would support implementation of Initiative 4B.

The staff considered whether there were fires that were screened from further consideration, i.e, not included in the PRA model due to frequency below the cutoff, which if included could make a meaningful difference in the calculated risk-informed completion times. The staff chose several screened fire scenarios and asked the licensee to estimate the risk associated with these scenarios under several maintenance scenarios, including the zero test and maintenance base case. Fire events FR22 (control room) and Z052 (auxiliary building switchgear room) were selected for this review. The results of the licensee's analysis of the risk of these fires, using the current PRA model, are in the table below:

		Delta CDF (/yr) for equipment out of service (OOS)			
Case	Baseline CDF (/yr)	“D” AFW OOS	“A” PORV OOS	“D” AFW “A” PORV OOS	“A” ECW OOS
FR22 (not in PRA)	1.12E-09	1.69E-08	9.19E-08	1.45E-06	
FR23 (in PRA)	1.80E-08		1.43E-06	1.43E-06	3.00E-09
Zero Test and Maintenance Model (includes FR23)	7.50E-06	1.05E-05	4.50E-06	4.85E-05	2.84E-05
Z052 (not in PRA)	3.14E-06				4.05E-06

Control room fire FR22 was screened out from the PRA model. It is the same as FR23 except that the “D” auxiliary feedwater (AFW) pump is not failed by the fire in FR22 but it is failed in FR23. The other three AFW pumps are failed in both fire scenarios. The audit team considered maintenance configurations that would cause FR22 fires to become significant: the turbine driven AFW pump (train "D") out of service, the primary Power-Operated Relief Valve (PORV) out of service, and both of these components out of service. (Note that either train of PORV would have a similar impact, because the success criterion for feed and bleed is two out of two PORVs.) The results are interesting: with just the “D” AFW pump out of service, fire FR22 is of similar magnitude as FR23, which is in the model. However, the total risk increase calculated using the internal events PRA model is three orders of magnitude higher than from the fire alone, so that the RICT value would not be adversely impacted. For a PORV out of service, FR23 has a much greater impact on change in risk than FR22, so the screening of FR22 from the model would again have no impact. When both the “D” AFW and “A” PORV are out of service, similar arguments could be made to justify not including FR22 in the PRA model.

The screened Z052 fire scenario shows a noticeable increase in core damage frequency (CDF) when the "A" emergency cooling water (ECW) train is unavailable. The FR23 fire does not serve as a good surrogate for the Z052 fire, as the risk from FR23 increased very slightly when "A" ECW is not available. However, the overall increase in CDF as calculated by the PRA is seven times greater than the increase from Z052. Also, it should be noted that the Z052 fire scenario that was included in the model for this sensitivity was for a fire that affected the entire fire area; that is, no detailed fire analysis had been performed since this fire was screened during the fire PRA development.

The two examples above would tend to support an assertion that the fire scenarios screened from the STP PRA would not be expected to substantially affect RICTs calculated using the current PRA model. However, there are a number of fire scenarios that screened out, and the additive effect might result in a different conclusion. Also, there may be fire scenarios that are far more sensitive to equipment being out of service; it is difficult to judge from so limited a sample. The NRC audit team recommended to licensee personnel that they develop a method to assess the potential impact of fire scenarios on the RICT calculation to support Initiative 4B implementation without a major fire PRA update. One way the licensee might address these issues would be to consider whether there are specific Risk Management Action Time (RMAT) and RICT times where the fire contribution would make a significant difference. What is meant by significant is somewhat subjective, but a change from 30 to 15 days would be considered significant, 29 to 27 would not. The licensee could identify those scenarios that were below but close to the screening criterion, and in particular those where the fire would affect two trains, as these are the most likely to have the biggest impact relative to the internal events. One case has already been shown where the "A" train of emergency core cooling system high-head safety injection is affected more because the "B" and "C" trains are more susceptible to fire than train "A". This is a result of the specific design of the plant, and gives some confidence that the model is identifying the appropriate effects of fires. The licensee would then demonstrate that if these screened fire scenarios were included, they would not significantly impact an RMAT or a RICT.

The licensee made the NRC staff aware of one aspect of fire risk that was being incorporated into the risk management program (currently the Risk Assessment Calculator (RASCAL) application). The site has three engine-driven fire pumps; these pumps are not controlled in TS. Taking fire pumps out of service affects the scenario frequency for those scenarios where fire suppression is taken into account. The licensee has estimated how much the credit for suppression should be changed from the fire PRA value to account for one or more fire pumps not available (e.g., as a result of random failures of the available pumps). The licensee has developed new risk calculations for some fire scenarios for zero, one, and two fire pumps out of service for those scenarios in the PRA (e.g., that survived the screening process). Fire scenario Z047B, and some others, have six total quantifications for CDF and large early release frequency (LERF), covering the cases of none, one and two fire pumps out of service.

The change in dependability of suppression as a result of the plant fire pump configuration (e.g., in or out of service) is certainly a factor that should be evaluated and considered in implementing Initiative 4B. A more subtle point, however, is that the credit for suppression assuming average availability could have lead to screening out of fire scenarios that, under some plant configurations, should have been left in the scope of the PRA model.

The staff identified another implicit assumption in the fire analysis that may not be appropriate for a configuration-specific risk calculation. The analysis of a turbine building fire that could result in loss of power to all three plant safety buses was screened because the operators could power the buses from the 138 kilo-volt transmission line (the "Blessing" line) that is separate from the other feeders. Site personnel did not appear to be aware of this implicit assumption that assumed unavailability of the "Blessing" line and the failure of the operator to successfully perform the action to power the buses is bounded by a failure probability of 0.1.

Seismic Risk

The STP PRA assesses seismic risk by using a seismic event tree to generate a set of seismic impact vectors. The seismicity of the site is very low, as demonstrated by the seismic hazard vector which is characterized in terms of four discrete acceleration ranges as follows:

Representative acceleration	Frequency
.1g	(4.44E-07)
.2g	(5.53E-07)
.4g	(4.15E-07)
.6g	(5.41E-08)

The seismic failures are modeled as if they are completely correlated within a system, i.e., the conditional probability of the second, third, etc. train of a system given failure of the first train at a given acceleration, is 1.0. This, coupled with the low seismicity of the site, and the seismic ruggedness of most of the plant equipment and structures, essentially guarantees that the seismic contributions will not impact the RICT and RMAT evaluations.

Task 2: Internal Events PRA and Low Power/Shutdown PRA

The licensee's PRA American Society of Mechanical Engineers (ASME) capability category criteria self assessment, including responses to the June 3, 2005 staff RAI Question 27, was reviewed. (Reference license amendment request (LAR) Attachment 1, Table 2, "Disposition of Findings and Observations from Peer Review" - Table 2 includes both dispositions of the industry peer review facts and observations (F&O) and the licensee's PRA self assessment.)

This portion of the staff audit covered the licensee's PRA self-assessment using ASME RA S-2003, RG 1.200, industry peer review, resolution of peer review comments (F&Os where applicable) and disposition of open items from the staff RG 1.200 audit.

The following questions were generated by the audit.

- The licensee's self assessment should also include specific discussion of the resolution to staff comments generated during the RG 1.200 audit and a disposition/discussion of cases where disagreements exist in the capability category assignments between the licensee's self assessment, the 1.200 audit and the industry peer review as applicable.

- The industry peer review and the staff RG 1.200 audit capability category results are not referenced or mapped to the self assessment results of Attachment 1, Table 2.

- Surveillance requirement (SR) IF-C1, References a Spatial Interaction Database update. This update is ongoing and is to be included in Revision 5 of the licensee's PRA.

- SR IF-D5, States capability category met with update of the internal flooding frequencies with EPRI TR-11880 piping failure rates. This update is ongoing and is to be included in Revision 5 of the licensee's PRA.

The following supporting requirements (SR) dispositions when mapped to the ASME standard and the results of the staff RG 1.200 audit require clarification as to the capability category met. The dispositions shown in Table 2 either specify or imply that capability Category 2 is met. Clarification is needed for capability categories that overlap. The licensee has proposed to revise the Table to add the clarifications.

SR 1E-A4
SR 1E-B3
SR 1E-C11
SR SY-A4
SR DA-C7
SR DA-C8
SR DA-C10
SR DA-D1
SR IF-D2
SR QU-E4
SR QU-F3

The following SRs dispositions state that the capability category will be met once Revision 5 to the PRA is completed. Revision 5 to the PRA should be evaluated and/or identified as a commitment prior to LAR implementation. A significant update of the STP PRA human reliability analysis (HRA) is planned for Revision 5 of the STP PRA. Other revisions under way and included in Revision 5 are key assumptions, uncertainties, common cause, and LERF assumptions and uncertainty.

SR-B5 SC-C2 SC-C3 SC-C4	HRA-A1 HRA-A2 HRA-A3 HR-B1 HR-B2 HR-C1 HR-C2 HR-C3 HR-D2 HR-D3 HR-D4 HR-D5	HR-F2 HR-G2 HR-G3 HR-G4 HR-G6 HR-G7 HR-G8 HR-H3 HR-I1	DA-D6 DA-E1	QU-C1 QU-C2 QU-D2 QU-E4 QU-F1 QU-F3	LE-F2 LE-G5 LE-G7 LE-G8

With above clarifications and SRs dispositioned, the ASME capability categories should map to Category 2 for STP and therefore are adequate to support the RMTS specification LAR per the Nuclear Energy Institute draft Risk Management Guidelines. These guidelines state that a PRA shall be reviewed to the guidance of RG 1.200 Rev 0 for a capability Category 2.

The staff reviewed the scope of the licensee's RMTS LAR and compared those systems and functions to their corresponding PRA models. The following issues were reviewed and discussed with the licensee:

TS 3.3.2.1.c Safety Injection (SI) Actuation Relays

The licensee identified instances where the scope of the PRA model did not include certain functions subject to the above TS. For example, some equipment which actuates on a safety injection signal may not be credited in the PRA model. The licensee stated that in such cases, the higher level function in the PRA model would be considered unavailable for purpose of applying the RMTS, and that administrative guidance and training for the users of the RMTS was not yet completed.

TS 3.6.1.7 Containment Ventilation

Action B applies when the system containment isolation valves are open and operable, but for reasons not addressed by the TS. The staff questioned how RMTS could be applied when there was no equipment non-functional.

Action C applies when the leakrate of the system containment isolation valves exceeds limits, and requires the penetration to be isolated in four hours. The staff questioned continued operation with an unisolated containment as this represents a potential loss of function.

TS 3.6.2.1 Containment Sprays

The licensee identified that the PRA model for containment sprays have no impact on LERF, and only impact scenarios involving longer term overpressure of the containment building. The containment sprays have no CDF impact.

TS 3.6.2.3 Reactor Fan Coolers

The licensee identified that the PRA model for containment fan coolers have no impact on LERF, and only impact scenarios involving longer term overpressure of the containment building. The fan coolers are evaluated to provide decay heat removal which impacts CDF.

TS 3.6.3 Containment Isolation Valves

The licensee identified that some containment isolation valves are screened from the PRA model based on their small size, and that the cumulative impact on the potential for a large early release of unclosable containment isolation valves could not be assessed by the current PRA model.

TS 3.7.1.5 Main Steam Isolation Valves (MSIVs)

The licensee identified that the safety functions of the MSIVs to limit positive reactivity insertion and containment pressure rise in the event of a steamline break are not addressed in the PRA model. The staff also identified to the licensee that an administrative change to the TS regarding applicability would have consequences not addressed by the LAR.

TS 3.7.7 Control Room Makeup and Cleanup Filtration

The staff questioned the applicability of the RMTS to this TS for control room makeup and filtration, since this function does not mitigate severe accidents.

The staff also reviewed a list of functions available in their CRMP tool to the operator as inputs for unavailable systems. The staff noted apparent omissions of RMTS TS systems, and was not able to clearly match a function on the list for each RMTS TS.

Task 3: CRMP Tool Development

The audit team received a presentation on the existing RASCAL and the proposed Risk-Informed Completion Time Calculator (RICTAL) computer programs that assess configuration specific risk. The programs are essentially database look-up programs; the actual risk calculations are performed in advance by PRA practitioners using the STP PRA model. About 20,000 separate plant configurations have been analyzed and the results are contained in the RASCAL database. Only a small fraction of these configurations have been experienced by the site since the STP risk management program began.

The audit team went over development of the database with licensee personnel. One area of interest was the quality assurance process used in developing the risk management process. This includes the PRA software and model, the input parameters for the 20,000 configurations, the results, and the RASCAL or RICTAL programs. The licensee said the following:

- The RASCAL and RICTAL programs are under the software quality assurance program as "Category 2" applications.
- The original risk management results were quantifications of the PRA model and were expressed as a matrix. Batch file results are compared to previous versions; the initial batch results were compared to the matrix results as a check.
- Generation of the batch file and the other activities associated with producing the RASCAL database are second checked by a reviewer.

The staff considered whether there were features of the STP PRA model used to calculate average risk that might not be appropriate for the risk management calculations. In response to NRC staff questions, the licensee provided the following:

- The STP model incorporates no time-variable split fractions that would impact the calculations, e.g., fraction of cycle with unfavorable moderator temperature coefficient; seasonal requirements for more running equipment. The STP model would assume the more conservative situation rather than use a seasonal or cycle average.
- The STP model credits repair of an emergency diesel generator (EDG) that fails to start, but does not credit repair when the EDG is out of service for maintenance.

The RASCAL calculations do not include consideration of "environmental factors" such as severe weather. The licensee stated that their risk management program includes qualitative consideration of these variables.

Uncertainty Analysis

Licensee personnel presented their plans for addressing uncertainty in the risk management calculations. A Monte Carlo simulation is used to generate the 5th and 95th percentiles, and the distribution, but does not address state-of-knowledge correlation. This is because the RISKMAN point estimates include the effect of state-of-knowledge correlation on a system by system basis, so that the point estimate and the mean are typically close. However, no across system state-of-knowledge correlation is evaluated.

The licensee does a number of sensitivity analyses to address uncertainty for the Graded Quality Assurance program:

- Set all common cause failure (CCF) probabilities to 0.
- Set all human error probabilities (HEPs) to 0.
- Increase the probabilities of low risk SSCs by a factor of 10.
- Assessment of maintenance configurations.

For Initiative 4B, the licensee is planning to address uncertainty as follows:

- Identify key uncertainties per the EPRI Guidelines for the Treatment of Uncertainty in Risk-Informed Regulatory Applications (e.g., Reactor Coolant Pump seal loss-of-coolant accident model, CCF data update, HRA update and dependency analysis).
- Identify the RICT calculations that are in the ~30 days or less.
- Identify if there are key uncertainties that can affect the evaluation (i.e., affect what is being credited in the CCDP calculations).
- Perform corresponding sensitivity studies.

It is impractical to look at all 20,000 cases, but the majority of plant configurations result in a RICT well in excess of the 30 days. The second step above is a screening step to limit the scope. The plant configurations with completion times less than 30 days all involve cross system or cross train configurations.

The NRC audit team made several suggestions to licensee personnel regarding uncertainty, including:

- Generate functional event trees to identify the scenarios that involve cross system or cross train combinations of equipment out of service as a means of identifying the key uncertainties that need to be addressed.
- Consider a sensitivity of LERF to the assumption that steam generator test rig scenarios do not bin to LERF.
- Consider whether new data from EPRI fire tests for hot shorts would change fire frequencies enough to affect the RICT results. (The STP fire PRA used a probability of a momentary hot short of .25, whereas a prolonged hot short probability was .0125. This should be compared to the EPRI data.)

- Consider whether adopting the latest fire frequency data (e.g., that referenced in NUREG/CR-6580) would affect RICT results. One key assumption is that the fire-induced vulnerability evaluation method for partitioning fires among equipment in a type of building is applicable to the unique, three-train configuration at STP.

HRA

The HRA was reviewed briefly, since it is being updated using the EPRI HRA calculator, and using a new quantification method based on the EPRI methods. Twenty-five of the 39 human failure events (HFEs) in the PRA model are being requantified. The remainder, all of which have risk achievement worth values approximately equal to 1.0, will have the original failure likelihood index method (FLIM) values. The HRA update is using either the cause-based decision tree (CBDT) or Human Cognitive Reliability/Operator Reactor Experiments (HCR/ORE) method (a time reliability curve method, developed as a result of the EPRI operator reliability experiments project) to determine the human error probabilities (HEPs). The staff made two observations with respect to the methods being used. First, when using the HCR/ORE approach, the approach to determining the shape factor for the time-reliability curve is based on the so-called sigma decision tree, the validity of which has been questioned in the draft NUREG-1842, Evaluation of Human Reliability Methods Against Good Practices (draft for comment), March 2006, and as a result this may be altered by EPRI. Second, it appears that incorrect Modular Accident Analysis Program (MAAP) runs were used to evaluate to time to depressurization following failure to isolate a ruptured steam generator. STP staff stated they would follow up on these observations. The staff notes that STP intends to have a peer review performed for the HRA, since it is an application of a method that is significantly different from that previously used. This is in accordance with the requirements of the ASME PRA Standard (ASME RA-S-2002).

Task 4: CRMP Implementation

The following procedures were provided to the audit team:

OPGP03-ZG-RMTS, "Risk-Managed Technical Specifications."
OPGP03-ZA-0091, "Configuration Risk Management Program."
OPGP03-ZO-0039, "Operations Configuration Management."
OPOP01-ZO-0006, "Risk Management Actions."

The above procedures were evaluated against draft EPRI Report 1011758, "Risk-Managed Technical Specifications (RMTS) Guidelines," dated April 2006.

STP procedure OPGP03-ZG-RMTS, "Risk-Managed Technical Specification Program" provides overall guidance on the implementation of RMTS and is the main procedure for implementing RMTS at STP. This procedure is based on the guidelines and format of EPRI Report 1011758 and is stated to supplement Section 11 of NEI, "Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants", NUMARC 93-01, Revision 3 dated July 2000.

A cross check with EPRI Report 1011758 confirmed that OPGP03-ZG-RMTS follows the program guidance requirements for applicability, thresholds, CRMP and TS applicability, documentation, training, PRA technical adequacy, configuration management tools and program implementation.

Differences were noted based on plant specific implementation, apparent clarification, of additional guidance. Differences included limiting the RMTS program to modes 1 and 2, the broader application of CDF/LERF and ICDP/incremental conditional large early release probability simultaneously, RMAT guidance for preplanned maintenance, plant configuration changes, more specific guidance on simultaneous risk and RICT actions, and risk management action documentation.

One difference in STP procedure OPGP03-ZG-RMTS 5.3.15 states that a RICT shall not be applied for pre-planned maintenance when all trains of equipment required by TS limiting condition for operation would be inoperable. This is revised from the EPRI guideline which states that a RICT exceeding the current front stop completion time (CT) may not be applied in cases where a total loss of function has occurred. It is not clear if an emergent event would be excluded in OPGP03-ZG-RMTS.

Based on the staff audit STP procedure OPGP03-ZG-RMTS follows the guidance of EPRI Report 1011758 for RMTS.

STP draft procedure OPGP03-ZA-0091, "Configuration Risk Management Program" has been modified to include components of the licensee's RMTS program into the licensee's CRMP implementation (i.e., 10 CFR 50.65(a)(4) Maintenance Rule). Procedure OPGP03-ZA-0091 provides guidance to control the risk impact of equipment out of service, the application of RICT, RMAT, and Risk Management Actions (RMAs). It is also used to assess the risk impact from planned and unplanned outages within the scope of the STP PRA. Based on the staff audit of this procedure, the licensee's CRMP program has been modified to incorporate RMTS consistent with the OPGP03-ZG-RMTS and EPRI Report 1011758.

STP draft procedure OPGP03-ZO-0039, "Operations Configuration Management" has also been modified to incorporate the licensee's RMTS program. This procedure includes administrative controls for operator aids, the operability assessment program, and the plant computer point program. Specifically, the operability assessment system was modified to include RMTS control of RMAT, RICT, RMAs, frontstop CTs, and the "risk assessment calculator." Additional systems and components were also added to the scope of OPGP03-ZO-0039. Based on the staff audit, procedure OPGP03-ZA-0091, the licensee's CRMP program, has been modified to incorporate RMTS consistent with the OPGP03-ZG-RMTS, and EPRI Report 1011758.

STP draft procedure OPOP01-ZO-0006, "Risk Management Actions" previously titled, "Extended Allowed Outage Time" has also been modified to incorporate the licensee's RMTS program. This procedure provides guidelines for plant operation with extended CTs whether planned or unplanned. Included in procedure OPOP01-ZO-0006 are pre-established RMAs when RMAT requirements apply. RMAs to be determined include specific RMA for specific plant configurations, generic actions, or additional RMAs not previously identified. In addition, procedure OPOP01-ZO-0006 provides for the establishment of compensatory measures when entering plant configurations that have or are expected to exceed the “Non Risk-Significant Threshold" (Maintenance Rule). Based on the audit performed by the staff, procedure

OPOP01-ZO-0006 has been modified to incorporate RMTS consistent with the OPGP03-ZG-RMTS, and EPRI Report 1011758.

The staff also received procedure OPGP07-ZA-0014, "Software Quality Assurance Program." The staff did not review this procedure during the audit except to note that EPRI Report 1011758, Section 4.2, Item 8 states the CRM application tools and software are to be accepted and maintained by an appropriate quality program. Software Quality Assurance is considered necessary by EPRI 1011758 for RMTS implementation. Procedure OPGP07-ZA-0014 as stated by the licensee meets this requirement.

Task 5: Plant Risk Culture

The review of STP safety culture was conducted in support of the audit of STP readiness to implement its license amendment application to utilize the RMTS RICT 4B as a pilot plant. In general the following areas were assessed in the review of the plant's risk/safety culture: the use of risk management programs in the conduct of plant operations; the use of risk management as an element of its safety culture; and, the overall plant risk/safety culture.

Interviews were conducted with five selected plant individuals in an effort to assess the plant risk/safety culture; an assistant maintenance manager, an I&C technician, a shift supervisor, the Corrective Action Program (CAP)/Condition Reporting (CR) process manager, and the Employee Concerns Program (ECP) manager. The assistant maintenance manager and shift supervisor were very familiar and conversant with the processes of assessing and managing configuration risk prior to the performance of maintenance using the Risk Assessment Calculator (RasCal) in Modes 1 and 2. The I&C technician while not as conversant with the detailed procedures for the performance of configuration risk assessments (i.e., not being his area of responsibility),, was however, very certain of his capability to raise safety issues throughout the planning and performance of surveillances and maintenance activities. The CAP/CR manager confirmed that the process adequately provided prompt reporting to the control room for operability considerations and to the cognizant maintenance support team. There are about 15,000 to 16,000 conditions reports submitted per year, indicating that there is no hesitation on the part of individuals to make such reports. The ECP manager confirmed that all individuals were free to raise concerns to the ECP staff, that every concern would be adequately addressed and dispositioned without fear of retribution, and that the program had management support.

The review has determined that risk assessment and management is integral to the daily operation and maintenance of the STP plants for both planning purposes and in coping with emergent issues. It is evident that risk management is an element of the STP safety culture by its inclusion in: the daily operations focus meeting, daily monitor reports, daily maintenance planning, procedures*, performance goals, and daily information news letters. The awareness of management and the responses to questions by STP personnel in interviews provides evidence of risk being an element of the STP safety culture.

*The following procedures were reviewed and are indicative of the STP use of risk, and evidence of risk being an element of the STP safety culture:

- OPGP01-ZA-0305, PRA Model Maintenance and Update.
- OPGP03-ZA-0091, Configuration Risk Management Program.
- OPGP04-ZA-0604, PRA Program.
- OPGP05-ZE-0001, PRA Analyses/Assessments.
- OPGP05-ZE-0002, Configuration Risk Management System Guidelines.
- OPGP03-ZG-RMTS, Risk Management Technical Specifications Program.
- OPGP03-ZO-0039, Operations Configuration Management

4. SUMMARY AND CONCLUSIONS

The licensee should provide justification that fire scenarios screened from its baseline model would not impact the RMTS calculations.

The licensee should evaluate the data used to support its fire PRA as a key source of uncertainty.

The licensee should update its assessment against RG 1.200 Rev. 0 and conformance with capability Category 2 of the ASME standard.

The licensee should provide justification that each TS to which the RMTS apply can be assessed using its CRMP tool.

An exit meeting was held with the STP President and members of his staff on June 22, 2006. The audit findings were provided to the licensee's PRA personnel during the audit and were discussed at the exit meeting. The audit team lead told the licensee that the NRC staff would review the audit findings and determine whether additional RAIs would be necessary to resolve any issues.

5. PERSONNEL CONTACTED

The following personnel were contacted during the audit.

PRA Technical Contacts:

- Roland Dunn
- Ray Fisk
- Bill Stillwell
- Ernie Kee
- Glen Schinzel

Entrance Meeting: (June 19, 2006)

- Wayne Harrison (STP Licensing)
- Ray Fisk (STP Risk Management)
- D. L. Musick (STP Operations)
- Rick Grantom (STP Risk Management)
- Glen Schinzel (STP Risk Management)
- Jay Phelps (STP Operations)
- Tim Bowman (STP Operations)

- Kevin Mulligan (STP Operations)
- Randy Hamilton (STP Operations)
- Scott Head (STP Licensing)
- Jim Morris (STP Licensing)
- Roland Dunn (STP Risk Management)
- Bill Stillwell (STP Risk Management)
- James Page (STP Operations Training)
- Ernie Kee (STP Risk Management)
- Stephen Hess (EPRI)
- Gary Chung (Southern California Edison)

Exit Meeting: (June 22, 2006)

- Wayne Harrison (STP Licensing)
- Ray Fisk (STP Risk Management)
- D. L. Musick (STP Operations)
- Rick Grantom (STP Risk Management)
- Glen Schinzel (STP Risk Management)
- Jay Phelps (STP Operations)
- Tim Bowman (STP Operations)
- Kevin Mulligan (STP Operations)
- Randy Hamilton (STP Operations)
- Jim Morris (STP Licensing)
- Roland Dunn (STP Risk Management)
- Bill Stillwell (STP Risk Management)
- Ernie Kee (STP Risk Management)
- W. E. Mookholk (STP Licensing)
- James Mertink (STP Operations)
- Drew Richards (STP Risk Management)
- Philip Walker (STP Licensing)
- G. T. Powell (STP SED Manager)
- Stephen Hess (EPRI)

6. DOCUMENTS REVIEWED

The following documents were referenced by the audit team while on site:

1992 IPE submittal: Letter from S. L. South Texas Project Electric Generating Station, to U.S. Nuclear Regulatory Commission, "South Texas Project Units 1 and 2, Docket Nos. STN 50-498, STN 50-499, Response to Generic Letter 88-20, Supplements 1, 2, 3, and 4 Individual Plant Examination," August 28, 1992 (ST-HL-AE-4193) (ADAMS Accession No. ML061700168)

U.S. NRC, NUREG/CR-5606, “A review of the South Texas Project Probabilistic Safety Analysis for Accident Frequency Estimates and Containment Binning,” prepared by Sandia National Laboratories, August, 1991.

“South Texas Project Probabilistic Safety Assessment,” PLG-0675, Pickard, Lowe and Garrick, Inc., May 1989, Sections 8, 9 and Appendix D.

“South Texas Project Probabilistic Safety Assessment, Support Systems Event Trees OFFGRID, EPONSITE, MECHSUP, and SEISET,” Revision 5 (March 1, 2006).

RASCAL Database - Excel Spreadsheet with the results of approximately 20,000 plant configurations.

“Fire Analysis Update for the South Texas Project Electrical Generating Station Probabilistic Safety Assessment,” PLG-1015, Pickard, Lowe and Garrick, Inc., December 1994.

“South Texas Project Human Reliability Analysis Update,” May 1, 2006 (Draft).

OPGP03-ZA-0091, "Configuration Risk Management Program."

OPGP01-ZA-0305, “PRA Model Maintenance and Update.”

OPGP04-ZA-0604, “PRA Program.”

OPGP05-ZE-0001, “PRA Analyses/Assessments.”

OPGP05-ZE-0002, “Configuration Risk Management System Guidelines.”

OPGP03-ZG-RMTS, "Risk-Managed Technical Specifications."

OPOP01-ZO-0006, "Risk Management Actions."

OPGP03-ZO-0039, "Operations Configuration Management."

REFERENCES

3. Letter from T. J. Jordan, STP to U.S. Nuclear Regulatory Commission, “South Texas Project Units 1 and 2 Docket Nos. STN 50-498, STN 50-499, Broad Scope Risk-Informed Technical Specification Amendment Request," August 2, 2004, NOC-AE-04001666 (ADAMS Accession No. ML042190366).

4. Letter from T. J. Jordan, STP to U.S. Nuclear Regulatory Commission, “South Texas Project Units 1 and 2 Docket Nos. STN 50-498, STN 50-499,Technical Adequacy of the STP PRA," October 28, 2004, NOC-AE-04001813 (ADAMS Accession No. ML043070448).

5. Letter from M. A. McBurnett, STP to U.S. Nuclear Regulatory Commission, “South Texas Project Units 1 and 2 Docket Nos. STN 50-498, STN 50-499, Response to NRC Requests for Additional Information on STPNOC Proposed Risk-Informed Technical Specifications," February 10, 2006, NOC-AE-06001969 (ADAMS Accession No. ML060480439).

6. Letter from M. A. McBurnett, STP to U.S. Nuclear Regulatory Commission, "South Texas Project Units 1 and 2 Docket Nos. STN 50-498, STN 50-499, Response to NRC Requests for Additional Information on STPNOC Proposed Risk-Informed Technical Specifications," April 26, 2006, NOC-AE-06001994 (ADAMS Accession No. ML061280591).

7. Letter from D. W. Rencurrel, STP to U.S. Nuclear Regulatory Commission, "South Texas Project Units 1 and 2 Docket Nos. STN 50-498, STN 50-499, Revised Broad Scope Risk-Informed Technical Specification Amendment Request," June 6, 2006, NOC-AE-06002005 (ADAMS Accession No. ML061630315).

8. American Society of Mechanical Engineers, "Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications," ASME RA-S-2002, April 5, 2002, "Addenda to ASME RA-S-2002," ASME RA-Sa-2003, December 5, 2003, and ASME RA-Sb-2005, December 20, 2005.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

July 10, 2006

MEMORANDUM TO: G. Apostolakis, Chairman, Reliability and PRA Subcommittee

FROM: Michael A. Junge, Senior Staff Engineer, ACRS

SUBJECT: WORKING COPY OF THE MINUTES OF THE JOINT MEETING OF THE SUBCOMMITTEES ON RELIABILITY AND PROBABILISTIC RISK ASSESSMENT AND ON PLANT OPERATIONS REGARDING RISK MANAGEMENT TECHNICAL SPECIFICATIONS, INITIATIVE 4b ON APRIL 28, 2006, IN ROCKVILLE, MARYLAND

A working copy of the minutes for the subject meeting is attached for your review. Please review and comment on them at your earliest convenience. If you are satisfied with these minutes please sign, date, and return the attached certification letter.

Attachments: Certification Letter
Minutes (DRAFT)

cc w/o Attachment:
J. Larkins
M. Snodderly
S. Duraiswamy

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

MEMORANDUM TO: Michael A. Junge, Senior Staff Engineer, ACRS

FROM: G. Apostolakis, Chairman, Reliability and PRA Subcommittee

SUBJECT: CERTIFICATION OF THE MINUTES OF THE JOINT MEETING OF THE SUBCOMMITTEES ON RELIABILITY AND PROBABILISTIC RISK ASSESSMENT AND ON PLANT OPERATIONS REGARDING RISK MANAGEMENT TECHNICAL SPECIFICATIONS, INITIATIVE 4b ON APRIL 28, 2006, IN ROCKVILLE, MARYLAND

I hereby certify, to the best of my knowledge and belief, that the minutes of the subject meeting on April 28, 2006, are an accurate record of the proceedings for that meeting.

George Apostolakis, Date
Reliability and PRA Subcommittee Chairman

CERTIFIED
Issued 07/10/06

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS MINUTES OF THE JOINT MEETING OF THE SUBCOMMITTEES ON RELIABILITY AND PROBABILISTIC RISK ASSESSMENT AND ON PLANT OPERATIONS REGARDING RISK MANAGEMENT TECHNICAL SPECIFICATIONS, INITIATIVE 4b
APRIL 28, 2006
ROCKVILLE, MARYLAND

On April 28, 2006, the joint Subcommittees on Reliability and Probabilistic Risk Assessment (PRA) and on Plant Operations held a meeting in Room T-2B1, 11545 Rockville Pike, Rockville, Maryland. The purpose of the meeting was to discuss the status of the development of risk management technical specifications related to Initiative 4b titled, "Use of Configuration Management for Determining Technical Specification Completion Times, Related to the Use of Probabilistic Risk Assessment (PRA) and Risk Monitoring Tools," with representatives of the Office of Nuclear Reactor Regulation (NRR), Nuclear Energy Institute (NEI), South Texas Project Nuclear Operating Company (STP), Southern California Edison (SCE), Omaha Public Power District, and Electric Power Research Institute (EPRI). Risk Management Technical Specifications Initiative 4b proposes to rely on PRA and risk monitors to calculate technical specification completion times for returning structures, systems, and components to operable status.

The meeting was open to the public. No written comments or requests to make oral statements were received from members of the public related to this meeting. Mr. Hossein Nourbakhsh was the Designated Federal Official for this meeting. The meeting was convened at 8:30 p.m. and adjourned at 11:21 p.m. on April 28, 2006

ATTENDEES:

ACRS MEMBERS/STAFF
George Apostolakis, Chairman
Tom Kress, Member
Otto Maynard, Member
Hossein Nourbakhsh, ACRS Staff
David Fischer, ACRS Staff
Michael Junge, ACRS Staff

NRC STAFF/PRESENTERS
R. Tjader, NRR/DRIS/ITSB
B. Bradley, NEI
S. Hess, EPRI
G. Chung, SCE - SONGS
Andrew Howe, NRR/DRA
J. Gaertner, EPRI
R. Grantom, STPNOC
A. Hackerott, OPPD

OTHER ATTENDEES
R.P. Grover, NRR
W. Harrison, STPNOC
J. Phelps, STPNOC
T. Kobetz, NRR
S. Head, STPNOC
R. Schneider, Westinghouse

The presentation slides, handouts used during the meeting, and a complete list of attendees are attached to the Office Copy of the meeting minutes. The presentations to the Subcommittees are summarized below.

Opening Remarks

Dr. Apostolakis, Chairman of the Subcommittee on Reliability and PRA convened the meeting and made a few introductory remarks. The purpose of this meeting was to discuss the status of the development of risk management technical specifications related to Initiative 4b titled, "Use of Configuration Management for Determining Technical Specification Completion Times, Related to the Use of Probabilistic Risk Assessment (PRA) and Risk Monitoring Tools (RMT)." Risk Management Technical Specifications (RMTS) Initiative 4b proposes to rely on PRA and risk monitors to calculate technical specification completion times for returning structures, systems, and components to operable status.

Dr. Apostolakis called upon Mr. Tjader of the Office of Nuclear Reactor Regulation (NRR) to begin the discussion.

Staff Introduction and Overview of RMTS Initiative 4b, Risk-Informed Completion Times

Mr. Bob Tjader and Mr. Andrew Howe with the Technical Specifications Branch and PRA Branch of NRR respectively, presented Risk Management Technical Specifications Guidelines for Initiative 4b, Risk Informed Completion Times. The purpose of the presentation was to familiarize ACRS with Initiative 4b and the Risk Management Guidance Document, to obtain feedback on the approach being taken and to seek a letter to the Commission supporting the pilot process.

The RMTS initiative purposes are to align technical specifications with the Commission Policy Statement on PRA and to implement that policy statement in making further regulatory decisions with respect to the technical specifications. It is consistent with the maintenance rule, particularly rule (a) (4) which requires assessing and managing risk prior to maintenance. This initiative is to enhance safety by allowing operators and the NRC to focus on safety. It makes them aware of risk contributors and the existing profile of the plants risk status. It makes the completion times of technical specifications and the specified actions appropriate to the risk that is involved in the configuration of the plant at the time.

Risk-informed completion times, initiative 4b, takes real time quantitative calculations of the risk associated with the plant configuration at the time and calculates an appropriate completion time for the required actions of the technical specifications. This time will not exceed 30 days which gives the licensee time to restore the system to operable status.

The risk management guidance document will contain requirements and will be part of the technical specifications. It includes an approved decision-making process and methodology, requirements and guidance. The document includes quantified metrics for plant configuration and cumulative risk. It also includes required documentation and training requirements.

The benefits of risk management, technical specification risk-informed completion time are that it is risk-informed. It considers the integrated configuration plant risk. It can consider multiple system outages. It manages a broader scope of systems, equipment and components than those considered in the technical specifications.

It does contain a greater degree of licensee control. The control of RICT will be under the licensee control, though the methodology will be in the technical specifications.

The risk management document contains an overview of the risk management technical specifications, program requirements, methodology for utilizing and implementing risk-informed completion times, requirements for PRA quality and configuration risk management tool attributes as well as documentation and training requirements.

Chairman Apostolakis stated that PRA quality was assured by the industry peer review process and asked if the Configuration Risk Model (CRM) had a similar process. There is not a process to verify CRM quality. The staff is considering a set of criteria for ascertaining the acceptability and confidence in the tool and that the PRA is accurately reflected.

Chairman Apostolakis questioned how a licensee creates a CRM from their PRA. The staff will be visiting sites to determine how the translation of the PRA model to the CRM tool takes place. He would like to see actual examples of this translation in detail.

Dr. Kress asked how the process worked if during one configuration aanother change in plant configuration occurred. Could configuration be changed to decrease the risk and extend the completion time. The completion time would be adjusted but it still starts from the initial event time and cannot exceed 30 days. The industry commented that they don't expect adjustment will be made to completion times on a routine basis. This type of adjustment would probably occur if during a completion time cycle, an emergent event occurs that changes the risk and therefore the completion time.

Member Maynard noted that all the pilot plants are PWRs. The staff noted that there were two plants that volunteered to be pilots, however economic or personnel reasons prevented them from participating. They didn't feel they could upgrade their PRA in a timely enough fashion to participate. One of them was a BWR.

The guidance document is not complete. Plant visits are needed as well and will occur during the summer months. The Subcommittee felt it would be good to have another meeting prior to the full ACRS meeting. The staff agreed to have the meeting in late August or early September, with a Full Committee in October with a letter written.

Risk Managed Technical Specifications Industry Guidance

Following a short introduction by Mr. Biff Bradley of NEI, Mr. Stephen Hess with the Electric Power Research Institute (EPRI) presented the industry overview of theRMTS initiative (4)(b) guidance information. The objective of the guidance is to provide a process and technical guidance to identify appropriate risk-informed completion times (RICT) for SSCs that are Technical Specification inoperable. The guidance is intended to apply PRA insights and knowledge to specific plant configurations to ensure the configuration and control safety risk is managed properly. Although the initiative is tied to technical specification inoperability, it considers both technical specification and non-technical specification equipment that are contained in the PRA and configuration risk models.

The initiative is similar to the maintenance rule in that it does require appropriate management compensatory risk management actions actively control the risk at specific threshold levels. Compensatory actions cannot be credited in the calculation of the completion time, unless the risk amount is known somehow; for example it is already within the scope of the PRA model. Since risk management compensatory actions would be management directed, to return equipment to service or not to remove other equipment, etc., these types of actions would not be in the PRA model.

Dr Kress asked when dealing with a specific component and the RICT at that configuration identifies 10 days to complete the fix and you are 8 days into the RICT time period then some contingency happens and you recalculate your new RICT to 6 days and you are already in day 8, what happens then? Mr. Hess answered, since you have reached the limit of the risk-informed completion time, it's the same as it is today when you are in a technical specification action statement. You have to implement the prescribed actions of the LCO conditions.

Dr Kress also asked since the basis for thresholds for compensatory risk management actions (RMA) and RICT are based on accepted regulatory guidance (R.G. 1.174), what happens when R.G. 1.174 gets changed? Mr. Tjader responded that the guidance document will be part of the license and when a technical specification is changed, the risk management document will be approved as part of the license.

The guidance document will have programmatic requirements such as, documentation, training, PRA technical adequacy, CRM tools and the application of CRM process to the tech spec completion times. It will include specific implementation guidance and examples.

The applicability of the Risk Managed Tech Specs is different for BWR's and PWR's. PRA's are predominately developed for at-power PRAs. There is direct applicability to modes 1 and 2 for both types of reactors. PWRs permit the extension into modes 3 and 4 to the point that you continue to cool with the Steam Generators.

The RMTS will have a formal structured process. Actions will be specified in a process flowchart, which will contain entry and exit conditions, actions for simultaneous LCO's and actions for exceeding specific tech spec completion times.

Calculation requirements are placed on using RMTS. The RMAT and RICT can only be referenced from the time of initial entry in the first RMTS. It can only be reset once all RMTS action statements for SSCs beyond their front-stop completion times have been exited. Calculations may use conservative or bounding analysis and must be referenced to CDF or LERF associated with the plant "zero-maintenance" configuration. Compensatory risk management actions may only be credited to the extent they are modeled in the PRA and are proceduralized. A RICT exceeding the front-stop completion time may not be applied in cases where a total loss of function has occurred.

PRA and CRM tool requirements must be specified and include, PRA for Internal Events and Flooding, Internal Fires, Seismic and other External Events and an application to a low power shutdown mode of operation.

PRA and Configuration Risk Management (CRM) Tool Requirements for Risk Management Technical Specifications

Mr. John Gaertner with EPRI presented PRA and Configuration Risk Management (CRM) Tool Requirements for Risk Management Tech Specs. The PRA requirements that are specified in the Risk Management Guidance included; (1) PRA for Internal Events and Flooding, (2) PRA for Internal Fires, (3) PRA for seismic and other external events and (4) PRA application to Low Power Shut Down (LPSD) modes. Mr. Gaertner also described the 9 CRM attributes: (1) initiator dependencies, (2) truncation levels, (3) translation from PRA model, (4) human action treatment, (5) activities mapped to basic events, (6) representing the as-built/as-operated plant, (7) consideration of uncertainty, (8) CRM software and model quality, (9) CRM model maintenance and update. The committee would like an information briefing to discuss the attributes in more detail.

Mr. Gaertner described the current status of industry CRM models as an integral part of the regulatory compliance, work management, and operations processes at Nuclear Power Plants. He discussed the current use by U.S. plants for Maintenance Rule (a)(4) requirements at power and that their use in the Maintenance Rule is subject to ROP oversight and actions.

The CRM models are integral to CRM tools such as Safety Monitor and RasCaL but that LERF is sometimes not part of the CRM model and although internal events are always part of the quantitative CRM model, the flooding, fire and seismic modeling is not always included. PRA requirements will require the model include Level 1 CDF plus LERF. PRA for internal fires can be integral to the CRM model or a conservative or a bounding methodology can be used. PRA for Seismic and other External Events can be included in the CRM model or addressed by a reasonable technical argument that the external event is not a significant contributor or perform an analysis of the contribution form the external event including the contribution in the Risk Informed Completion Time (RICT). PRA application to LPSD modes can be used in modes greater than mode 2 if the at-power PRA model is verified to be conservative or bounding.

The review of CRM technical adequacy would require a PRA Peer Review, PRA Standards Assessment and Verification of the CRM attributes.

STP Implementation of Risk-Informed Technical Specifications

Mr. Rick Grantom and Mr. Jay Phelps with South Texas Project Nuclear Operating Company presented an overview of South Texas Project's (STP) PRA and On-line risk assessment tool, the Risk Assessment Calculator (RAsCal), they discussed the RAsCal attributes and applications used at STP and the RMTS implementation at STP.

STP uses a full scope level 1 / 2 PRA which includes internal events, external events including fire, external flood, high winds and seismic. The PRA has undergone industry peer review and STP was a pilot plant for PRA quality.

The "real-time" risk assessment tool, RAsCal, maintains 20,000 maintenance states quantified by the STP PRA. RAsCal reflects PRA results and does not perform the CDF/LERF calculation. The activities mapped in RAsCal are specifically tailored to be the same as PRA based on tag-out procedures, similar to Maintenance Rule requirements. RAsCal is updated to represent the as-built, as operated plant. The software is controlled by the STP Appendix B Software QA program.

Mr. Phelps provided examples of how to use the system via monitor screen shots of the program.

San Onofre Nuclear Generating Station (SONGS)

Mr. Gary Chung with Souther California Edison presented the San Onofre Nuclear Generating Stations plans to become a pilot plant for RMTS. SONGS is currently assessing logistics and schedule prior to submitting a formal intent letter. They are developing the program, license change submittal scope and performing training on implementation.

The SONGS PRA is a full scope PRA with internal and external events. It was a R.G. 1.200 pilot plant, and the PRA has been peer reviewed with the facts and observations of the peer review resolved.

Fort Calhoun Station Approach to Initiative 4b: Single System Pilot

Mr. Alan Hackerott with Omaha Public Power District presented the Fort Calhoun Station (FCS) approach to initiative 4B with a single system pilot. Why the single system pilot was performed and the Risk Informed Maintenance program was discussed during this presentation.

Earlier pilot programs demonstrated that technical specifications could be risk-informed. The flexible allowable outage times concept emerged following a successful single system application. The process is straight-forward but individual permanent extensions were manpower intensive and potentially burdensome for both industry and NRC. FCS chose to be a single system pilot plant. This method provided a means of tackling issues in a measured, methodical manner. The High Pressure Safety Injection system was selected. The HPSI system dynamics, interaction and role in safety was well understood and it has a well defined overlap with Fire and external events.

FCS process integrates PRA with normal day-to-day maintenance. PRA is used to support the maintenance week schedule. The PRA uses a Level 1/LERF PRA model to support maintenance Rule (a)(4). Key seismic failures are considered in the model, and fire insights are considered.

FCS plans to evolve the single system pilot. A single system application backstop change requires a relatively small change to existing processes and procedures. The Maintenance Rule process will be adjusted based on RMTS guidelines. This will provide the basis for their expansion of the project.

Member Comments

Dr. Apostolakis would like to see actual examples of a Risk Management tool. The staff plans on presenting an example of a tool at a future subcommittee meeting.

Mr. Maynard would like to see a vertical slice inspection of a CRM performed. The staff plans on the performing reviews at several plants this summer and presenting the results to the Subcommittee.

Dr. Kress asked how can this apply to different types of plants such as a Gas cooled reactor. The process can be applied to any plant if there is a PRA developed as will be described in the RMTS guidelines.

Mr. Maynard commented that the risk management tools can only be applied to the modes in which the sites PRA is complete.

Agreements

Dr. Apostolakis said that he wanted to understand how a licensee's PRA will be translated to their configuration risk management (CRM) tool before he recommends that the ACRS Full Committee endorse the EPRI RMTS guidelines. Dr. Apostolakis suggested that the Subcommittee have another meeting in the fall of 2006, on Risk-Informed Completion Times, after the staff's planned site visits to the pilot plants in the June-July 2006 time frame. Dr. Apostolakis also wanted the benefit of the staff safety evaluation report before bringing this to the Full Committee. The Subcommittee, NRC staff, and industry representatives were in general agreement with Dr. Apostolakis' proposed approach.

Staff/Industry Follow-up Actions

The staff agree to provide the Subcommittee chairman with a copy of the EPRI Technical Report "Methodology for Fire Configuration Risk Management."

EPRI agreed to clarify the meaning of the sentence "The processes described herein depart from the Maintenance Rule requirements by formally requiring high risk plant configurations to be treated in a required action for the Risk Managed Technical Specification not being met." on page 1-3 of the draft RMTS Guidelines as requested by Dr. Apostolakis.

EPRI agreed to clarify the meaning of the sentence "At a minimum, the PRA applied in support of a RMTS program shall include a Level 1 PRA with LERF capability." on page 4-1 of the draft RMTS Guidelines as requested by Dr. Apostolakis.

Subcommittee Decisions and Follow-up Actions

The Subcommittee Chairman provided a copy of the following documents to the ACRS members in attendance at the meeting and to each organization represented at the meeting.

- Reliability Engineering and System Safety paper, 66 (1999) 41-47, "Calculating and addressing uncertainty for risk-based allowable outage times," by C.L. Smith, J.K. Knudsen, and M.B. Calley accepted 1 February 1999.

- Reliability Engineering and System Safety paper, 78 (2002) 259-266 "Evaluation of allowed outage time considering a set of plant configurations," by Marko Čepin and Sebastián Martorell, accepted 15 August 2002.

- Reliability Engineering and System Safety paper, 87 (2005) 395-403, "Analysis of truncation limit in probabilistic safety assessments," by Marko Čepin, accepted 30 June 2004.

The staff and the applicant plan to provide a briefing regarding this matter to the full Committee following an additional subcommittee meeting in the fall 2006 **(within a year)**.

Background Materials Provided to the Committee

1. "Risk-Managed Technical Specification (RMTS) Guidelines," Electric Power Research Institute (EPRI), February 2006 (ADAMS Accession No. ML060290043)

2. Regulatory Guide 1.177, "An Approach for Plant-Specific, Risk-Informed Decisionmaking: Technical Specifications," August 1998 (ADAMS Accession No. ML003740176)

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NOTE:
Additional details of this meeting can be obtained from a transcript of this meeting available in the NRC Public Document Room, One White Flint North, 11555 Rockville Pike, Rockville, MD, (301) 415-7000, downloading or view on the Internet at http://www.nrc.gov/reading-rm/doc-collections/acrs/ can be purchased from Neal R. Gross and Co., 1323 Rhode Island Avenue, NW, Washington, D.C. 20005, (202) 234-4433 (voice), (202) 387-7330 (fax), nrgross@nealgross.com (e-mail).

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ELECTRIC POWER
RESEARCH INSTITUTE

Methodology for Fire Configuration Risk Management

Technical Report

Methodology for Fire Configuration Risk Management

1012948

Final Report, December 2005

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This report describes research sponsored by the Electric Power Research Institute (EPRI).

The report is a corporate document that should be cited in the literature in the following manner:

Methodology for Fire Configuration Risk Management. EPRI, Palo Alto, CA: 2005. 1012948.

REPORT SUMMARY

This report presents a methodology for performing bounding fire risk assessments at nuclear power plants (NPPs) for on-line equipment configurations. The methodology is designed to support risk assessments prior to performing maintenance, as required by 10CFR50.65 Section (a)(4), the Maintenance Rule. Risk assessments are typically performed for internal events using probabilistic risk assessments (PRAs). However, fire probabilistic risk assessments (FPRAs) are often not available or their use for this purpose is not always feasible. This report provides a practical alternative to a complete FPRA for configuration risk management (CRM).

Background

A structured CRM process using models based on the plant PRA is prevalent at U.S. NPPs. CRM supports the planning and scheduling of equipment outages when NPPs are at power and when they are experiencing a plant outage. CRM enables the evaluation of equipment configurations from a safety risk standpoint and provides valuable information about possible risk-management actions associated with the configurations. CRM models based on the PRA generally address the Nuclear Regulatory Commission (NRC) requirement of the Maintenance Rule to assess configuration-specific risk at power for internally initiated events. Most CRM models do not include the treatment of externally initiated events. In this context, external events include fires originating within the plant. Fire events are often excluded because quantitative models have not been developed or such models are incomplete and conservative relative to internal event models. Therefore, configuration risk of fire is managed indirectly by other plant programs. There is a recent interest in treating configuration risk from external events more explicitly in CRM programs.

Objectives

- To develop a non-quantitative method to characterize the risk from fire for plant maintenance configurations at power. The method must be consistent with current NPP practices for CRM and must comply with the Maintenance Rule.
- To perform a limited demonstration of the method at an NPP that has an FPRA. The objective of the demonstration is to determine the level of effort necessary to implement the FPRA, the feasibility of using it, and its accuracy of the risk characterizations.
- To evaluate the application of this method to support calculating completion times for a risk-managed technical specifications program.

Approach

The proposed approach is to use existing plant fire risk analyses to evaluate the impact of on-line maintenance on internal fire risk, without the need to quantify an FPRA for each configuration. The end-user determines readily available attributes of the configuration and employs tables to complete the assessment. The configuration assessment results in a risk management category that is assigned a risk color (green, yellow, or red) similar to risk color assignments familiar to plant staff in CRM. Risk management actions are suggested for the resultant end states when using this method. A limited scope evaluation of the method is performed using actual scenarios from a BWR plant. The results of the evaluation are compared with quantified results from the plant's FPRA. Additionally, the investigators consider enhancements of the methodology to support calculating technical specification completion times as part of a risk-managed technical specifications program.

Results

The methodology that meets the project objectives and the aforementioned approach was developed and is presented in the report. The results of the evaluation compare favorably with quantified results from the plant's FPRA. The method results in conservative, yet useful, risk category assignments, for fire risk that can be combined with the assessment of risk from internally initiated events to determine appropriate risk management actions. The methodology was also shown to enhance the support calculation of risk-managed technical specification completion times.

EPRI Perspective

This work was sponsored by the EPRI Outage Risk Assessment and Management (ORAM)-SENTINEL Users Group. It is consistent with the blended qualitative and quantitative approach and the use of risk colors that are an inherent part of the ORAM-SENTINEL method. This work is also supported by the EPRI Configuration Risk Management Forum (CRMF), which is committed to addressing the technical needs in CRM. This work also is a key component of EPRI's strategic objective to help improve the risk management capabilities of NPPs.

Application of CRM at U. S. nuclear plants evolved without specific regulatory requirements. It was motivated by the ability of CRM to justify increased on-line maintenance and more aggressive outage maintenance configurations, while maintaining safety. By the time CRM became a Maintenance Rule requirement in 2000, it was a mature and well-established practice. As risk technology continues to advance, the expectations for technical rigor and the completeness of CRM will increase for all stakeholders. This report investigates one such potential enhancement to CRM and is intended to provide an objective evaluation of the method for consideration as part of an effective CRM program.

Keywords

Risk/safety management
Probabilistic risk assessment
Configuration risk management
Risk-informed regulations

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1

INTRODUCTION

The Nuclear Regulatory Commission (NRC) in 10CFR50.65 [1] Section (a)(4) requires that nuclear power plants (NPPs) evaluate the risk of performing maintenance activities. NPPs have been performing configuration risk management (CRM) evaluations to meet these requirements using probabilistic risk assessment (PRA) tools, focusing primarily on internal events. Recent industry interest has been shown in the evaluation of internal fire risk to complement the existing evaluations.

This report provides an approach to use existing plant fire risk analyses to evaluate the impact of on-line maintenance on internal fire risk without the need to quantify a fire probabilistic risk assessment (FPRA) for each configuration. A method that does not rely on quantification is used to provide an alternative to choosing a complex, time consuming, and inherently conservative method to determine the impact of maintenance on fire risk. It also provides a viable method to incorporate fire insights into configuration risk management for those without a fully-developed FPRA.

Industry experience in converting and upgrading individual plant examination (IPE)-vintage internal event PRAs has shown the process to be technically challenging and costly. Developing or upgrading an FPRA can also be quite difficult and expensive. Although a number of plants are preparing FPRAs according to guidance developed by EPRI and NRC [5], the transition to modern FPRAs will take several years. Many plants have no current plans for FPRAs. This method provides a viable and cost-effective interim or alternative method to meeting the requirement of (a)(4) with respect to fire risk.

Fire events can be characterized as spatial events. The specific challenge to plant systems and equipment is based on whether they are present or affected by the fire in a particular space. Because fire events can challenge the availability of multiple systems due to the location of equipment or their associated cabling, the incorporation of the fire risk analysis results could significantly change the plant risk profile. This change to the risk profile due to fire-related insights could impact the risk characterization of on-line maintenance activities and the selection of compensatory measures.

Fire risk assessments (FRAs) evaluate the potential consequences of postulated fire events. These analyses typically provide various risk insights and identify the dominant fire areas that contribute to fire-related risk. The unavailability of equipment can alter the fire risk profile, because some fire areas may rely on the unavailable system for achieving and maintaining safe shutdown. The postulated occurrence of a fire event in those areas that rely on the unavailable system can be dominant risk contributors. Additionally, it can make other equipment more important to protect.

Therefore, it is desirable to include insights from the fire risk analysis as part of the configuration risk assessment prior to performing on-line maintenance activities. These insights need to provide the following:

- Information concerning the specific fire zones that are most vulnerable to a fire
- An indication of what remaining systems are important to keep in service, based on the fire risk results
- An awareness of the level of risk associated with the maintenance configuration

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METHODOLOGY

This section describes the proposed approach for performing fire risk assessments for on-line configuration risk management. The first part of this section describes the data collection and analyses needed as the basis for the evaluation of fire risk due to on-line maintenance. It does not describe how to build a model, but it describes how to collect, evaluate, and organize the fire risk analysis data currently available to risk management personnel. The second half of the section describes the methodology for evaluating the fire risk impact of the unavailability of systems, structures, and components (SSCs) and provides a recommendation for graded risk management actions in response to the change in fire risk.

The basis for this methodology is described in Section 3 of this report.

Scope

This methodology is intended to use existing FPRAs. This proof-of-concept project describes a methodology capable of evaluating the impact of unavailable SSCs on the fire risk. The primary focus of this method is to evaluate the impact of SSCs that mitigate core damage during a fire. The effect of removing fire-suppression systems from service is also considered. The methodology described is currently limited to configurations during at-power conditions for internal fires only. However, the general principles could be adapted to low-power and shutdown conditions.

The methodology does not directly address maintenance activities that increase the likelihood of a fire or have the potential to cause a fire, such as hotwork or increased combustible material loading. Maintenance affecting fire barrier integrity is also not explicitly evaluated. Hotwork, combustible material loading, and fire barriers are controlled by plant procedures and processes that are considered adequate to manage the impact of those activities. Also, because most existing models do not mention fire-detection equipment explicitly, the methodology presented here does not include extensive consideration of detection equipment.

Overview

This subsection will give a brief overview of the process. Each of the process steps will be discussed in greater detail in subsequent subsections. The intent of the process is to perform an analysis of the fire scenarios, determine the important SSCs for each scenario, and determine the impact of removing the SSCs from service. Once this initial analysis is done, the results can be entered into a matrix, database, or configuration risk model to provide a tool that can analyze the impact of unavailable SSCs on fire risk.

It is proposed that the input to the configuration fire risk model would be:

- The unavailable SSCs
- The duration of the SSCs unavailability
- The status of any applicable suppression systems

The output, regardless of the tool chosen, should be the important fire scenarios, important SSCs, and the appropriate risk management actions to be taken. As part of the methodology, a suggested set of risk management actions is provided.

Fire Scenario Evaluation

The proposed process starts with the existing fire models. These models are used to identify risk-significant fire scenarios and their associated success paths. The scenarios include the fire source, the corresponding fire compartments, and the affected equipment. The scenario also identifies whether fire suppression is available or credited. Finally, the scenario specifies the success paths considered to avoid core damage, given the associated fire and loss of equipment. Based on the number and reliability of the remaining success paths, it is possible to identify which equipment is important to the fire risk for that scenario.

Many fire risk analyses perform a screening step to identify fire compartments or scenarios that are considered low risk (for example, less than 1E-6 per year). However, these scenarios can become risk significant if multiple SSCs are removed from service simultaneously. Therefore, it is important to reevaluate previously screened fire compartments, areas, and scenarios. If SSCs that are normally removed from service during on-line maintenance make a scenario significant, the scenario should be included in the analysis.

The output of this step should be a list of fire scenarios to consider for further evaluation. The data needed for further evaluation are the fire source, the impact, the availability of suppression systems, and the success paths available to mitigate core damage. If available, cutsets for the fire scenarios are beneficial in developing the list of important equipment.

Method for Determining Available Success Paths

Once the scenarios have been identified and reviewed, the success paths considered for the scenario are evaluated to determine the important SSCs for the fire of concern. This evaluation can use the existing fire model and results to identify the sequences for each fire scenario and the corresponding success paths. The basic process is as follows:

1. Determine the success criteria for the plant. This step establishes the maximum set of available success paths to prevent core damage during a fire.
2. Determine the equipment that is made unavailable by the fire scenario. This includes all equipment that is directly impacted by the fire, as well as any equipment whose control or

power cables may be affected by the fire. Additionally, certain operator actions may not be viable due to the fire scenario.

3. Determine the remaining success paths available and the equipment that supports those success paths. This can be done based on failures (cutsets) that lead to core damage during a fire scenario. Information gathered from the failures that lead to core damage can identify the required equipment to prevent it.

Some fire scenarios have no success paths available. Examples may include some main control room (MCR) fires or severe fires in electrical equipment rooms. For these scenarios, there are essentially no impacts of removing equipment from service. These scenarios are almost always risk significant, but not impacted by on-line maintenance. It is recommended that these scenarios be screened from further consideration.

Example – Part 1

Throughout this section, the example provided is based on Fire Area 1013, Unit 1, Division 1 (Train A) switchgear room in a dual-unit boiling water reactor (BWR). The fire area is divided into three scenarios:

- 1013-A: Non-severe fire that results in the loss of only the switchgear itself.
- 1013-B: Severe fire that is postulated to result in damage to cables located in overhead cable trays. Because of the arrangement of the switchgear breakers and bus ducts providing the offsite power connection, one of the two startup sources fails due to the fire.
- 1013-C: Severe fire similar to 1013-B. In this fire, a different startup source fails due to the fire.

The plant success criteria are either:

- Feedwater (FW)
- Early injection and suppression pool cooling
- Early injection, venting, and control rod drive (CRD) system injection

All three scenarios for Fire Area 1013 fail Division 1 entirely, which results in the failure of Train A suppression pool cooling and venting. The remaining success paths are FW, injection, and suppression pool cooling (Train B). The failure of support systems, such as turbine enclosure cooling water (TECW) for FW, must also be considered.

Determine Impact of Removing Equipment from Service

After determining the success paths for each scenario and reviewing the failures (cutsets) that can affect those success paths, a table is developed that maps the impact of unavailable equipment to the number of remaining success paths. The purpose of this step is to determine the list of SSCs that affect each scenario. If an SSC or a combination of SSCs reduces the number of available success paths for a scenario, it is considered important to that scenario. Support systems such as cooling water and electrical supplies must also be considered in this list. The list should be manageable because many fires may have only one or two success paths.

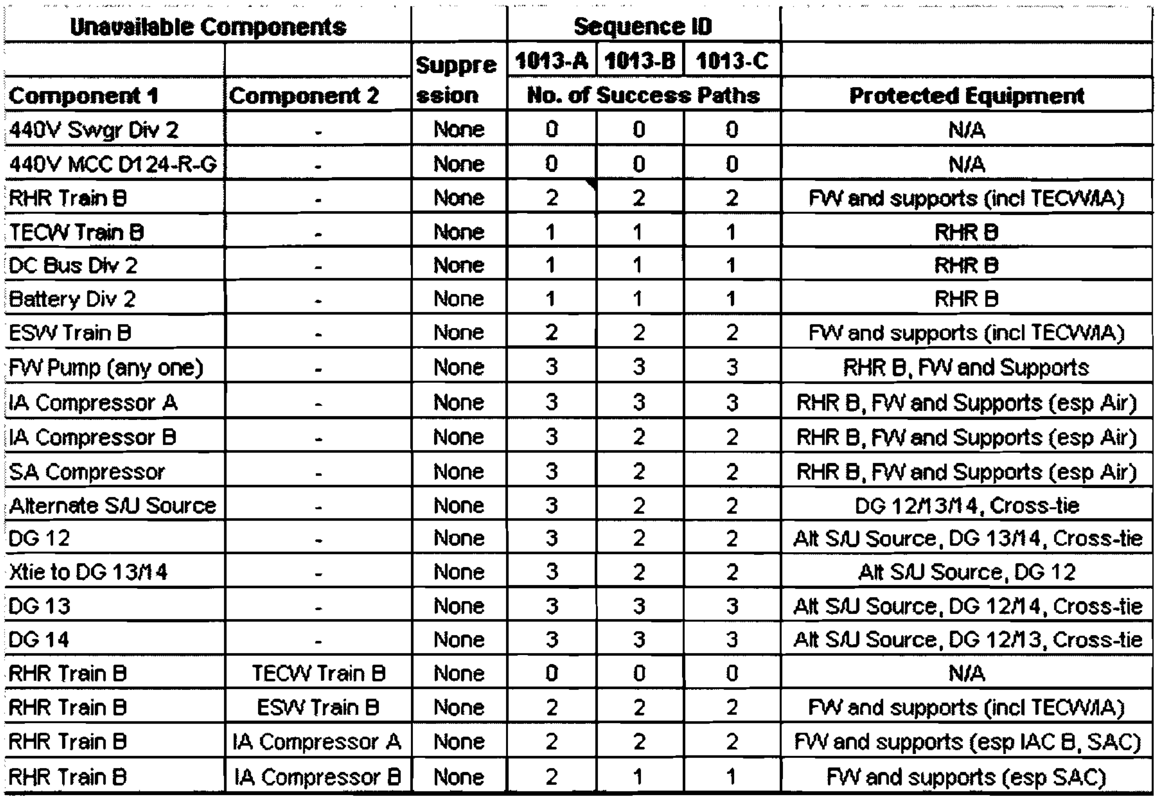
The list of impacts serves two purposes:

- It provides the first screen for the fire impact analysis that is done by the fire configuration risk model. This limits the evaluation that must be done for each SSC to only those scenarios that are directly impacted.
- It is used in the fire configuration risk model to determine the number of success paths remaining for a given SSC unavailability. The number of success paths remaining represents the relative fire risk for those SSCs and is used to trigger risk management actions.

In addition to the list of impacts, it is necessary to determine the equipment that provides the remaining success paths for the scenario. This information is needed to support the risk management actions for scenarios that meet the threshold for protecting equipment that is determined in the impact analysis.

Example – Part 2

An example of the output from this analysis is shown in Figure 2-1.



Unavailable Components			**Sequence ID**			
		Suppression	**1013-A**	**1013-B**	**1013-C**	
Component 1	**Component 2**		**No. of Success Paths**			**Protected Equipment**
440V Swgr Div 2	-	None	0	0	0	N/A
440V MCC D124-R-G	-	None	0	0	0	N/A
RHR Train B	-	None	2	2	2	FW and supports (incl TECW/IA)
TECW Train B	-	None	1	1	1	RHR B
DC Bus Div 2	-	None	1	1	1	RHR B
Battery Div 2	-	None	1	1	1	RHR B
ESW Train B	-	None	2	2	2	FW and supports (incl TECW/IA)
FW Pump (any one)	-	None	3	3	3	RHR B, FW and Supports
IA Compressor A	-	None	3	3	3	RHR B, FW and Supports (esp Air)
IA Compressor B	-	None	3	2	2	RHR B, FW and Supports (esp Air)
SA Compressor	-	None	3	2	2	RHR B, FW and Supports (esp Air)
Alternate S/U Source	-	None	3	2	2	DG 12/13/14, Cross-tie
DG 12	-	None	3	2	2	Alt S/U Source, DG 13/14, Cross-tie
Xtie to DG 13/14	-	None	3	2	2	Alt S/U Source, DG 12
DG 13	-	None	3	3	3	Alt S/U Source, DG 12/14, Cross-tie
DG 14	-	None	3	3	3	Alt S/U Source, DG 12/13, Cross-tie
RHR Train B	TECW Train B	None	0	0	0	N/A
RHR Train B	ESW Train B	None	2	2	2	FW and supports (incl TECW/IA)
RHR Train B	IA Compressor A	None	2	2	2	FW and supports (esp IAC B, SAC)
RHR Train B	IA Compressor B	None	2	1	1	FW and supports (esp SAC)

Figure 2-1
Impact Matrix

Impact Analysis

The results of the analysis described to this point are comprised of the data that will be used in the fire configuration risk model. As previously discussed, this model can be developed in a spreadsheet, database, or configuration risk management software tool (for example, a risk monitor). It is not necessary to perform the impact analysis using software, but the large number of scenarios, configurations, and impacts lends itself to an automated tool or database.

The basic process of performing the impact analysis for each scenario is to:

- Determine whether the unavailable SSCs affect the scenario. If not, the scenario is not impacted, and no further analysis is required.
- Assess the availability of fire suppression capability.
- Determine the number of success paths remaining and the associated equipment necessary for those success paths.
- Provide the expected duration of SSC unavailability.

A fire risk impacts flowchart is shown in Figure 2-2. This flowchart follows the basic process of performing the impact analysis, assuming that the scenario is affected by the unavailable SSCs. The output of the flowchart is specific guidance (risk management actions) that falls into three categories.

- Normal controls (green)
- Risk management actions (yellow)
- Avoid or assess further

The basis for the decision criteria and the recommended actions are provided in Section 3. Although this process is relatively simple, the number of repetitions required to evaluate each scenario makes this unsuitable for a purely manual process.

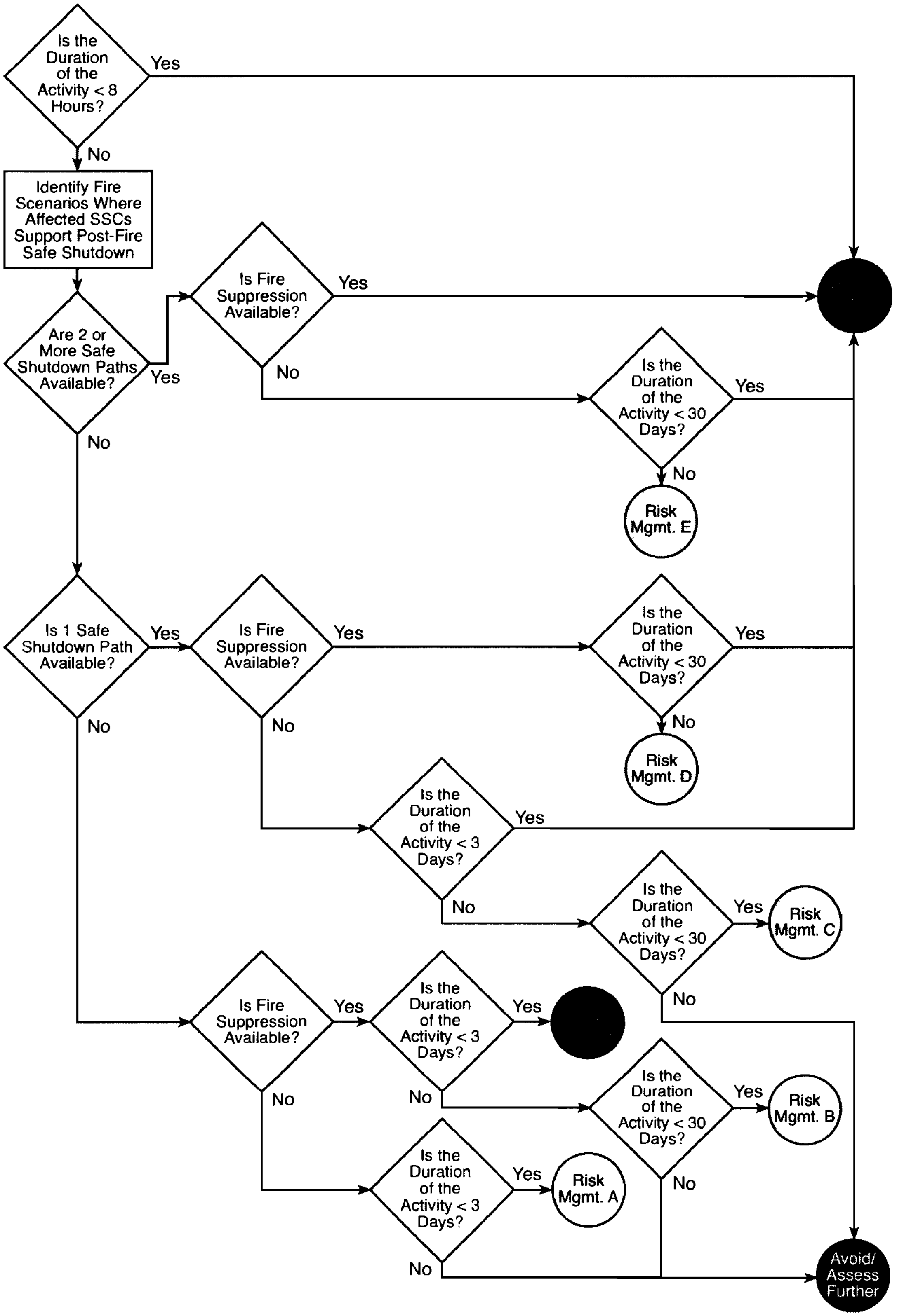


Figure 2-2
Process for Assessing Fire Risk Impacts of Maintenance Activities Flowchart

Risk Management Action Thresholds

The output of the fire risk impacts flowchart in Figure 2-2 is specific guidance that is divided into three categories. The first is to apply normal controls. The second option is a set of specific risk-management actions for the configuration in question. The most severe option is to either avoid the planned entrance into that configuration or perform more detailed quantitative analysis before entering the configuration.

Normal Controls

If the planned configuration falls into the normal controls category (those flowchart end states ending in green), no additional requirements beyond the normal (non-fire) at-power risk management controls are required. This corresponds to a low or minimal fire risk configuration.

Risk Management Actions – Increased Controls

If the planned configuration falls into the increased controls category (those flowchart end states ending in yellow), specific additional actions are required. The recommended actions are described in Table 2-1. This category corresponds to a moderate fire risk configuration, either due to the number of available success paths or the duration of the unavailability.

Avoid or Assess Further

If the planned configuration falls into the avoid or assess further category (the flowchart end state ending in red), then two choices are available. The first option is to simply avoid the planned configuration. However, if it is decided that avoidance is not the preferred solution, the configuration analyst needs to use additional tools to more fully understand the risk significance of the configuration. Any further analysis is beyond the scope of this report. These tools could include a more comprehensive quantitative analysis of the configuration.

Table 2-1
Fire Risk Management Matrix

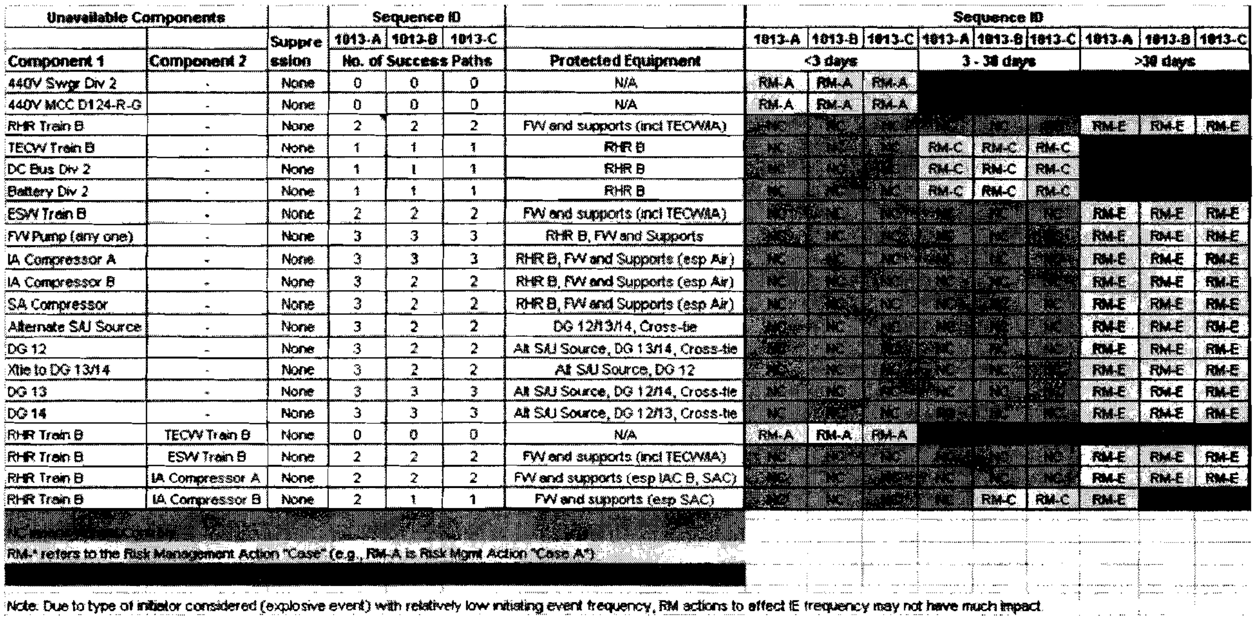
Risk Management Action	Case A	Case B	Case C	Case D	Case E
Increase awareness and reduce duration	Yes	Yes	Yes	Yes	Yes
Minimize magnitude of risk increase					
Reduce likelihood of initiators	Fire watch (1)	Fire watch (1)	Fire watch (2)	Fire watch (2)	Fire watch (3)
Improve/restore suppression	Fire watch (1) OR Restore suppression (4)	N/A (5) AND Protect fire suppression AND associated detection systems	Fire watch (2) OR Restore suppression	N/A (5) AND Protect fire suppression AND associated detection systems	Fire watch (3) OR Restore suppression AND/OR protect detection (6)
Protect redundant equipment	N/A, although an informed fire watch (1) can protect important equipment in fire area	N/A, although an informed fire watch (1) can protect important equipment in fire area	Yes	Yes	Yes
Establish alternate success paths	Yes	Yes	Yes	Yes	Evaluate (7)

1. Fire watches reduce the likelihood of fire. The fire watch should also be informed of important equipment in the space. If there is a fire, it is important to prevent the fire from impacting those critical components.
2. It is important for the fire watch to prevent a challenge to the plant (that is, prevent the fire that leads to a plant trip). Because there is still a success path available, it is less critical (but still important) to protect the equipment in the space where the fire is.
3. It is important for the fire watch to prevent a challenge to the plant, as in (2). However, since this configuration is relatively low risk (at least two success paths available), it may be able to provide adequate coverage with a roving or intermittent fire watch.
4. If the suppression system is restored (that is, available), this configuration would become a Case B configuration.
5. Fire suppression is available, so there is not much to improve. However, it would be prudent to protect the fire suppression (and associated detection) systems for the scenarios of concern.

6. If the area has a detection system, consider protecting the detection system since a continuous fire watch may not be stationed.
7. At least two success paths are available in this configuration. If success paths are reliable, there may be no significant benefit in establishing an alternate success path.

Example – Part 3

Figure 2-3 provides the results of the impact analysis for fire scenarios and configurations presented in parts 1 and 2 of this example. For each configuration of unavailable components (row), the table shows the number of remaining success paths for each of the three scenarios, the SSC representing the remaining success paths (protected equipment), and the results of the impact analysis for the three scenarios, considering three different time frames (less than 3 days, 3–30 days, and greater than 30 days).



Unavailable Components			Sequence ID				Sequence ID								
		Suppression	1013-A	1013-B	1013-C		1813-A	1813-B	1813-C	1813-A	1813-B	1813-C	1813-A	1813-B	1813-C
Component 1	Component 2		No. of Success Paths			Protected Equipment	<3 days			3 - 30 days			>30 days		
440V Swgr Div 2	-	None	0	0	0	N/A	RM-A	RM-A	RM-A						
440V MCC D124-R-G	-	None	0	0	0	N/A	RM-A	RM-A	RM-A						
RHR Train B	-	None	2	2	2	FW and supports (incl TECW/IA)	NC	NC	NC	NC	NC	NC	RM-E	RM-E	RM-E
TECW Train B	-	None	1	1	1	RHR B	NC	NC	NC	RM-C	RM-C	RM-C			
DC Bus Div 2	-	None	1	1	1	RHR B	NC	NC	NC	RM-C	RM-C	RM-C			
Battery Div 2	-	None	1	1	1	RHR B	NC	NC	NC	RM-C	RM-C	RM-C			
ESW Train B	-	None	2	2	2	FW and supports (incl TECW/IA)	NC	NC	NC	NC	NC	NC	RM-E	RM-E	RM-E
FW Pump (any one)	-	None	3	3	3	RHR B, FW and Supports	NC	NC	NC	NC	NC	NC	RM-E	RM-E	RM-E
IA Compressor A	-	None	3	3	3	RHR B, FW and Supports (esp Air)	NC	NC	NC	NC	NC	NC	RM-E	RM-E	RM-E
IA Compressor B	-	None	3	2	2	RHR B, FW and Supports (esp Air)	NC	NC	NC	NC	NC	NC	RM-E	RM-E	RM-E
SA Compressor	-	None	3	2	2	RHR B, FW and Supports (esp Air)	NC	NC	NC	NC	NC	NC	RM-E	RM-E	RM-E
Alternate S/U Source	-	None	3	2	2	DG 12/13/14, Cross-tie	NC	NC	NC	NC	NC	NC	RM-E	RM-E	RM-E
DG 12	-	None	3	2	2	Alt S/U Source, DG 13/14, Cross-tie	NC	NC	NC	NC	NC	NC	RM-E	RM-E	RM-E
Xtie to DG 13/14	-	None	3	2	2	Alt S/U Source, DG 12	NC	NC	NC	NC	NC	NC	RM-E	RM-E	RM-E
DG 13	-	None	3	3	3	Alt S/U Source, DG 12/14, Cross-tie	NC	NC	NC	NC	NC	NC	RM-E	RM-E	RM-E
DG 14	-	None	3	3	3	Alt S/U Source, DG 12/13, Cross-tie	NC	NC	NC	NC	NC	NC	RM-E	RM-E	RM-E
RHR Train B	TECW Train B	None	0	0	0	N/A	RM-A	RM-A	RM-A						
RHR Train B	ESW Train B	None	2	2	2	FW and supports (incl TECW/IA)	NC	NC	NC	NC	NC	NC	RM-E	RM-E	RM-E
RHR Train B	IA Compressor A	None	2	2	2	FW and supports (esp IAC B, SAC)	NC	NC	NC	NC	NC	NC	RM-E	RM-E	RM-E
RHR Train B	IA Compressor B	None	2	1	1	FW and supports (esp SAC)	NC	NC	NC	NC	RM-C	RM-C	RM-E		

NC [illegible] Config

RM-* refers to the Risk Management Action "Case" (e.g., RM-A is Risk Mgmt Action "Case A")

Note: Due to type of initiator considered (explosive event) with relatively low initiating event frequency, RM actions to affect IE frequency may not have much impact

Figure 2-3
Example Fire Configuration Risk Management Guidance Matrix

Methodology Summary

The methodology presented uses the existing fire risk model to identify configurations and scenarios of interest along with the availability of fire suppression capability and the number of success paths. This information is evaluated using an impact analysis (represented by a flow chart) that provides three categories of actions. Specific guidance is suggested for those configurations of moderate risk levels (indicated by yellow in this report).

3

METHODOLOGY BASIS

This section explains the basis for the methodology presented in Section 2.

Background

Existing fire protection programs identify safe shutdown paths for each postulated fire scenario. FPRAs typically expand the complement of equipment that can prevent core damage to include alternate success paths excluded from the design-basis events (for example, feed and bleed cooling for PWRs and containment venting for BWRs). Removing equipment from service affects the success paths available and reduces the ability to mitigate core damage. This, in turn, increases the conditional core damage probability (CCDP) in certain fire scenarios.

The core damage frequency (CDF) for a fire scenario can be represented by Equation 3-1.

$$CDFi = IEFi * NSPi * CCDPi \qquad \textbf{Eq. 3-1}$$

where,

CDFi = core damage frequency for scenario i

IEFi = fire initiating event frequency for scenario i

NSPi = non-suppression probability for scenario i

CCDPi = conditional core damage probability for scenario i

IEFi and NSPi include assessments of the physical damage from the fire and may implicitly include credit for fire barriers.

CCDPi includes credit for safe shutdown paths beyond those considered in 10 CFR 50 Appendix R.

$$Total\ Fire\ CDF = \sum CDFi \qquad \textbf{Eq. 3-2}$$

Assessing and Managing Fire Risks

Section 11.3.7.2 of Nuclear Management and Resources Council (NUMARC) 93-01, *Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants* [2] describes how the risk of maintenance activities can be addressed and managed to meet the requirements of 10CFR50.65(a)(4) [1]. Regulatory guide 1.182 [3] states that NUMARC 93-01 "...provides methods that are acceptable to the NRC staff for complying with the provisions of 10 CFR 50.65(a)(4)." In NUMARC 93-01, consideration is given to both the duration and magnitude of the increase in risk due to the maintenance configuration. This is typically accomplished by calculating incremental core damage probability (ICDP) and incremental large early release probability (ILERP).

$$ICDPi = CDFi \times Duration \qquad \textbf{Eq. 3-3}$$

Likewise, the ILERP is the product of the configuration-specific large, early-release frequency (LERF) and duration.

$$ILERPi = LERFi \times Duration \qquad \textbf{Eq. 3-4}$$

The specific guidance from NUMARC 93-01 is shown in Table 3-1. The proposed process for assessing fire risk during maintenance uses these criteria. Although the guidance in NUMARC 93-01 does not apply a color code to the three quantitative criteria, a typical industry approach using green, yellow, and red for progressively increasing relative risk is used in Table 3-1. The colors assigned to each category are consistent with the colors used in the examples in Section 2.

Table 3-1
NUMARC 93-01 Guidance

ICDP		ILERP
[illegible]	[illegible]	[illegible]
10E-6 to 10E-5	Assess non-quantifiable factors and establish risk management actions	10E-7 to 10E-6
[illegible]	[illegible]	[illegible]

Quantitative Perspectives

A typical fire initiating event frequency for an individual scenario is generally on the order of 1E-3 per year. For bounding design basis events, the frequencies can be lower than 1E-3. In general, most at-power maintenance activities on risk-significant equipment have durations of less than one week. Assuming that the maintenance resulted in no mitigation paths for a given scenario (that is, setting the CCDP to 1.0), the fire ICDP would be on the order of 1E-5. The ICDP will be lower if any mitigation (CCDP < 1.0) and/or suppression systems are available.

Fire suppression systems reduce the impact of the fire and can reduce the frequency of the scenario or the likelihood of core damage.

Using Equation 3-1, with the activity duration equal to one week and an initiating event frequency (IEF) of 1E-3 per year, the result is an ICDP of approximately 2E-5:

IEFi ~1E-3 per year

NSPi = 1 (assumed)

CCDPi = 1.0 (assume no mitigation)

$CDFi = IEFi \times NSPi * CCDPi \sim$ 1E-3 per year

Duration ~1 week ~0.02 years

$ICDPi = CDFi \times Duration \sim$ 2E-5

Based on the example above, it can be seen that reducing the duration to approximately three days (72 hours, a typical duration for technical specification equipment) would reduce the ICDP to less than or equal to about 1E-5. Additional reductions in the ICDP would result if mitigation equipment remained or suppression systems were available. Even a single success path with a conservative failure probability of 0.1 would result in a scenario ICDP of less than 1E-6 for a three-day maintenance duration.

Quasi-Quantitative Assessment

The above example suggests a method to evaluate fire configurations that can be described as quasi-quantitative. The results shown in Table 3-2 are based on Equation 3-1 and the general rules for assigning (conservative) quantitative values to the variables of concern.

These general rules are:

- Initiating event frequencies are approximately 1E-3 per year.
- Durations can be divided into time frames of less than 3 days (~0.01 year), 3–30 days (~0.1 year), or greater than 30 days (~1 year).
- The impact of fire suppression systems reduces the fire likelihood or impact by a factor of 10 (that is, non-suppression probability [NSP] ~0.1).
- The failure probability of one safe shutdown train is less than ~0.1, and the failure probability of two or more safe shutdown trains is less than ~0.01.

Table 3-2
Quantitative Roll-Up

<table>
<tr><th>Safe Shutdown Paths Available</th><th colspan="3">>1 Path
(Pf < 0.01)</th><th colspan="3">1 Path
(Pf ~ 0.1)</th><th colspan="3">None
(Pf = 1.0)</th></tr>
<tr><td>Duration</td><td>< 3d
(<0.01)</td><td>3-30d
(~0.1)</td><td>> 30d
(1.0)</td><td>< 3d
(<0.01)</td><td>3-30d
(~0.1)</td><td>> 30d
(1.0)</td><td>< 3d
(<0.01)</td><td>3-30d
(~0.1)</td><td>> 30d
(1.0)</td></tr>
<tr><td>No Suppression (Pf = 1)</td><td colspan="2">$<10^{-6}$
Normal Controls</td><td>10^{-6}- 10^{-5}
Risk Mgmt.</td><td>$<10^{-6}$
Normal Controls</td><td>10^{-6}- 10^{-5}
Risk Mgmt.</td><td>$>10^{-5}$
Avoid Config.</td><td>10^{-6}- 10^{-5}
Risk Mgmt.</td><td colspan="2">$>10^{-5}$
Avoid Configuration</td></tr>
<tr><td>Suppression Available (Pf < 0.1)</td><td colspan="3">$<10^{-6}$
Normal Controls</td><td colspan="2">$<10^{-6}$
Normal Controls</td><td>10^{-6}- 10^{-5}
Risk Mgmt.</td><td>$<10^{-6}$
Normal Controls</td><td>10^{-6}- 10^{-5}
Risk Mgmt.</td><td>$>10^{-5}$
Avoid Config.</td></tr>
</table>

By applying the criteria from Table 3-1, the numerical results in Table 3-2 can be converted to colors that indicate the relative risk and acceptability of the various scenarios. These results are presented in Table 3-3.

Table 3-3
Risk Management Categories

	Number of Safe Shutdown Paths Available								
	>1 Path			**1 Path**			**None**		
Duration	**< 3 days**	**3–30 days**	**> 30 days**	**< 3 days**	**3–30 days**	**> 30 days**	**< 3 days**	**3–30 days**	**> 30 days**
No Suppression	Normal controls		Risk management	Normal controls	Risk management	■	Risk management	■	■
Suppression Available	Normal controls			Normal controls		Risk management	Normal controls	Risk management	■

A flowchart (see Figure 2-2) was developed based on the results presented in Table 3-3. Note that an initial screen is completed based on activity durations of less than 8 hours. If the duration is less than 8 hours (~0.001 year), the ICDP can be considered low (less than about 1E-6).

Risk Management Action Thresholds

NUMARC 93-01, Section 11.3.7.3 [2] specifies three levels of risk management actions:

- Normal controls
- Risk management actions
- Configurations not normally entered voluntarily

Normal Controls

Normal controls would be employed for configurations having nominal risk significance. This means that the normal plant work control processes are followed for the maintenance activity and that no additional actions to address risk management are necessary.

Risk Management Actions – Increased Controls

Risk management actions should be considered for configurations that result in a minimal increase from the plant's baseline risk. These actions are aimed at providing an increased risk awareness of appropriate plant personnel, providing more rigorous planning and control of the activity, and taking measures to control the duration and magnitude of the increased risk. Examples of risk management actions are as follows:

- Increase risk awareness and control
- Reduce the duration of maintenance activity
- Minimize the magnitude of risk increase to:
  - Reduce the likelihood of initiators
  - Protect redundant equipment (both suppression systems and alternative success paths)
  - Establish alternate success paths

The recommended implementation of these actions is provided in Table 2-1. Note that the case assignments (A–E) in Table 2-1 refer to the different risk management end states in Figure 2-2.

Avoid or Assess Further

NUMARC 93-01 states: This final action threshold should be established such that risk significant configurations are not normally entered voluntarily. However, because our methods are only quasi-quantitative, it is appropriate to allow the end user to use more rigorous tools or methods to determine if significant conservatism can be removed to obtain acceptable results within the parameters of NUMARC 93-01 that would allow these configurations to be performed.

4

DEMONSTRATION APPLICATION

This section describes the results of a proof-of-concept evaluation that was completed using the proposed methodology. Some of the results from this evaluation are already provided in the example in Section 2. The complete scope of the proof-of-concept and the associated results are described here.

Scope and Background

In the proof-of-concept, a limited number of fire scenarios are evaluated for a dual-unit BWR with an FPRA. Four fire scenarios for Unit 1 are evaluated using the process described in Section 2. The results of the evaluation are compared against FPRA quantifications to check the correlation between the qualitative and quantitative evaluations. This methodology does not intend to reproduce the results of an FPRA, but intends to highlight configurations with relatively higher risk profiles and focuses on minimizing those risks.

The fire scenarios evaluated are listed in Table 4-1.

Table 4-1
List of Fire Scenarios

Scenario	Description
1013-A	Division 1 switchgear non-severe fire
1013-B	Division 1 switchgear, startup source (1 of 2) breaker severe fire
1020-A	Static inverter compartment, severe fire, loss of offsite power
1020-C	Static inverter compartment, severe fire, loss of offsite power

As described in Section 2, the plant success criteria are either:

- Feedwater (FW)
- Early injection and suppression pool cooling
- Early injection, venting, and CRD system injection

Scenario Evaluation and Success Paths

Each scenario is described with the remaining success paths. A list of the equipment unavailability/failure combinations is listed for each scenario. The lists are not exhaustive, but are intended to show the significant equipment combinations that would preclude a safe shutdown of the plant.

Scenario 1013-A

This scenario causes a complete loss of the Division 1 electrical switchgear and the Division 1 safe shutdown equipment. No suppression is credited for this scenario because the postulated explosive switchgear fire is assumed to progress too quickly for the suppression system to respond. Two success paths remain: the residual heat removal (RHR) from Train B (Division 2) and FW.

Based on the redundancy in the FW system (three pumps), it could be considered as two success paths. However, there are single-path vulnerabilities in the FW support systems, so it is only counted as a single success path. Support systems for FW are TECW, DC Division 2 and instrument/station air.

Table 4-2 provides the combinations of equipment failures/unavailability that will prevent safe shutdown for scenario 1013-A.

Table 4-2
Scenario 1013-A

	Equipment Failures	Unavailable Equipment
1	440V Switchgear Division 2	
2	440V MCC D124-R-G	
3	RHR Train B	FW (three pumps)
4	RHR Train B	TECW Train B
5	RHR Train B	Battery or DC Bus Division 2
6	RHR Train B	Instrument/station air (three air compressors)

Scenario 1013-B

This scenario is basically the same as 1013-A. It is a complete loss of the Division 1 electrical switchgear and the Division 1 safe shutdown equipment. Additionally, one startup source is lost. No suppression is credited for this scenario because the postulated explosive switchgear fire is assumed to progress too quickly for the suppression system to respond. Two success paths remain, RHR from Train B (Division 2) and FW.

The combinations of equipment failures/unavailability that will prevent safe shutdown are essentially the same as 1013-A, except that in combination 6, only instrument air compressor B is available. Additionally, the loss of a startup source with diesel generator (DG) 12 failure will preclude safe shutdown (combination 7).

For combination 7, it is possible to cross-tie to an available DG 13 or 14. However, this type of recovery action is conservatively not considered in the FPRA, although it is in the internal events PRA. For the purposes of this study, diesel cross-tie is not credited, although the success path is shown in brackets. During actual implementation, the analyst would need to determine whether this action can be credited as a normal success path or as an alternate success path as part of risk management actions.

Table 4-3 provides the combinations of equipment failures/unavailability that will prevent safe shutdown for scenario 1013-B.

Table 4-3
Scenario 1013-B

	Equipment Failures	Unavailable Equipment	Recovery Action
1	440V Switchgear Division 2		
2	440V MCC D124-R-G		
3	RHR Train B	FW (three pumps)	
4	RHR Train B	TECW Train B	
5	RHR Train B	Battery or DC bus Division 2	
6	RHR Train B	Instrument air compressor B and station air compressor	
7	Alternate startup source	DG 12	[Cross-tie to DG 13/14]

Scenario 1020-A

This scenario causes a loss of offsite power and a complete loss of the Division 1 and 3 electrical equipment. Passive suppression, in the form of cable wraps, is credited for this scenario in the FPRA. RHR from Train B (Division 2) is the only remaining success path.

Similar to combination 7 in scenario 1013-B, it is possible to cross-tie to an available DG or bus upon the failure of one diesel or bus. However, this type of recovery action is conservatively not considered in the FPRA, although it is in the internal events PRA. For the purposes of this study, diesel cross-tie is not credited, although the success path is shown in brackets. During actual implementation, the analyst would need to determine whether this action can be credited as a normal success path, or as an alternate success path, as a part of risk management actions.

Furthermore, an additional operator action could be considered, but is not in this example. The RHR heat exchange is dependent on both electrical buses in one division (for example, RHR B will fail if either DG 12 or DG 14 fails). An operator manual recovery of the valve could be considered, but is not because the action is outside the control room. Additional evaluation would need to be done to determine if this could be considered as a compensatory action.

Table 4-4 provides the combinations of equipment failures/unavailability that will prevent safe shutdown for scenario 1020-A.

Table 4-4
Scenario 1020-A

	Equipment Failures	Recovery Action
1	RHR Train B	
2	DG 12	[Cross-tie to DG 14]
3	Battery or DC Bus Division 2	[Cross-tie to Bus 14]
4	DG 14	[Cross-tie to DG 12]
5	Battery or DC Bus Division 4	[Cross-tie to Bus 12]

Scenario 1020-C

This scenario causes a loss of offsite power with no substantial electrical equipment failures. Both trains of RHR are available as success paths.

As in previous scenarios, it is possible to cross-tie to an available DG or bus upon the failure of one diesel or bus. For the purposes of this study, diesel cross-tie is not credited, although the success path is shown in brackets.

Table 4-5 provides the combinations of equipment failures/unavailability that will prevent safe shutdown for scenario 1020-C.

Table 4-5
Scenario 1020-C

	Equipment Failures	Unavailable Equipment	Recovery Action
1	RHR Train A	RHR Train B	
2	RHR Train A	DG 12	[Cross tie to DG 14]
3	RHR Train A	DG 14	[Cross tie to DG 12]
4	RHR Train B	DG 11	[Cross tie to DG 13]
5	RHR Train B	DG 13	[Cross tie to DG 11]
6	DG 11	DG 14	[Cross tie to DG 12/13]
7	DG 11	DG 12	[Cross tie to DG 13/14]
8	DG 12	DG 13	[Cross tie to DG 11/14]
9	DG 13	DG 14	[Cross tie to DG 11/12]

Success Paths for Sample Configurations

Eight hypothetical configurations are proposed in order to test the method for the scenarios in this study. Each configuration has one or two unavailable SSCs. Based on the configuration, the remaining success paths were determined for each scenario. The results provided Table 4-6 show the unavailable SSCs with the number of success paths available for each scenario. The availability of suppression is also noted. In the cases where the unavailable equipment has no impact on the scenario, NA is entered. This indicates that no further analysis for that scenario is required.

Table 4-6
Success Paths Available

	Scenario	1013-A	1013-B	1020-A	1020-C
	Suppression?	**No**	**No**	**Yes**	**No**
RHR Train A	–	NA	NA	NA	1
RHR Train B	–	1	1	0	1
TECW Train B	–	1	1	NA	NA
RHR Train B	TECW Train B	0	0	0	1
IA Compressor B	–	2	2	NA	NA
RHR Train B	IA Compressor B	1	1	0	1
DG 12	–	NA	1	0	1
HPCI	–	NA	NA	NA	NA

Risk Assessment for Sample Configurations

Once the success paths have been defined, the process flow chart in Figure 2-2 is used to assess the risk impact and determine the set of risk management actions that should be taken for each combination of unavailable SSCs and fire scenarios. Tables 4-7 through 4-9 show the results of the assessment for time frames of less than 3 days, 3–30 days, and greater than 30 days.

The risk management actions are coded as follows:

- NC (green) – Normal controls. Equivalent to ICDP less than ~1E-6.
- RM-A through RM-E (yellow) – Risk management actions required, where the letter (A through E) indicates the specific risk management actions shown in Table 2-1 and determined by the end state in Figure 2-2. Equivalent to ICDP between ~1E-6 and ~1E-5.
- Avoid (red) – Avoid entry into configuration or assess configuration further. Equivalent to ICDP greater than ~1E-5

Table 4-7
Risk Assessment for Less Than Three Days

	Scenario	**1013-A**	**1013-B**	**1020-A**	**1020-C**
	Suppression?	**No**	**No**	**Yes (a)**	**No**
RHR Train A	–	░	░	░	▓
RHR Train B	–	▓	▓	▓	▓
TECW Train B	–	▓	▓	░	░
RHR Train B	TECW Train B	RM-A	RM-A	▓	▓
IA Compressor B	–	▓	▓	░	░
RHR Train B	IA Compressor B	▓	▓	▓	▓
DG 12	–	░	▓	▓	▓
HPCI	–	░	░	░	░

Table 4-8
Risk Assessment for 3–30 Days

	Scenario	1013-A	1013-B	1020-A	1020-C
	Suppression?	No	No	Yes (a)	No
RHR Train A	–	▨	▨	▨	RM-C
RHR Train B	–	RM-C	RM-C	RM-B	RM-C
TECW Train B	–	RM-C	RM-C	▨	▨
RHR Train B	TECW Train B	■	■	RM-B	RM-B
IA Compressor B	–	NC	NC	▨	▨
RHR Train B	IA Compressor B	RM-C	RM-C	RM-B	RM-C
DG 12	–	▨	RM-C	RM-B	RM-C
HPCI	–	▨	▨	▨	▨

Table 4-9
Risk Assessment for Greater Than 30 Days

	Scenario	1013-A	1013-B	1020-A	1020-C
	Suppression?	No	No	Yes (a)	No
RHR Train A	–	▨	▨	▨	■
RHR Train B	–	■	■	■	■
TECW Train B	–	■	■	▨	▨
RHR Train B	TECW Train B	■	■	■	■
IA Compressor B	–	RM-E	RM-E	▨	▨
RHR Train B	IA Compressor B	■	■	■	■
DG 12	–	▨	■	■	■
HPCI	–	▨	▨	▨	▨

The results generally follow a pattern that is expected. For configurations of less than 3 days, normal controls are generally adequate except when multiple systems are unavailable, which result in no success paths for a given scenario. Once the configuration lasts for more than 3 days, risk management actions are generally required, except for configurations where no success paths are available (avoid), or where the number of success paths available is two or more (normal controls). Configurations that last more than 30 days should generally be avoided unless there is more than one remaining success path.

Comparison with Quantified Results

The four fire scenarios were quantified using the FPRA for the eight configurations evaluated for this study. This was done to compare the quantified ICDP with the results obtained using this proposed methodology.

The FPRA results are shown in Tables 4-10 through 4-13. The first table shows the increase in CDF (per year) for each scenario due to the specific configuration.

Table 4-10
Scenario Increase in Core Damage Frequency

		Delta CDF (per year)			
	Scenario	**1013-A**	**1013-B**	**1020-A**	**1020-C**
RHR Train A	–	▨	▨	▨	1.9E-05
RHR Train B	–	1.7E-05	1.2E-05	2.2E-07	1.9E-05
TECW Train B	–	9.1E-06	4.6E-06	▨	▨
RHR Train B	TECW Train B	6.3E-04	3.1E-04	2.2E-07	1.9E-05
IA Compressor B	–	6.6E-08	3.8E-07	▨	▨
RHR Train B	IA Compressor B	2.1E-05	3.8E-05	2.2E-07	1.9E-05
DG 12	–	▨	2.7E-07	2.2E-07	4.3E-06
HPCI	–	▨	▨	▨	▨

Table 4-11 shows the ICDP for each scenario if the duration of the configuration is 8 hours. If the duration is less than 8 hours, the method allows the scenario to be screened. This table shows that for these scenarios and configurations, the ICDP for 8 hours is less than 1E-6. Scenario 1013-A, with RHR B and TECW B unavailable, is close to 1E-6. In this case, there are no success paths available, so the CCDP should be equal to 1.0, and the CDF would be equal to the IEF. A review of the quantified results confirms this. If the scenario IEF were greater than 1E-3 per year, then the ICDP would be greater than 1E-6. If the IEF is significantly greater than 1E-3, it might require special treatment.

Table 4-11
Scenario ICDP for 8-Hour Configuration

		ICDP at 8 Hours			
	Scenario	**1013-A**	**1013-B**	**1020-A**	**1020-C**
RHR Train A	–	▨	▨	▨	2E-08
RHR Train B	–	2E-08	1E-08	2E-10	2E-08
TECW Train B	–	8E-09	4E-09	▨	▨
RHR Train B	TECW Train B	6E-07	3E-07	2E-10	2E-08
IA Compressor B	–	6E-11	3E-10	▨	▨
RHR Train B	IA Compressor B	2E-08	3E-08	2E-10	2E-08
DG 12	–	▨	3E-10	2E-10	4E-09
HPCI	–	▨	▨	▨	▨

For each scenario, Tables 4-12 and 4-13 show the number of days that the configuration would need to exist before reaching an ICDP of 1E-6 and 1E-5, respectively. These values are useful to compare with the risk assessment results provided in Tables 4-7 through 4-9. Ideally, the method should require risk management actions to be established for cases where the ICDP exceeds 1E-6 within a time frame (less than 3 days, 3–30 days, and greater than 30 days).

For example, it takes about one day for the ICDP of scenarios 1013-A and 1013-B to reach 1E-6 when RHR Train B and TECW Train B are unavailable. This corresponds to the time period of less than three days. From Table 4-7 it can be seen that risk management actions are suggested.

For all other cases in Table 4-12, the ICDP threshold of 1E-6 is not reached until greater than three days, and in some cases, greater than one year. Comparing the time frames with Tables 4-8 and 4-9, it can be seen that the method is generally conservative in assigning risk management actions. For example, scenario 1020-A requires risk management actions if RHR Train B is unavailable for 3–30 days, yet it takes more than one year to reach 1E-6.

Table 4-12
Scenario Duration for ICDP of 1E-6

		Days to ICDP = 1E-6			
	Scenario	**1013-A**	**1013-B**	**1020-A**	**1020-C**
RHR Train A	–	▨	▨	▨	19
RHR Train B	–	22	30	> 365	19
TECW Train B	–	40	80	▨	▨
RHR Train B	TECW Train B	0.6	1.2	> 365	19
IA Compressor B	–	> 365	> 365	▨	▨
RHR Train B	IA Compressor B	17	10	> 365	19
DG 12	–	▨	> 365	> 365	85
HPCI	–	▨	▨	▨	▨

Table 4-13 shows the number of days before ICDP reaches 1E-5, the threshold at which the configuration should be avoided or evaluated in greater detail. Again, comparing the time frames with the results in Tables 4-8 and 4-9, the method is generally conservative in assigning red (avoid) end states.

Table 4-13
Scenario Duration for ICDP of 1E-5

		Days to ICDP = 1E-5			
	Scenario	**1013-A**	**1013-B**	**1020-A**	**1020-C**
RHR Train A	–	▨	▨	▨	193
RHR Train B	–	220	297	> 365	194
TECW Train B	–	> 365	> 365	▨	▨
RHR Train B	TECW Train B	6	12	> 365	193
IA Compressor B	–	> 365	> 365	▨	▨
RHR Train B	IA Compressor B	172	97	> 365	192
DG 12	–	▨	> 365	> 365	> 365
HPCI	–	▨	▨	▨	▨

5

APPLICATION TO RISK-INFORMED COMPLETION TIMES

The methodology developed in this report can be used to support the calculation of risk-informed completion times (RICTs) to support Nuclear Energy Institute (NEI) Initiative 4B, "Risk Managed Technical Specifications." The RICT bases and calculation methods are provided in *Risk-Managed Technical Specifications (RMTS) Guidelines: Technical Update to EPRI Interim Development Report 1002965* (EPRI report 1009674) [4]. These guidelines provide processes for supporting maintenance beyond the front-stop in cases where the plant does not have an external event (such as fire) PRA. There are three ways to address external events in the RMTS Guidelines. This section describes how the proposed methodology can be used to address two of the guidelines:

- "...provide a reasonable technical argument that the configuration risk of interest is dominated by internal events..."
- "...perform a reasonable bounding analysis of the...contribution to configuration risk and apply this upper bound external events risk contribution along with the internal events contribution in calculating the configuration risk and the associated RICT..."

Additionally, this report (see Table 2-1) provides risk mitigation and contingency actions that support the third RMTS guideline, "to provide a reasonable technical argument that internal fire events are an insignificant contributor to configuration risk."

Configuration Risk Dominated by Internal Events

The output of the methodology described in this report includes specified normal controls end states. These green end states are configurations in which fire scenario ICDP and ILERP are less than 1E-6 and 1E-7, respectively. Tables 3-2 and 3-3 provide the details for the various combinations of available shutdown paths, suppression availability, and duration. In the case of ICDP, all of the combinations that specify normal controls are less than 1E-6. Some may be substantially less than 1E-6. For example, with one safe shutdown path (0.1) and suppression available (0.1), the ICDP for a configuration less than 3 days (0.01) is less than 1E-7 (recall from Section 3 that the IE frequency is assumed to be 1E-3 per year).

RICT is calculated based on not exceeding an ICDP of 1E-5. If the fire results using the methodology specify normal controls (green) for the RICT, calculated using the internal events PRA, then the ICDP from fire is estimated to be less than 10% of the internal events ICDP for configuration durations up to the RICT. This means that the configuration risk is dominated by internal events and fire can be considered an insignificant contributor to the configuration risk.

This conclusion can also be shown in terms of the instantaneous risk (for example, CDF) from internal and fire events. Starting with a RICT that is calculated from the internal events incremental core damage frequency (ICDF), the estimated fire ICDF is shown to be less than 10% of the internal events ICDF for all cases where the fire methodology end state is normal controls (green). Tables 5-1 and 5-2 show the internal events ICDF for a range of RICT and the bounding fire ICDF for the duration of the RICT, given that the fire end state is green. Table 5-1 assumes that no suppression is available, and Table 5-2 takes into account the affect of suppression on ICDF (0.1). In each table, a separate calculation is performed based on the number of available safe shutdown paths. The total ratio of the fire ICDF to total ICDF (fire + internal events) is provided to show the range of fire risk contribution for the green end state.

Table 5-1
Fire Versus Internal ICDF with No Suppression

Internal Events RICT		Internal Events ICDF	Bounding Fire CDF			Ratio of Fire CDF to Total CDF at RICT Limit		
Days	**Hours**	**at 1E-5 ICDP**	**> 1 SD Path**	**1 SD Path**	**0 SD Paths**	**> 1 SD Path**	**1 SD Path**	**0 SD Paths**
0.33	8	1.1E-02	1E-05	1E-04	NA (1)	0%	1%	NA (1)
1	24	3.7E-03	1E-05	1E-04	NA (1)	0%	3%	NA (1)
2	48	1.8E-03	1E-05	1E-04	NA (1)	1%	5%	NA (1)
3	72	1.2E-03	1E-05	1E-04	NA (1)	1%	8%	NA (1)
5	120	7.3E-04	1E-05	NA (1)	NA (1)	1%	NA (1)	NA (1)
7	168	5.2E-04	1E-05	NA (1)	NA (1)	2%	NA (1)	NA (1)
10	240	3.7E-04	1E-05	NA (1)	NA (1)	3%	NA (1)	NA (1)
14	336	2.6E-04	1E-05	NA (1)	NA (1)	4%	NA (1)	NA (1)
21	504	1.7E-04	1E-05	NA (1)	NA (1)	5%	NA (1)	NA (1)
28	672	1.3E-04	1E-05	NA (1)	NA (1)	7%	NA (1)	NA (1)
31	744	1.2E-04	NA (1)	NA (1)	NA (1)	NA (1)	NA (1)	NA (1)

Note: (1) It is not possible to be green (fire ICDP < 1E-6) with this combination of available shutdown paths, duration, and no suppression.

Based on the results provided in Tables 5-1 and 5-2, the RICT is not modified based on fire risk because the internal events risk is shown to be dominant. For internal events with an RICT of less than 8 hours, the internal events ICDF is greater than 1E-2. Even in the worst case, (that is, no safe shutdown paths or suppression) the fire risk is expected to be less than 1E-3. This is the value assumed for the initiating event frequency in Section 3. Therefore, the internal events risk is considered to dominate the risk for RICT less than 8 hours.

Table 5-2
Fire Versus Internal ICDF with Suppression Available

Internal Events RICT		Internal Events ICDF	Bounding Fire CDF			Ratio of Fire CDF to Total CDF at RICT Limit		
Days	**Hours**	**at 1E-5 ICDP**	**> 1 SD Path**	**1 SD Path**	**0 SD Paths**	**> 1 SD Path**	**1 SD Path**	**0 SD Paths**
0.33	8	1.1E-02	1E-06	1E-05	1E-04	0%	0%	1%
1	24	3.7E-03	1E-06	1E-05	1E-04	0%	0%	3%
2	48	1.8E-03	1E-06	1E-05	1E-04	0%	1%	5%
3	72	1.2E-03	1E-06	1E-05	1E-04	0%	1%	8%
5	120	7.3E-04	1E-06	1E-05	NA (1)	0%	1%	NA (1)
7	168	5.2E-04	1E-06	1E-05	NA (1)	0%	2%	NA (1)
10	240	3.7E-04	1E-06	1E-05	NA (1)	0%	3%	NA (1)
14	336	2.6E-04	1E-06	1E-05	NA (1)	0%	4%	NA (1)
21	504	1.7E-04	1E-06	1E-05	NA (1)	1%	5%	NA (1)
28	672	1.3E-04	1E-06	1E-05	NA (1)	1%	7%	NA (1)
31	744	1.2E-04	1E-06	NA (1)	NA (1)	1%	NA (1)	NA (1)

Note: (1) It is not possible to be green (fire ICDP < 1E-6) with this combination of available shutdown paths, duration, and available suppression.

Incorporating Results of Bounding Fire Risk Analysis in Risk-Informed Completion Times

The two other end state results provided by this methodology are:

- Risk management actions (yellow) – The ICDP is between 1E-6 and 1E-5. If the fire results specify risk management actions (yellow) for the duration of the RICT calculated using the internal events PRA, then the ICDP from fire is on the order of the internal events ICDP. Therefore, the fire risk can be a significant contributor to the configuration risk and cannot be neglected in the calculation of the RICT. The RICT calculation, taking into account fire risk, is provided in the next subsection and in the subsequent table and graphs.
- Avoid or assess further (red) – The ICDP is greater than 1E-5. If the fire risk is greater than 1E-5 for the duration of the RICT calculated using the internal events PRA, then the fire risk would preclude using that RICT. In these cases, the duration of the configuration should be reduced to establish a green or yellow result.

Calculating a New Risk-Informed Completion Time

In order to calculate the new RICT that incorporates both internal and fire events risk, the total ICDF is needed. Similar to the calculations for the green configurations, the fire ICDF is estimated from Tables 3-2 and 3-3, based on the duration provided by the internal events RICT. Given the suppression availability status, there is no more than one yellow end state per duration category. Therefore, the Table 5-3 is considerably more simple than the tables needed for the green end state.

Table 5-3 shows the new RICT that is determined based on an ICDP of 1E-5 and an ICDF that is the sum of the internal and fire events. The reduction in time from the new RICT to the original, internal events RICT is also shown in the table. Figures 5-1 and 5-2 provide a curve that can be used to determine the new RICT, given the internal events RICT and a yellow fire end state. A separate curve is provided for RICT less than 3 days and for RICT between 3–30 days. Beyond 30 days, the RMTS back-stop of 30 days applies, so calculating a new RICT is moot. Table 5-3 shows the new value for comparison between fire risk and internal events risk only.

Table 5-3
RICT Calculation Incorporating Fire Risk

Internal Events RICT		**Internal Events**	**Bounding Fire CDF**		**New RICT (Hours)**	**RICT Reduction**
Days	**Hours**	**ICDF at 1E-5 ICDP**	**No Suppression**	**With Suppression**	**All Cases**	**From Internal Events RICT**
0.33	8	1.1E-02	1E-03	NA (1)	7	8%
1	24	3.7E-03	1E-03	NA (1)	19	22%
2	48	1.8E-03	1E-03	NA (1)	31	35%
3	72	1.2E-03	1E-03	NA (1)	40	45%
5	120	7.3E-04	1E-04	1E-04	110	8%
7	168	5.2E-04	1E-04	1E-04	140	17%
10	240	3.7E-04	1E-04	1E-04	190	21%
14	336	2.6E-04	1E-04	1E-04	240	29%
21	504	1.7E-04	1E-04	1E-04	320	37%
28	672	1.3E-04	1E-04	1E-04	380	43%
31	744	1.2E-04	1E-05	1E-05	690	7%

Note: (1) It is not possible to be yellow (fire ICDP between 1E-6–1E-5) with a duration less than three days and available suppression.

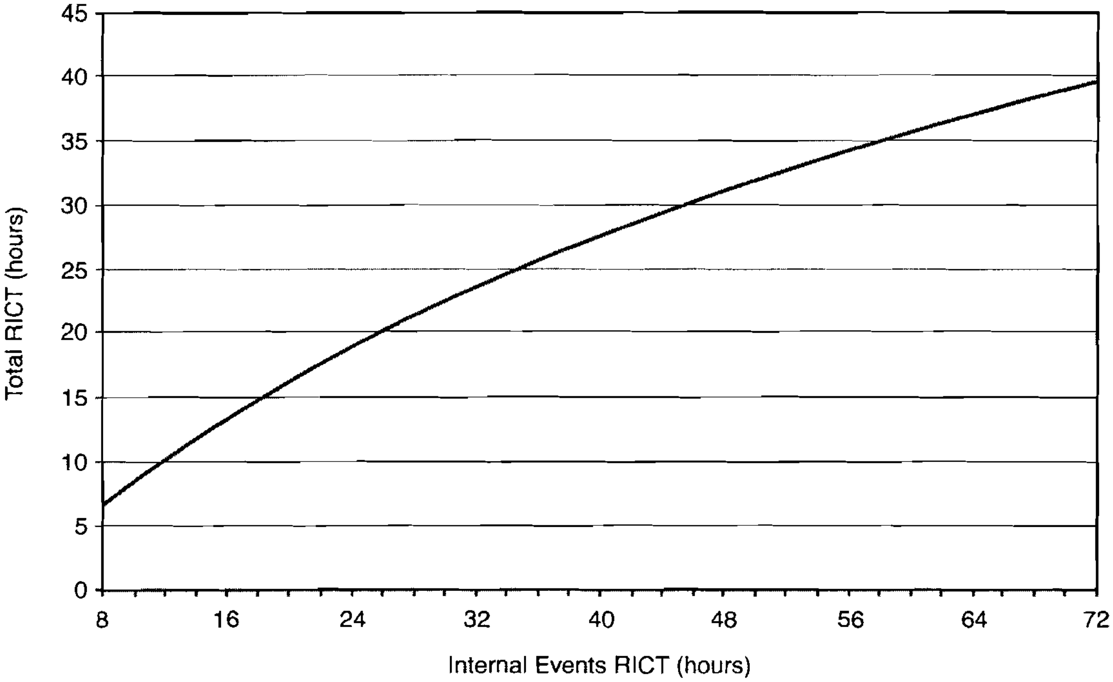


Figure 5-1
New RICT Curve – Internal Event RICT Less Than Three Days

Summary of Risk-Informed Completion Time Application

This section has provided a process by which the fire methodology developed in this report can be used to support implementation of the RMTS Guidelines [4] without the use of an FPRA. The input to the process is: 1) the RICT calculated from the internal events PRA and 2) the end state result from the methodology (that is, the color). Given these inputs, the following apply:

- Green fire result – The fire risk is insignificant compared to the internal events risk. Use the internal events RICT.
- Yellow fire result – The fire risk is estimated to be on the same order as the internal events risk. Recalculate the RICT, taking into account the fire risk as shown in Table 5-3 and Figures 5-1 and 5-2. The new RICT may be reduced by a few percent to nearly 50% of the internal events RICT.
- Red fire result – The fire risk is estimated to be above the threshold of 1E-5 ICDP. The RICT cannot be used. A new RICT must be proposed that meets the yellow or green end state.

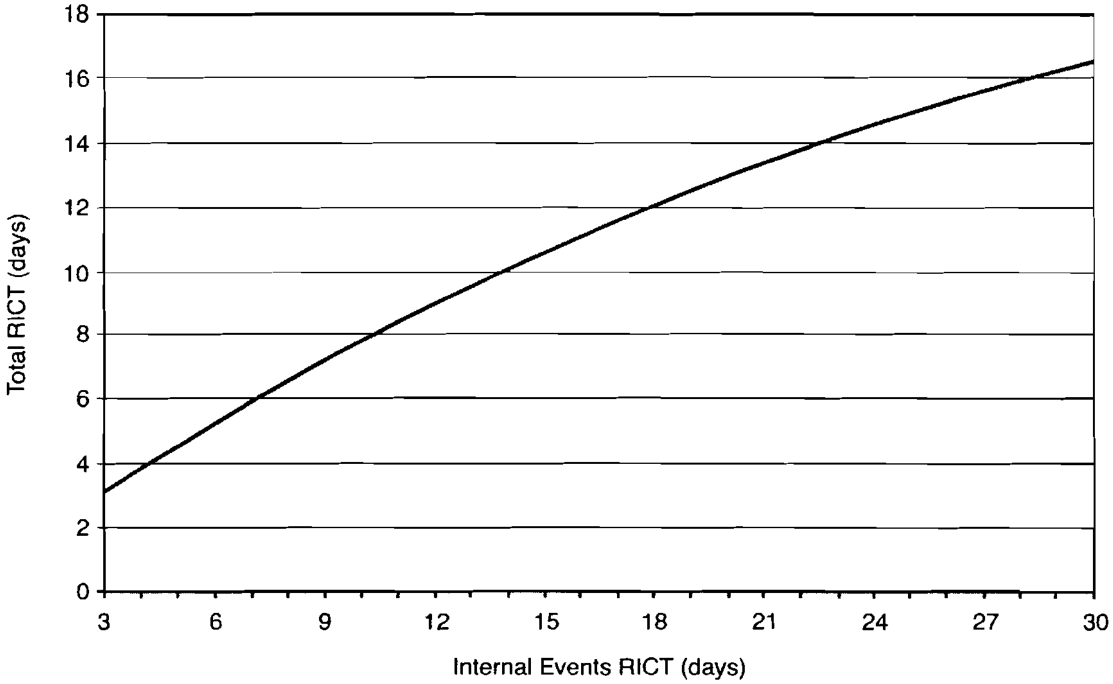


Figure 5-2
New RICT Curve – Internal Event RICT Between 3–30 Days

6
CONCLUSIONS

This report provides a non-quantitative methodology for evaluating fire risk associated with unavailability of equipment due to on-line maintenance. The methodology is focused on the risk associated with configurations due to the unavailability of fire suppression and fire scenario mitigation equipment. The methodology is currently limited to configurations during at-power conditions for internal events and considers the risk associated with core damage. It does not directly address the risk of large early release. This methodology is generally consistent with the guidance supplied by NUMARC 93-01 [2], and is based on quasi-quantitative evaluations, such as the bounding order of magnitude estimates of likelihood.

The methodology does not directly address maintenance activities that increase the likelihood of a fire or have the potential to cause a fire, such as hotwork or increased combustible material loading. Maintenance affecting fire-barrier integrity is also not explicitly evaluated. Hotwork, combustible material loading, and fire barriers are controlled by plant procedures and processes that are considered adequate to manage the impact of those activities. Also, since most existing models do not model fire detection equipment explicitly, the methodology presented here does not include extensive consideration of detection equipment.

Some limitations or potential challenges to this methodology are:

- Fire scenarios with initiating event frequencies much greater than 1E-3 per year
- Equipment unavailability that results in multiple fire scenarios with an increased ICDP

Recommended risk management actions are provided. A large portion of the risk management strategy involves fire watches. The effectiveness of these compensatory actions are based on the competence, training, and specific instructions given to the fire watches. The quantitative impact on risk associated with stationing fire watches is not evaluated.

This methodology builds on the utilities' existing fire models and their current CRM practices for tracking equipment availability. For this fire CRM methodology, the utilities will need to track both fire suppression systems and systems required for safe shutdown. In return, the methodology supplies insights on which safe shutdown capabilities are impacted. It identifies the limiting number of safe shutdown paths for the current configuration and supplies guidance for tracking and control of the duration of the configurations. This is all done without the need to quantify an FPRA.

A case study was completed by applying the methodology to a limited set of fire scenarios at a BWR unit. Four fire scenarios were evaluated assuming eight hypothetical configurations with one or two risk-significant SSCs unavailable. Risk assessments were performed for three time frames (less than 3 days, 3–30 days and greater than 30 days). The results obtained using the methodology are compared with quantitative results using the FPRA. The results were well correlated between the methodology and the quantitative results.

The case study demonstrated that considerable resources would be required to establish the assessment tables for all of the important fire areas in a plant. This level of effort would depend on the sophistication of existing fire risk analyses at the plant. The largest potential resource commitment is the determination of cable locations, if this is not already documented. The level of effort is significantly less than that required for an FPRA, and most of the effort would be directly applicable to the development of a subsequent FPRA.

Lastly, the methodology is applied to the RMTS guideline to account for external events (fire, in this case) in the calculation of RICT.

7

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A
ABBREVIATIONS AND ACRONYMS

BWR	Boiling water reactor
CCDP	Conditional core damage probability
CDF	Core damage frequency
CRD	Control rod drive
CRM	Configuration risk management
DG	Diesel generator
FIVE	Fire-Induced Vulnerability Evaluation
FPRA	Fire probabilistic risk assessment
FRA	Fire risk analysis
FW	Feedwater
HPCI	High-pressure coolant injection
IA	Instrument air
ICDF	Incremental core damage frequency
ICDP	Incremental core damage probability
IEF	Initiating event frequency
ILERP	Incremental large early release probability
IPE	Individual plant examination
MCR	Main control room
NEI	Nuclear Energy Institute
NPP	Nuclear power plant
NRC	Nuclear Regulatory Commission
NSP	Non-suppression probability

PRA	Probabilistic risk assessment
RHR	Residual heat removal
RICT	Risk-informed completion time
SDP	Significance determination process
SSC	Systems, structures, and components
TECW	Turbine enclosure cooling water

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