March 4, 2008

TSTF-08-05
PROJ0753

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

SUBJECT: TSTF-506, Revision 0, "Revise Primary Containment and Drywell Hydrogen Igniter Specification to Not Require Recombiners"

Dear Sir or Madam:

Enclosed for NRC review is Revision 0 of TSTF-506, "Revise Primary Containment and Drywell Hydrogen Igniter Specification to Not Require Recombiners."

Any NRC review fees associated with the review of TSTF-506 should be billed to the Boiling Water Reactor Owners Group.

The TSTF requests that the Traveler be made available under the Consolidated Line Item Improvement Process.

Should you have any questions, please do not hesitate to contact us.

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Enclosure

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Technical Specification Task Force
Improved Standard Technical Specifications Change Traveler

Revise Primary Containment and Drywell Hydrogen Igniter Specification to Not Require Recombiners

NUREGs Affected: ☐ 1430 ☐ 1431 ☐ 1432 ☐ 1433 ☑ 1434

Classification: 1) Technical Change

Recommended for CLIIP?: Yes

Correction or Improvement: Improvement

NRC Fee Status: Not Exempt

Benefit: Prevents Unnecessary Actions

Industry Contact: John Messina, (330) 384-5878, jmessina@firstenergycorp.com

See attached.

Revision History

OG Revision 0 Revision Status: Active

Revision Proposed by: CGARI Committee

Revision Description:
Original Issue

Owners Group Review Information

Date Originated by OG: 31-Jan-08

Owners Group Comments
(No Comments)

Owners Group Resolution: Approved Date: 15-Feb-08

TSTF Review Information

TSTF Received Date: 19-Feb-08 Date Distributed for Review 19-Feb-08

OG Review Completed: ☑ BWOG ☑ WOG ☑ CEOG ☑ BWROG

TSTF Comments:
(No Comments)

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NRC Review Information

NRC Received Date: 04-Mar-08

Affected Technical Specifications

Action 3.6.3.1.B Primary Containment and Drywell Hydrogen Igniters

Action 3.6.3.1.B Bases Primary Containment and Drywell Hydrogen Igniters

1.0 Description

The Nuclear Regulatory Commission (NRC) has revised 10 CFR 50.44 to amend its standards for combustible gas control in light-water-cooled power reactors. The Commission eliminated the design basis loss of coolant accident (LOCA) hydrogen release from 50.44 and consolidated the requirements for hydrogen and oxygen monitoring into 50.44, while relaxing safety classifications and licensee commitments to certain design and qualification criteria. TSTF-447, "Elimination of Hydrogen Recombiners and Change to Hydrogen and Oxygen Monitors," implemented a number of the Technical Specification (TS) changes resulting from this rule change. Specifically, TSTF-447 provided model changes to permit the NRC to efficiently process amendments to remove requirements for hydrogen recombiners, and hydrogen and oxygen monitors from TS. TSTF-447 was approved for adoption using the Consolidated Line Item Improvement Process (CLIIP) on September 25, 2003, and many Boiling Water Reactor (BWR) units have submitted TS changes to adopt the TSTF.

Subsequently, TSTF-478, Revision 2, has implemented additional Technical Specification changes for BWRs including elimination of Containment Atmosphere Dilution (CAD) Systems and has corrected inconsistencies between the revised 50.44 rule and the BWR Improved Technical Specifications (ISTS) for Drywell Cooling System Fans and Drywell Purge System. TSTF-478 was approved for adoption using the Consolidated Line Item Improvement Process (CLIIP) on November 21, 2007.

An additional inconsistency still remains between the revised 50.44 rule and the BWR Improved Standard Technical Specifications (ISTS). Namely, BWR/6 Specification 3.6.3.1, Primary Containment and Drywell Hydrogen Igniters, contains Required Actions to "Verify by administrative means that the hydrogen control function is maintained." The alternate hydrogen control function for BWR 6 designs is described in the TS Bases as the hydrogen recombiners. This alternate hydrogen control function was originally designed for the design basis LOCA hydrogen release, which has been eliminated by the 10 CFR 50.44 rule change. In contrast, the function of the hydrogen igniters is to control a large hydrogen release from a beyond design basis degraded core event. The recombiners are basically ineffective as a backup to the hydrogen igniters in controlling the large release from the degraded core event.. When the design basis LOCA hydrogen release was eliminated by the 10 CFR 50.44 rule change, the TS requirements for the design basis hydrogen control function (i.e., the recombiners) were also eliminated by TSTF-447. However, the link to the design basis LOCA hydrogen release in the igniter TS Actions was not recognized and the igniter TS was not revised by TSTF-447.

Therefore, this Traveler corrects the ISTS by eliminating the subject alternate hydrogen control function. In addition to correcting the inconsistency with 10CFR50.44, this Traveler proposes to reduce the time allowed for both divisions of hydrogen igniters to be out of service from seven (7) days to 48 hours as a risk improvement for severe accident concerns. A technical analysis is included as Attachment A which demonstrates the risk improvement that is provided by the proposed change.

2.0 Proposed Change

NUREG-1434, TS 3.6.3.1, "Primary Containment and Drywell Hydrogen Igniters," is revised to eliminate Required Action B.1 and change the Completion Time for two inoperable divisions of hydrogen igniters from 7 days to 48 hours. The subsequent Required Action (B.2) is renumbered. The Bases are revised to reflect this change and changes needed to maintain consistency with the 50.44 rule.

3.0 Background

In the revised 10 CFR 50.44 rule, the Commission eliminated the requirements for hydrogen recombiners and hydrogen purge systems, and relaxed the requirements for hydrogen and oxygen monitoring equipment to make them commensurate with their risk significance. Installation of hydrogen recombiners and/or vent and purge systems originally required by 50.44(b)(3) was intended to address the limited quantity and rate of hydrogen generation that was postulated from a design basis LOCA. In the basis for the rule change, the Commission found that this hydrogen release is not risk significant because the design basis LOCA hydrogen release does not contribute to the conditional probability of a large release during the first 24 hours after the onset of core damage. In addition, the Commission found that these systems were ineffective at mitigating hydrogen releases from risk significant accident sequences that could threaten containment integrity. The Commission noted that the regulatory analysis for the rulemaking found the cost of maintaining the recombiners exceeded the benefits of retaining them to prevent containment failure sequences that only progress in the very late time frame.

While the rule change was broad in its implications, the TS changes that were approved by the NRC (TSTF-447) in association with the rule change were relatively narrow and only addressed containment gas monitoring instrumentation requirements and the elimination of the hydrogen recombiner TS. Other justifiable TS changes were identified prior to and subsequent to the completion of the rule change. However, revision of the rule change package to address these other issues would have delayed the rule change, so the industry and the NRC agreed to address the other ISTS changes related to the 50.44 rule change in separate Travelers.

4.0 Technical Analysis

The function of the hydrogen igniters is to reduce the hydrogen concentration following a beyond design basis degraded core event. TS 3.6.3.1 requires two divisions of primary containment and drywell hydrogen igniters to be OPERABLE, each with > 90% of the associated igniter assemblies OPERABLE. The TS allows continued operation with one division inoperable for up to 30 days. With both divisions inoperable, the TS allows continued operation for up to 7 days provided the hydrogen control function is maintained by alternate means. The alternate control function described in the TS Bases is the hydrogen recombiners and purge compressors, which are only designed to control the smaller hydrogen release from design basis LOCA event.

The Required Actions to verify the Hydrogen Control Function when both divisions of hydrogen igniters are out of service for BWR 6 designs results in the need to retain hydrogen recombiners, which is inconsistent with the conclusion of the 10CFR50.44 rule change. Mark III containment plants were originally designed with only hydrogen recombiners to control the hydrogen from a DBA (5% cladding reaction). The igniters were added later to control hydrogen from a severe accident (75 % cladding reaction).

BWR/6 TS 3.6.3.1, Required Action B.1, requires verification that the hydrogen control function is maintained if both igniter divisions are inoperable. The Bases only requires this verification for the DBA design function (i.e., one recombiner and one purge system). It does not require verification of alternate severe accident mitigation design features. Note that a recombiner is not sufficient to control hydrogen from a severe accident.

The 50.44 rule change eliminated the DBA hydrogen control requirements and the recombiner TS requirements. TSTF-447 eliminated the Required Action B.1 Bases statement describing which systems provide the alternate DBA hydrogen control capabilities, but the Action itself was unchanged. BWR/6 TS 3.6.3.1, Required Action B.1, needs to be deleted since the action was related to maintaining an alternate DBA function (i.e., the hydrogen recombiners) which has been eliminated. Alternate methods of managing a severe accident hydrogen release are addressed through the Severe Accident Management Guidelines. To further address severe accident concerns, the time allowed for both Divisions of hydrogen igniters to be out of service is revised from 7 days to 48 hours. This results in a risk improvement by reducing the time allowed for operation for the low probability of both Divisions of hydrogen igniters being out of service together with the occurrence of a postulated severe accident.

It should be noted that use of the 48 hour allowed outage time would be a very rare unexpected situation. The most likely cause of both igniter divisions being inoperable would be due to a failure of the associated power supplies. In this situation, the power source TS, 3.8.1, or the power distribution system TS, 3.8.9, would be more limiting. For example, TS 3.8.9 would require restoration of the power distribution systems within 8 hours. Additionally, in response to Generic Issue-189, BWR6 plants have voluntarily provided commitments to have backup power supplies to power the igniters in the event of a station blackout. Therefore, even in the event of a loss of normal or emergency power to both igniter divisions, alternate means to power one division of igniters would be available.

In addition, both divisions would not be removed concurrently for planned maintenance. The Bases for LCO 3.0.2 asserts that intentional entry into ACTIONS must be done in a manner that does not compromise safety. More specifically, it states that alternatives that would not result in redundant equipment being inoperable should be used.

In summary, the proposed TS change is consistent with the intent of the 10 CFR 50.44 rule change and approved TSTF-447, provides risk improvements, and its use is only needed for very rare, unexpected situations.

5.0 Regulatory Analysis

5.1 No Significant Hazards Consideration

1. Does the proposed change involve a significant increase in the probability or consequences of an accident previously evaluated?

   Response: No.

   The Required Actions taken when two primary containment and drywell hydrogen igniter divisions are inoperable are not initiators of any accident previously evaluated. As a result, the probability of any accident previously evaluated is not significantly increased. The primary containment and drywell hydrogen igniters are used to mitigate the consequences of an accident. However, the revised 10 CFR 50.44 no longer includes a design basis accident (DBA) hydrogen release and the Commission has determined that the DBA loss of coolant accident (LOCA) hydrogen release is not risk significant. Use of the revised Required Actions for inoperable primary containment and drywell hydrogen igniters does not change the consequences of the previously evaluated accidents as compared to use of the current Required Actions. The reduction in time that both divisions of hydrogen igniters may be out of service until one division is restored from seven (7) days to 48 hours will be an improvement in the risk for consequences of severe accidents. As a result, the consequence of any accident previously evaluated is not significantly increased.

   Therefore, the proposed changes do not involve a significant increase in the probability or consequences of an accident previously evaluated.

2. Does the proposed change create the possibility of a new or different kind of accident from any accident previously evaluated?

   Response: No.

   No new or different accidents result from utilizing the proposed change. The changes do not involve the installation of any new or different type of equipment or a change in the methods governing normal plant operation. The changes will permit elimination of the hydrogen recombiners from the plant, which was one of the purposes of revising 10 CFR 50.44. The allowance to eliminate the recombiners does not create the possibility of a new or different type of accident. The changes to the Technical Specifications are consistent with the revised safety analysis assumptions that were made by the 10 CFR 50.44 rule change.

   Therefore, the proposed changes do not create the possibility of a new or different kind of accident from any accident previously evaluated.

3. Does the proposed change involve a significant reduction in a margin of safety?

   Response: No.

The Commission has determined that the DBA LOCA hydrogen release is not risk significant and is not required to be assumed in the plant's accident analyses. The proposed changes reflect this new position and, in light of the remaining plant equipment, instrumentation, procedures, and programs that provide effective mitigation of and recovery from reactor accidents, including postulated beyond design basis events, does not result in a significant reduction in a margin of safety.

Therefore, the proposed changes do not involve a significant reduction in a margin of safety.

Based on the above, the TSTF concludes that the proposed change presents no significant hazards consideration under the standards set forth in 10 CFR 50.92(c), and, accordingly, a finding of "no significant hazards consideration" is justified.

5.2 Applicable Regulatory Requirements/Criteria

The proposed changes revise the ISTS to reflect changes in the applicable regulatory requirements and criteria in 10 CFR 50.44.

In conclusion, based on the considerations discussed above, (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the approval of the proposed change will not be inimical to the common defense and security or to the health and safety of the public.

6.0 Environmental Consideration

A review has determined that the proposed change would change a requirement with respect to installation or use of a facility component located within the restricted area, as defined in 10 CFR 20, or would change an inspection or surveillance requirement. However, the proposed change does not involve (i) a significant hazards consideration, (ii) a significant change in the types or significant increase in the amounts of any effluent that may be released offsite, or (iii) a significant increase in individual or cumulative occupational radiation exposure. Accordingly, the proposed change meets the eligibility criterion for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the proposed change.

7.0 References

1. Notice of Proposed Rulemaking, Federal Register: August 2, 2002 (Volume 67, Number 149), Proposed Rules, Page 50374-50383, Combustible Gas Control in Containment.

2. Final Rule, Federal Register: 68 FR 54141 (Volume 67, Number 149), September 16, 2003, Combustible Gas Control in Containment.

3. Letter from Thomas H. Boyce (NRC) to Technical Specification Task Force dated October 1, 2003, approving TSTF-447, Revision 1, "Elimination of Hydrogen Recombiners and Change to Hydrogen and Oxygen Monitors."

Attachment A

Technical Analysis To Support Risk Informed Input In Support Of Mark III Igniter Completion Time Changes

TECHNICAL ANALYSIS TO SUPPORT RISK INFORMED INPUT IN SUPPORT OF MARK III IGNITER COMPLETION TIME CHANGES

Prepared for
BWR Owners' Group

Prepared by

ERIN Engineering and Research, Inc.
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Principal Investigator

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January 2008

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Section 1
INTRODUCTION

1.1 PURPOSE

The BWROG seeks to establish a reduced Allowed Outage Time (Completion Time (CT)) for the Mark III hydrogen control mitigating system, i.e., the igniters.

This report addresses the impact on the risk profile associated with the proposed Completion Time change. Comparisons with the acceptance guidelines provided by the NRC in RG 1.174 and RG 1.177 are also included to assess the safety significance of the change.

Table 1-1 identifies the current and proposed completion times (CT) for the case with both igniter divisions unavailable.

Table 1-1
SUMMARY OF COMPLETION TIME (CT) CASES TO BE EVALUATED

	Completion Time (CT)	
System	Current	Proposed
Both Hydrogen Igniter Divisions	7 days[(1)]	48 hrs.

The approach is to perform a best estimate evaluation for a typical Mark III plant. This best estimate calculation is then supplemented by several sensitivity calculations to demonstrate a range of possible risk metrics given variations in assumptions or the plant risk profile (e.g., higher CDF).

The intent of this process is to demonstrate that the proposed CT results in acceptable risk metrics and a public safety benefit – not a risk increase regardless of the assumed risk profile or the modeling assumptions evaluated.

1.2 OVERVIEW

The Nuclear Regulatory Commission (NRC) has revised 10 CFR 50.44 to amend its standards for combustible gas control in light-water-cooled power reactors. The Commission eliminated the design basis loss of coolant accident (LOCA) hydrogen release from 50.44 and consolidated the requirements for hydrogen and oxygen monitoring to 50.44, while relaxing safety classifications and licensee commitments to certain design and qualification criteria. TSTF-447, Elimination of Hydrogen Recombiners and Change to Hydrogen and Oxygen Monitors, implemented the majority of the Technical Specification (TS) changes resulting from this rule change. Specifically, TSTF-447 provided changes to permit the NRC to efficiently process amendments to remove requirements for hydrogen recombiners, and hydrogen and oxygen monitors from Technical Specifications. TSTF-447 was approved for adoption using the Consolidated Line Item Improvement Process (CLIIP) on September 25, 2003, and many Boiling Water Reactor (BWR) units have submitted TS changes to adopt the TSTF.

In the revised 10 CFR 50.44 rule, the Commission eliminated the requirements for hydrogen recombiners and hydrogen purge systems, and relaxed the requirements for hydrogen and oxygen monitoring equipment to make them commensurate with their risk significance. Installation of hydrogen recombiners and/or vent and purge systems originally required by 50.44(b)(3) was intended to address the limited quantity and rate of hydrogen generation that was postulated from a design basis LOCA. In the basis for the rule change, the Commission found that this hydrogen release is not risk significant because the design basis LOCA hydrogen release does not contribute to the conditional probability of a large release up to 24 hours after the onset of core damage. In addition, the Commission found that these systems were ineffective at mitigating hydrogen releases from risk significant accident sequences that could threaten containment integrity. The Commission noted that the regulatory analysis for the rulemaking found the cost of maintaining the recombiners exceeded the benefits of retaining them to prevent containment failure sequences that progress to the very late time frame.

However, there remain some residual Technical Specification requirements that should also be modified to be consistent with the elimination of the design basis loss of coolant accident (LOCA) hydrogen release from 50.44 and the hydrogen recombiner.

Specifically, a potential inconsistency currently exists between the revised 50.44 rule and the BWR Improved Standard Technical Specifications (ISTS). Namely, BWR/6 (Mark III) Specifications 3.6.3.1, Primary Containment and Drywell Hydrogen Igniters, which contains Required Actions to "Verify by administrative means that the hydrogen control function is maintained." The alternate hydrogen control function for BWR/6(Mark III) designs is described in the TS Bases as the hydrogen recombiners. This alternate hydrogen control function is for the design basis LOCA hydrogen release which was previously eliminated by the 10 CFR 50.44 rule change. The function of the hydrogen igniters is to control a large hydrogen release from a beyond design basis degraded core event, whereas the recombiners were only designed and intended to control a much smaller hydrogen release from a design basis LOCA. When the design basis LOCA hydrogen release was eliminated by the 10 CFR 50.44 rule change, the TS requirements for the design basis hydrogen control function (i.e., the recombiners) were also eliminated by TSTF-447. However, the link to the design basis LOCA hydrogen release in the igniter TS Actions was not fully recognized and the igniter TS was not revised by TSTF-447.

The enclosed analysis assesses the removal of this inconsistency AND the reduction in the Completion Time for the case with both divisions of igniters unavailable.

<u>Primary Containment and Drywell Hydrogen Igniters</u>

10 CFR 50.44 requires that systems and measures be in place to reduce the risks associated with hydrogen combustion from beyond design basis accidents. The

purpose of the Primary Containment and Drywell Hydrogen Igniters is to prevent the build up of higher hydrogen concentrations during an accident that could result in a violent reaction if ignited by a random ignition source. STS 3.6.3.1. "Primary Containment and Drywell Hydrogen Igniters" in NUREG-1434, "General Electric Plants, BWR/6 STS," implements the requirements of 10 CFR 50.44. The proposed change modifies the Required Actions that operators take when the Primary Containment and Drywell Hydrogen Igniters are inoperable. 10 CFR 50.36(c)(2) states that 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. Therefore, the Remedial Actions and associated allowed Completion Times when Primary Containment and Drywell Hydrogen Igniters are inoperable may be revised as permitted by 10 CFR 50.36(c)(2).

The BWROG seeks to modify these requirements to:

a) <u>Reduce</u> the allowed CT to 48 hours when both divisions of the igniters are unavailable

   AND

b) Eliminate the requirement that the recombiner be available during the 48 hour CT for both igniter divisions.

Additionally, in response to Generic Issue-189, BWR/6 plants have voluntarily provided commitments to have backup power supplies to power the igniters in the event of a station blackout. Therefore, even in the event of a loss of normal and emergency power to both igniter divisions, alternate means to power one division of igniters would potentially be available.

1.3 RISK ASSESSMENT OVERVIEW

The NRC in Reference [1] and NUREG-1150 [3] has evaluated the risk contributors to BWR/6 (Mark III) plants. In these assessments, the potential for combustible gas generation under severe accident conditions is included. The Mark III mitigation measures evaluated in NUREG-1150 and Reference [1] as effective for combustible gas control over the severe accident spectrum includes only the igniters.

Similarly in plant specific PRA evaluations for Mark III plants, only the igniters are credited as an adequate mitigation measure for combustible gases over the severe accident spectrum. The recombiners were designed for relatively low hydrogen generation rates and have been identified as eligible to be eliminated from the plant via NRC analysis for 50.44 and TSTF-447 because they are ineffective for the risk significant severe accidents. (In fact, in existing BWR/6 Mark III EOPs without igniters and a severe accident in progress, the Hydrogen Deflagration Overpressure Limit (HDOL) would be reached and the recombiners and Purge System (or Mixer System) is directed to be shut down. Therefore, for potential LERF contributors, the Hydrogen Recombiner is procedurally disabled because it is viewed to have little benefit but a large negative impact as a potential ignition source.)

In other words, both divisions of the igniters are currently allowed to be unavailable for 7 days with no effective mandated backup for hydrogen control sufficient for response to severe accident hydrogen generation rates.

The enclosed probabilistic risk assessment compares the existing risk profile between a typical Mark III plant with the current 7 day CT for igniters with that for the proposed CT of 48 hours. This best estimate calculation is then supplemented by several sensitivity calculations to demonstrate a range of possible risk metrics given variations in assumptions or the plant risk profile (e.g., higher CDF). The risk assessments of these two configurations are performed recognizing that the elimination of the hydrogen recombiners has no effect on either the current level of risk or the risk after the proposed changes are completed.

The intent of the analysis is to demonstrate for a baseline calculation of risk and over a range of sensitivity cases that the risk to the public decreases with the proposed change to the Technical Specifications. This is a safety enhancement relative to the current Mark III configuration which the NRC has previously found acceptable [8].

In addition, the absolute level of risk is estimated to demonstrate that both configurations represent acceptable risk levels.

1.4 REGULATORY PROCESS

General guidance for evaluating the technical basis of a proposed risk-informed change is provided in Chapter 19 of the NRC Standard Review Plan (SRP) (NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants"). SRP Chapter 19 and RG 1.177 state that a risk-informed application should be evaluated to ensure that the proposed change(s) meet five key safety principles.

This analysis is directed at the assessment of one of these five key safety principles:

- when the proposed change increases risks (i.e., core damage frequency (CDF) or large early release frequency (LERF)) the increases should be small and consistent with the intent of the Commission's Safety Goal Policy

In addition, it is noted that the quality of the probabilistic risk assessment (PRA) supporting the change must be compatible with the safety implications of the TS change being requested. In this case, the PRA needs to be of sufficient quality to support the identified trend that the proposed Technical Specification change is a positive safety enhancement.

RG 1.174, "An Approach for Using Probabilistic Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," and RG 1.177, "An Approach for Plant-Specific, Risk-Informed Decision making: Technical Specifications," provides specific guidance and acceptance guidelines for assessing the impact of licensing basis changes, including proposed permanent TS changes. RG 1.177 provides additional acceptance guidelines for evaluating the risk associated with revised completion times (CTs).

The requirements cited in RG 1.177 include the following:

> Page 1.177-4 of RG 1.177 lists expectations for a full risk-informed Technical Specification change:
>
> 1. ***The proposed change meets the current regulations unless it is explicitly related to a requested exemption or rule change.*** *Applicable rules and regulations that form the regulatory basis for TS are discussed in Regulatory Position 2.1, "Compliance with Current Regulations."*
> 2. ***The proposed change is consistent with the defense-in-depth philosophy.*** *The guidance contained in Regulatory Position 2.2, "Traditional Engineering Considerations," applies the various aspects of maintaining defense in depth to the subject of changes in TS.*
> 3. ***The proposed change maintains sufficient safety margins.*** *The guidance contained in Regulatory Position 2.2, "Traditional Engineering Considerations," applies various aspects of maintaining sufficient safety margin to the subject of changes to TS.*
> 4. ***When proposed changes result in an increase in core damage frequency or risk, the increases should be small and consistent with the intent of the Commission's Safety Goal Policy Statement.*** *Regulatory Position 2.3, "Evaluation of Risk Impact," provides guidance for meeting this principle.*
> 5. ***The impact of the proposed change should be monitored using performance measurement strategies.*** *The three-tiered implementation approach discussed in Regulatory Position 3.1 and Maintenance Rule control discussed in Regulatory Position 3.2 provide guidance in meeting this principle.*
>
> These principles are to be addressed if R.G. 1.177 is deemed necessary.

This analysis addresses item 4 on the RG 1.177 list.

Other requirements for a plant specific CT change are not addressed in the enclosed evaluation.

The approach is to compile a set of probabilistic risk analyses using the average Mark III risk profile[(1)] and sensitivity cases for other, postulated "worst case" Mark III risk profiles. These analyses use the following information to support the risk assessment:

- It is recognized by the NRC in the final Hydrogen Rule (10CRF50.44) that the recombiner has NO impact on the Mark III risk profile.
- The current Mark III configuration already allows a 7 day CT for both divisions of igniters if the recombiner is available (but the recombiner has no impact on the risk determination). This is an allowed 7 day CT and represents a currently accepted risk that is already allowed as part of Technical Specifications.
- With no change in Technical Specifications, this level of risk will continue indefinitely into the future.
- The approach for the risk assessment presented here assumes that the CT will be reduced significantly to a shorter allowed CT (e.g., 48 hours), if the condition that the recombiners remain available is eliminated.
- A shorter CT in the Technical Specifications will reduce risk to the public and be a safety enhancement, i.e., not an adverse impact on safety for any risk profile. From this, it follows that the postulated risks that may exist are larger if the Technical Specification remains unchanged. (Failing to change the Technical Specification would appear to be contrary to the NRC goal of minimizing the risk associated with the subject igniter CT condition as discussed in the SER. [8])

(1) Consistent with the NRC approach in GSI 189 analyses for Mark III plants used a single CDF data point which was not the limiting case and did not include external events. Additionally, worst case release consequences were not utilized (i.e., not the Perry site).

Section 2
MARK III IGNITERS

The Mark III plants have incorporated within the plant and the Technical Specifications a combustible gas control system composed of a large number of hydrogen igniters in the drywell and in the outer containment. The igniter system consists of two independent divisions of distributed igniters. Either division is adequate to provide the accident mitigation for hydrogen generation that may occur due to 75% clad reaction occurring at a specified rate.

The hydrogen igniters cause hydrogen in containment to burn in a controlled manner as it accumulates following a degraded core accident. Burning occurs at the lower flammability concentration, where the resulting temperatures and pressures are relatively benign. Without the system, hydrogen could build up to higher concentrations that could result in a violent reaction if ignited by a random ignition source after such a buildup. Extensive testing by the Hydrogen Control Owners' Group (HCOG) have demonstrated the effectiveness of these igniters in protecting the containment during accidents with relatively high hydrogen release rates.

Therefore, the hydrogen igniters have been shown by probabilistic risk analysis to be a significant mitigator in limiting the severity of accident sequences that are commonly found to dominate risk for units with a Mark III containment.

The currently approved Technical Specifications allow both divisions of igniters to be unavailable and provides a 7 day completion time if the hydrogen control function (i.e., the DBA hydrogen control with the recombiner) is available. However, this hydrogen control function is to respond to a DBA LOCA and is <u>not</u> capable of coping with the severe accident hydrogen generation rates. To this point, the 10CFR50.44 revised rule allows the DBA LOCA hydrogen control function to be removed from the Technical Specifications based on low safety significance.

This means that the igniters are currently allowed to be unavailable for 7 days with no effective mandated backup for hydrogen control sufficient for response to severe accident hydrogen generation rates.

Section 3
RISK ASSESSMENT APPROACH

3.1 INTRODUCTION

The current Standard Technical Specifications (STS) allow both divisions of igniters to be unavailable and provides a 7 day Completion Time if the hydrogen control function (i.e., the DBA hydrogen control with purge system and recombiner) is available. However, this hydrogen control function is designed for response to a design basis accident (DBA) Loss of Coolant Accident (LOCA) and is not capable of coping with the assumed hydrogen generation rates caused by severe accidents. [1, 2, 3, 4] In addition, the DBA LOCA hydrogen control function has been removed from the Standard Technical Specifications following the approval of the revised 10CFR50.44 rule. Therefore, the current Standard Technical Specifications allow the hydrogen igniters to be unavailable for 7 days with no mandated backup for hydrogen control sufficient for response to severe accident hydrogen generation rates. As a result, the current 7 day CT for both divisions of igniters represents an existing risk to the public that has been accepted by the staff [8] in the approval of the STS for Mark III plants and the revised 10CFR50.44.

The BWROG considers that the uncertainties in severe accident mitigation, the frequency of internal and external events, and the potential for risk associated with postulated security events argues that the Completion Time for cases with both igniter divisions unavailable should be reduced to minimize risk to the public. The enclosed probabilistic risk calculations lend support to this.

Therefore, the intent of this process is to demonstrate that the proposed CT results in acceptable risk metrics and a public safety benefit – not a risk increase.

The BWROG is proposing a change to BWR Technical Specifications that currently allows a 7 day completion time (CT) for both igniter divisions unavailable. As such, the BWROG requests reducing the Completion Time for cases with both igniter divisions unavailable from 7 days to 48 hours. As part of this change, the BWROG also requests the deletion of the need to have the hydrogen recombiner available during the 48 hour CT. This second provision is consistent with the recognition by the NRC and industry that the recombiner is ineffective in limiting the risk for these severe accidents. The proposed change results in a 48 hour Completion Time for the igniters when both igniter divisions are unavailable regardless of the status of the recombiner.

3.2 RISK ASSESSMENT APPROACH

This probabilistic risk assessment includes the following:

- 3.3 Background Discussion of Risk Metrics
- 3.4 Internal Events Risk Evaluation for an Example Mark III
- 3.5 Approach to Incorporation of External Events
- 3.6 Internal and External Event Risk Quantification
- 3.7 Conclusion

Because this risk informed analysis is based on a reduction in the overall risk to the public, it is judged that a generic evaluation using a typical BWR Mark III risk profile is sufficient to demonstrate the salient features of the change in risk.

Generic analysis can be performed using average estimates of the risk profiles. The approach is to perform a best estimate evaluation for a typical Mark III plant. Then using the average of the risk metrics will result in some plants with a slightly higher risk metrics and others with a slightly lower. The net risk impact across the industry, then, is judged well represented by the average. This best estimate calculation is then supplemented by several sensitivity calculations to demonstrate a range of possible risk metrics that characterize the magnitude of the safety benefit associated with the proposed Technical Specification change.

3.3 BACKGROUND AND RISK METRICS

3.3.1 Core Damage Frequency (CDF)

The operation of the Mark III with or without igniters operational has not been found to result in changes in the Core Damage Frequency (CDF) risk metric. [3]

3.3.2 LERF or ICLERP Risk Measures

Given that CDF is unaffected by igniter availability, there are two risk-informed regulatory guides that provide risk metrics that can be used to assess the efficacy of plant changes. These are:

Regulatory Guide	Risk Metric	Acceptance Guideline for Very Low Change in Risk
RG 1.174	ΔLERF	<1E-7/yr
RG 1.177	ICLERP	5E-8

The Incremental Conditional Large Early Release Probability (ICLERP) is defined as follows:

> ICLERP = [(conditional LERF with the subject equipment out of service) – (baseline LERF with nominal expected equipment unavailabilities)] x (duration of single CT under consideration)

The ICLERP is not calculated to reflect the difference in the CT before and after the Technical Specification change, otherwise it would be a negative value for the current risk calculation. Therefore, what are shown are the ICLERP for the current CT (7 days) and the ICLERP for the proposed CT (48 Hours). A comparison of the two ICLERP values provides a measure of the level of safety improvement resulting from the proposed Technical Specification change.

3.4 INTERNAL EVENTS RISK EVALUATION

An assessment of the impact on the LERF risk metric by changing the completion time for igniters can be performed for an example Mark III plant that has a full Level 2 model for internal events.

3.4.1 PRA Quality

The PRA used in this analysis has been developed to be consistent with the ASME PRA Standard Addendum B and has had a self assessment to confirm that all of the High Level Requirements (HLRs) are met and 85% of the SRs meet Capability Category II. Because this application involves a risk reduction, the quality of the PRA is judged acceptable.

3.4.2 Input

The realistic inputs to these assessments are the following:

- Full Level 2 Mark III PRA
- Completion Time (CT) for igniters is 7 days for the current plant configuration
- Completion Time (CT) for igniters is 48 hours for the proposed plant configuration
- No credit is included in this Level 2 PRA for primary containment steam inerted conditions and Combustible Gas vent precluding a hydrogen deflagration event. Removal of that credit is estimated to increase the ΔLERF values by a factor of two.
- External events are not included. See later discussion regarding the incorporation of external events.

3.4.3 Methodology

BWR Mark III (Level 1 and Level 2) model is recalculated for an example plant. The parameter changed is the probability that the igniters are available. When the igniters are unavailable, a severe accident results in the possibility of a hydrogen deflagration which would directly fail containment and create a large magnitude release.

3.4.4 Internal Events Quantitative Results

Consistent with the approach taken by the NRC in the cost benefit evaluation for igniters [1, 2, 9], this initial evaluation examines only the internal events risk spectrum. The internal events risk has been studied more extensively than the external events spectrum and is judged to have a smaller uncertainty band. In addition, the external events probabilistic evaluations are judged to retain significant conservative bias and the quantitative results do not compare directly to the internal events analysis. [5]

For risk-informed changes, RG 1.177 specifies a figure of merit, ICLERP, and the acceptance guidelines to be used in this comparison. The acceptance guideline is 5E-8 for ICLERP.

RG 1.174 uses ΔLERF as the appropriate risk metric where 1E-7/yr is the threshold for transition out of the "very small change" in risk.

The results of the internal events risk assessment compared with regulatory guide acceptance guidelines are summarized below.

3.4.5 Internal Events Evaluation

The NUREG-1150 evaluation [3] of risk for combustible gas mitigation has been reviewed. The NUREG-1150 quantitative model is not readily available for sensitivity quantification.

Therefore, a full Level 2 Mark III PRA for a U.S. BWR is used to assess the risk associated with internal events. The results of this Level 2 PRA are judged to be reflective of other Mark III plants and to incorporate the assessments of risk associated with combustible gas control from NUREG-1150 and the NRC. [3, 10] This Level 2 PRA is used to quantify the risk associated with the current and proposed CT for igniters.

The evaluation of the Mark III results in the following:

$LERF_{BASE}$ = 1.20E-7/yr (CAFTA[1] calculation for Level 2)

$LERF_{NOIGNTR}$ = 6.65E-7/yr (CAFTA[1] calculation for Level 2)

Additional inputs for the ICLERP calculation are the following:

$CT_{CURRENT}$ = 7 days (current)

$CT_{PROPOSED}$ = 48 hours (proposed)

ICLERP = [(conditional LERF with the subject equipment out of service) – (baseline LERF with nominal expected equipment unavailabilities)] x (duration of single AOT under consideration)

3.4.5.1 ICLERP

Current Technical Specification Risk Metric: ICLERP

$$\text{ICLERP} = (6.65\text{E-7/yr} - 1.20\text{E-7/yr}) * 7 \text{ days} * \frac{1 \text{ yr}}{365 \text{ days}}$$

$$= 1.04\text{E-08}$$

This result indicates that based on the internal events evaluation the 7 day CT for igniters meets the acceptance guideline from RG 1.177.

Proposed Technical Specification Risk Metric: ICLERP

$$\text{ICLERP} = (6.65\text{E-7/yr} - 1.20\text{E-7/yr}) * 2 \text{ days} * \frac{1 \text{ yr}}{365 \text{ days}}$$

$$= 2.99\text{E-09}$$

The proposed Technical Specification with a 48 hour CT produces an ICLERP risk metric that is a factor of 3.5 less than the current risk metric, however, both metrics are well within the RG 1.177 Acceptance Guideline for ICLERP.

(1) Software computer code used in the probabilistic model calculations for the example plant.

3.4.5.2 ΔLERF

The application of the RG 1.174 Acceptance Guideline for ΔLERF is more difficult to precisely define for CT changes because it requires estimating the frequency with which the Technical Specification CT might be used. Because of the rarity of the condition, it is judged that this CT would be used no more frequently than once every 10 years. The ΔLERF calculation is performed to show that as a function of the "allowed" CT the ΔLERF would increase in direct proportion to the length of the CT and the magnitude of the LERF with no igniters available.

This allows the RG 1.174 ΔLERF risk metric to be calculated:

<u>LERF (7 day CT)</u>

$$\text{LERF} = \left(\text{LERF}_{\text{NO IGNITER}} * \frac{7\text{ days}}{10\text{ years}}\right) + \left(\text{LERF}_{\text{BASE}} * \sim 1.0\right) - \left(\text{LERF}_{\text{BASE}}\right)$$

= 6.65E-7/yr * 1.92E-3 + 6.98E-6/yr - 6.98E-6/yr
= 1.28E-9/yr (given a LERF of ~1.2E-7/yr)

<u>LERF (48 hours CT)</u>

$$\text{LERF} = \left(\text{LERF}_{\text{NO IGNITER}} * \frac{2\text{ days}}{10\text{ years}}\right) + \left(\text{LERF}_{\text{BASE}} * 1.0\right) - \left(\text{LERF}_{\text{BASE}}\right)$$

= 6.65E-7/yr * 5.48E-4
= 3.64E-10/yr (given a LERF of ~1.2E-7/yr)

ΔLERF = LERF(48 hr CT) – LERF (7 day CT)
= 3.64E-10/yr – 1.28E-9/yr
= (-)9.16E-10/yr

The negative sign indicates that the change in LERF as a result of the CT change results in a decrease in risk, i.e., a positive safety benefit.

Calculation Conclusion for Igniters

The internal event evaluation is presented to demonstrate that, given a reasonable characterization of the risk spectra for a typical Mark III containment, the risk metrics will remain within the Acceptance Guidelines of the NRC Regulatory Guides.

The reduction in LERF for the proposed CT of 48 hours relative to the current 7 day CT indicates that the LERF decreases with the proposed Technical Specification change. Obviously, a risk reduction is a public safety benefit. This is within the very low risk regime for the RG 1.174 acceptance guideline

See Figure 3-1 for the Acceptance Guidelines.

It is noted that, conceptually, changes in the time that igniters are unavailable is directly correlated with increases in the LERF. This holds true for sequences which:

a) Result in core damage early in the accident sequences, i.e., prior to completion of effective evacuation,

AND

b) Sequences that do not otherwise cause a LERF.

Consistent with this conclusion is the fact that the sequences involving the following do not influence LERF or ICLERP:

- Long term loss of DHR events which leave time for effective evacuation.
- Long term SBO events which leave time for effective evacuation.

Therefore, plants that have their CDF risk spectrum dominated by either loss of DHR and/or late SBO events are likely to be least affected by the change in igniter CT time.

3.4.6 Conclusion

The internal event risk evaluation is presented to demonstrate that, given a reasonable characterization of the risk spectra for a Mark III containment, the risk metrics will remain within the Acceptance Guidelines of the NRC Regulatory Guides.

Results for 7 Day CT (Current Risk Profile Measures)

Risk Metric	Risk Metric Calculation Internal Events	Acceptance Guideline	
		Value	RG
ICLERP	1.04E-8	5E-8	RG 1.177

Therefore, the 7 day Completion Time (CT) for both divisions of igniters meets the Acceptance Guideline from R.G. 1.177 and would be acceptable for this base case (best estimate internal events calculation).

Results for 48 hour CT (Proposed Risk Profile Measures)

Risk Metric	Risk Metric Calculation Internal Events	Acceptance Guideline	
		Value	RG
ICLERP	2.99E-9	5E-8	RG 1.177
ΔLERF	(-)9.16E-10/yr	1E-7/yr	RG 1.174

Therefore, the 48 hours Completion Time (CT) for both divisions of igniters meets the Acceptance Guidelines from R.G. 1.177 and R.G. 1.174 and would be acceptable based on a typical Mark III for the internal events risks.

It is emphasized that the proposed Technical Specification represents a reduction in risk to the public compared with the existing Technical Specifications.

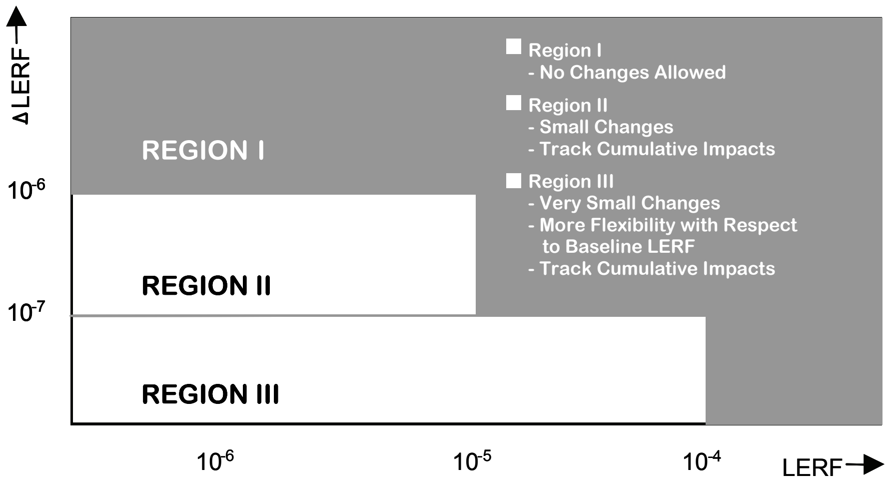

Figure 3-1 Summary of the Example BWR Mark III and the Impact of Changes to the Igniter Completion Time (Internal Events)

3.5 INCORPORATION OF EXTERNAL EVENTS

The methods, standards, and analysis tools available to assess external event effects are significantly less than those available for the assessment of internal events. This lack of analytic capability generally translates into treating the external events in a more conservative manner. As a result, it is difficult to compare the calculated external event risk metrics on the same "scale" as the internal events risk metrics. Nevertheless, this assessment is performed to demonstrate that, even with conservative estimates of the external event risks, the proposed change is acceptable. [5]

The following analyses are performed to investigate the impact of external events on the igniter completion time.

3.5.1 Inputs

- The igniters are assumed unavailable for 7 days/yr.
- The available risk estimates can be determined from BWR external event analysis coupled with reasonable estimates of the risk spectrum makeup.

3.5.2 Methodology

The approach taken for the incorporation of external events is to use an average estimate of the contributions from various hazards to develop an estimate of the average impact on the LERF risk metric. This will lead to approximating the net effect over the BWRs.

The contributors that are investigated are:

- Internal events
- Seismic initiated events
- Fire initiated events

There is very little work performed regarding LERF calculations for fire and seismic contributions to Mark III plant risk profiles. Therefore, the concentration is on the use of CDF estimates from existing sources and then inferring the associated LERF impacts with and without igniters operating.

3.5.2.1 Internal Events Contributions

The base calculation uses an internal events CDF from a typical Mark III plant of 5.57E-6/yr.(1)

3.5.2.2 Seismic Induced CDF

The average seismic CDF is derived from NUREG-1742 [7].

Table 3-2 summarizes the seismic CDF from BWRs in NUREG-1742. The average seismic CDF from this BWR-only comparison (see Column 3) is 6.58E-06/yr. (Based on available BWR seismic PRA results – no MARK III plants represented.)

3.5.2.3 Fire Induced CDF

The average fire induced CDF is derived from NUREG-1742 [7].

Table 3-3 summarizes the fire CDF from Mark III BWRs in NUREG-1742. The average fire CDF from this Mark III BWR-only comparison (Column 4) is 1.69E-05/yr.

(1) The average of the internal events CDF can be derived from the BWROG effort on MSPI. [3] The average of the CDF for internal events derived from the BWROG MSPI Program [6] (see attached Figure 3-2) is 6.4E-6/yr. This calculation is not used in the analysis.

3.5.2.4 Total CDF

These CDF values are not recommended to be added together or even to be considered comparable in their levels of realism incorporated into the models. In addition, the nature of the risk spectra for each can be substantially different, including:

- Sequence makeup
- Offsite effects

Table 3-4 summarizes a brief comparison.

Based on these baseline CDF values, an evaluation of the potential LERF contributors is performed using insights from the internal events evaluation.

3.6 INTERNAL AND EXTERNAL EVENT CALCULATIONS

In addition to the total CDF, it is also critical to the assessment of LERF to assess the character of the contributing accident sequences. This is because, there are portions of each of the hazard spectra that:

- Preclude their assignment to LERF because of sufficient warning time for effective evacuation

  <u>OR</u>

- Preclude their impact on ΔLERF because they already cause a LERF and changes in the igniter completion time would not alter this conclusion, i.e., would not affect ΔLERF.

3.6.1 <u>Factors Affecting the Risk Spectra</u>

The factors that influence the assessment include the following:

3.6.1.1 Fire Sequence Effects on LERF

- Fire induced CDF events tend to be dominated by events that adversely impact the ability to remove heat from containment or events that cause long term station blackout. These sequences are not LERF contributors because they allow significant time for evacuation.

  In other words, the fire induced CDF is generally attributed to loss of DHR or long term SBO events with long duration before core damage occurs. This analytic result is attributed to the following:
  - Because BOP cables are generally not mapped, the fire has been in past analyses "assumed" to fail the BOP system and defeat the main condenser as a heat sink.
  - The containment vent generally does not have a unique capability to cope with a fire and therefore many fires that adversely affect RHR also result in failing the containment vent.
  - There are generally two divisions of RHR and RHRSW that remain and are capable of removing decay heat; however, there are a number of potential challenges to one of the divisions and some challenges to both divisions.
- The NRC sponsored assessment of fire induced risk to support NUREG-1150 is provided for a Mark I in NUREG/CR-4550, Vol. 4, Rev. 1, Part 3. Based on that evaluation, it was found that 65% of the fire CDF is not a potential LERF contributor because the associated core damage sequences occur well after effective evacuation would have occurred.

3.6.1.2 Seismic Sequence Effects on LERF

- Seismic events have a large percentage of contributors that may be both CDF and LERF contributors, therefore these events do not have that portion of the risk spectrum that is already a LERF affected by igniter operation. In addition, the ANS Standard for External Events states the following with regard to the treatment of LERF and the assessment of "early" and "late":

  "There are some accident sequences, leading to core damage but not to large early releases in the internal-events PRA model, that need to be designated as potential LERF sequences when the initiator is an external event. These are sequences in which off-site protective action (specifically, the evacuation of nearby populations) is impeded due to the external event. The same sequence that might not be a LERF sequence due to any internal initiator may perhaps

affect nearby populations that cannot evacuate as effectively.

These sequences would fall into the LERF category because the word "early" in the definition of LERF does not refer to a specific point in time but rather to the issue of whether a large release might occur before effective protective (e.g., evacuation and sheltering) can be implemented to protect surrounding populations.

For example, suppose that an earthquake or tornado that initiates an accident sequence at the nuclear plant were to damage the only road available to evacuate close-in populations. … Therefore, in analyzing external events that have the potential to impede effective emergency evacuation, the analysis must examine whether any accident sequences that are not in the LERF category in the internal-events PRA model need to be included in that category for the particular external event being evaluated."

The internal events PRA assumptions regarding surrounding population evacuation will be severely impacted by seismic scenarios. It is not reasonable to assume that the same time frame for "Early" applies to seismic scenarios. Although it may be justified to assume some other time in the 4 hr to 24 hr time frame to define "Early" for seismic scenarios, the enclosed analysis takes the reasonable approach of reclassifying all corresponding seismic Level 2 PRA "Late" release sequences as "Early" sequences.

- The NRC sponsored assessment of seismic induced risk to support NUREG-1150 is provided for a Mark I in NUREG/CR-4550, Vol. 4, Rev. 1, Part 3. Based on that evaluation, it was found that the seismic contributors involve short term (early) station blackout for 62.5% of the sequences and LOCAs for 34% of the sequences. In addition, there is concern that for a seismic event severe enough to cause core damage that evacuation would be severely impaired. Therefore, seismic events leading to core damage are also assumed to lead to LERF. Therefore, whether the igniters operate or not, these seismic sequences will lead directly to LERF.

  For the enclosed analyses, all seismic events are treated as leading to LERF.

3.6.1.3 Internal Events Sequence Effects on LERF

- The Mark III example plant has a CDF of 5.57E-6/yr.
- Similar to the above discussions, the example Mark III plant from Section 3.5 has 54% of the internal events risk spectrum composed of late SBO events and long term loss of Decay Heat Removal (DHR). These sequences are found not to be potential contributors to LERF because of the timing of the radionuclide release.

3.6.2 <u>Input Assumptions</u>

The above influences can be incorporated into the best estimate Base Model for a typical BWR Mark III.

<u>Assumptions</u>

- Baseline CDF Estimates from previous compilations of risk assessments:

  $CDF_{BASE}^{FIRE} = 1.69E\text{-}5/yr$

  $CDF_{BASE}^{SEISMIC} = 6.58E\text{-}6/yr$

  $CDF_{BASE}^{INTERNAL} = 5.57E\text{-}6/yr$
- For the fire sequences, use the NUREG-1150 assessment that the relative contribution of sequence contributors is such that 65% are loss of DHR or long term SBO sequences, therefore 35% of the fire sequences represent sequences that could be affected by igniter Completion Time and result in ΔLERF contributors.
- For the seismic sequences, for this analysis it is assumed that 100% of the seismic CDF sequences lead to LERF.
- For the internal events, use the example plant results that 54% are loss of DHR or long term SBO sequences, therefore 46% of the internal event sequences represent sequences that could be affected by igniter Completion Time and result in ΔLERF contributors.
- The example Mark III Internal Events from Section 3.5 is used to derive an estimate of the conditional LERF to relate LERF to CDF for the fire accident sequences.

3.6.3 Insights Based on Available Internal Events PRA Model

CDF_{BASE} = 5.57E-6/yr (example plant from Section 3.5)[(1)]

However, within this base CDF there are accident sequence cutsets that cannot produce a LERF because of the timing of the sequence relative to the evacuation directed by the EALs. The residual CDF after deleting DHR and long term SBO sequences (which make up 54% of the risk spectrum) can be found in the following calculation.

- Baseline modified to eliminate sequences that cannot cause LERF or always cause LERF: The ratio of LERF to CDF is calculated by the CAFTA model calculation from the typical Mark III given the above assumptions with a nominal igniter unavailability.

  CDF = 0.46 * 5.57E-6/yr = 2.56E-6/yr

  LERF = 1.20E-7/yr (CAFTA model calculation)

  $$RATIO_{BASE}: \frac{LERF}{CDF} = \frac{1.20E\text{-}7/yr}{2.56E\text{-}6/yr} = 4.69E\text{-}2$$

  This ratio is calculated from the available CAFTA model for a typical Mark III and is then applied to the full spectrum of fire CDF sequences to determine the frequency of those sequences that can potentially cause a LERF. This provides a conservative estimate of the fire LERF for this sensitivity case.

- Case with igniters taken to be unavailable, after deleting the DHR and long term SBO sequences (comparable to above modified baseline). Again the ratio of LERF to CDF is calculated by the CAFTA model calculation from the typical Mark III given the above assumptions with the igniters assumed unavailable.

  CDF = 2.56E-6/yr

  LERF = 6.65E-7/yr (CAFTA model calculation)

  $$RATIO_{NO\ IG}: \frac{LERF}{CDF} = \frac{6.65E\text{-}7/yr}{2.56E\text{-}6/yr} = 0.26$$

---

(1) Modified in subsequent responses to address minor changes in example Mark III CDF calculation.

This ratio is calculated from the available CAFTA model for a typical Mark III and is then applied to the fire CDF sequences to estimate the frequency of those sequences that can potentially cause a LERF. This provides a conservative estimate of the fire LERF for this sensitivity case.

This information from the internal events Level 1 and 2 PRA establishes the conditional probability of a LERF applicable to the residual accident sequences after the non-LERF sequences for loss of DHR and late SBO are eliminated. These conditional LERF probabilities are then used for the fire accident sequence frequency to infer the approximate LERF level.

3.6.4 Calculation of Applicable CDF For All Events – Internal and External (Treatment of sequences that cannot cause LERF or always cause LERF.)

This leads to the following calculation for CDF that could potentially lead to LERF (CDF^{L}_{BASE})[1]:

$$
\begin{aligned}
CDF^{\text{LERF POTENTIAL}}_{\text{BASE INTERNAL}} &= 0.46\ CDF^{\text{INTERNAL}}_{\text{BASE}} \\
&= 0.46(5.57\text{E-}6/\text{yr}) \\
&= 2.56\text{E-}6/\text{yr}
\end{aligned}
$$

$$
\begin{aligned}
CDF^{\text{LERF POTENTIAL}}_{\text{BASE FIRE}} &= 0.35\ CDF^{\text{FIRE}}_{\text{BASE}} \\
&= 0.35(1.69\text{E-}5/\text{yr}) \\
&= 5.9\text{E-}6/\text{yr}
\end{aligned}
$$

$$
\begin{aligned}
CDF^{\text{LERF POTENTIAL}}_{\text{BASE SEISMIC}} &= 1.0\ CDF^{\text{SEISMIC}}_{\text{BASE}} \\
&= 6.58\text{E-}6/\text{yr}
\end{aligned}
$$

(1) The CDF values used in this calculation are the sum of internal and external contributors that could have the resulting LERF affected by the presence of igniters.

It can be considered that the treatment of the seismic sequences is conservative because <u>all</u> of these residual sequences could be considered potential LERF sequences due to the reduced evacuation speed. In other words, LERF could result regardless of the igniter system.

3.6.5 Calculation of ICLERP

Using the internal events plus external events CDF, coupled with the conditional LERF probability derived from the Mark III example internal events assessment in Section 3.6.3.

Best estimate base model with igniters probabilistically available:

$$\begin{aligned}
LERF_{BASE}^{INTERNAL} &= CDF_{BASE\ INTERNAL}^{LERF\ POTENTIAL} * RATIO_{BASE} \\
&= 2.56E\text{-}6/yr * 4.69E\text{-}2 \\
&= 1.20E\text{-}7/yr
\end{aligned}$$

$$\begin{aligned}
LERF_{BASE}^{FIRE} &= CDF_{BASE\ FIRE}^{LERF\ POTENTIAL} * RATIO_{BASE} \\
&= 5.9E\text{-}6/yr * 4.69E\text{-}2 \\
&= 2.77E\text{-}7/yr
\end{aligned}$$

$$\begin{aligned}
LERF_{BASE}^{SEISMIC} &= CDF_{BASE}^{SEISMIC} * 1.0 \\
&= 6.58E\text{-}6/yr
\end{aligned}$$

$$\begin{aligned}
LERF_{BASE} &= LERF_{BASE}^{INTERNAL} + LERF_{BASE}^{FIRE} + LERF_{BASE}^{SEISMIC} \\
&= 1.20E\text{-}7/yr + 2.77E\text{-}7/yr + 6.58E\text{-}6/yr \\
&= 6.977E\text{-}6/yr
\end{aligned}$$

Best estimate base model with igniters <u>not</u> available:

$$\begin{aligned}
LERF_{NO\ IGNITER}^{INTERNAL} &= CDF_{BASE\ INTERNAL}^{LERF\ POTENTIAL} * RATIO_{NO\ IGNITER} \\
&= 2.56E\text{-}6/yr * 0.26 \\
&= 6.65E\text{-}7/yr
\end{aligned}$$

$$\begin{aligned}
LERF_{NO\ IGNITER}^{FIRE} &= CDF_{BASE\ FIRE}^{LERF\ POTENTIAL} * RATIO_{NO\ IGNITER} \\
&= 5.9E\text{-}6/yr * 0.26 \\
&= 1.53E\text{-}6/yr
\end{aligned}$$

$$\begin{aligned}
LERF_{NO\ IGNITER}^{SEISMIC} &= CDF_{NO\ IGNITER}^{SEISMIC} * 1.0 \\
&= 6.58E\text{-}6/yr
\end{aligned}$$

$$\begin{aligned}
LERF_{NO\ IGNITER} &= LERF_{NOIGNITER}^{INTERNAL} + LERF_{NOIGNITER}^{FIRE} + LERF_{NOIGNITER}^{SEISMIC} \\
&= 6.65E\text{-}7/yr + 1.53E\text{-}6/yr + 6.58E\text{-}6/yr \\
&= 8.775E\text{-}6/yr
\end{aligned}$$

The ICLERP calculation as directed by RG 1.177 is performed as a function of the CT duration. It is a risk metric of the CT duration not a comparative measure relative to the initial condition. Therefore, an ICLERP can be calculated for both the current Technical Specification CT or 7 days and the proposed 2 day CT.

ICLERP (7 days)	=	∆LERF * CT
	=	(8.775E-06/yr – 6.977E-06/yr) * 1.92E-2 yr
	=	1.80E-6/yr * 1.92E-2
	=	3.45E-8
ICLERP (2 days)	=	1.80E-6/yr * 5.48E-3 yr
	=	9.86E-09

As can be seen by the calculations, the reduction in the Completion Time (CT) from 7 days to 48 hours as proposed by the BWROG results in a reduction in the ICLERP risk metric from 3.45E-08 to 9.86E-09. Both results are below the Acceptance Guideline from RG 1.177.

<u>Calculation of ∆LERF</u>

The application of RG 1.174 Acceptance Guideline is more difficult to precisely define because it requires estimating the frequency with which the Technical Specification CT might be used. Because of the rarity of the condition, it is judged that this CT would be used no more frequently than once every 10 years. The ∆LERF calculation is performed to show that as a function of the "allowed" CT the ∆LERF would increase in direct proportion to the length of the CT and the magnitude of the LERF with no igniters available.

This allows the RG 1.174 ∆LERF risk metric to be calculated:

LERF (CT = 7 days)

$$\text{LERF} = \text{LERF}_{\text{NO IGNITER}} * \frac{7\text{ days}}{10\text{ years}} + \text{LERF}_{\text{BASE}} * 1.0 - \text{LERF}_{\text{BASE}}$$

= 8.78E-6/yr * 1.92E-3 + 6.98E-6/yr - 6.98E-6/yr
= 1.68E-8/yr (given a LERF of ~7.1E-6/yr)

ΔLERF (CT = 2 days)

$$\text{LERF} = \text{LERF}_{\text{NO IGNITER}} * \frac{2\text{ days}}{10\text{ years}} + \text{LERF}_{\text{BASE}} * 1.0 - \text{LERF}_{\text{BASE}}$$

= 8.78E-6/yr * 5.48E-4
= 4.81E-9/yr (given a LERF of ~7.1E-6/yr)

ΔLERF = LERF(48 Hr CT) – LERF(7 day CT)
= 4.81E-9/yr – 1.68E-8/yr
= (-)1.20E-8/yr

The negative sign indicates that the change in LERF as a result of the CT change results in a decrease in risk, i.e., a positive safety benefit.

Calculation Conclusion for Igniters

The external plus internal event evaluation is presented to demonstrate that, given a reasonable characterization of the risk spectra for a typical Mark III containment, the risk metrics will remain within the Acceptance Guidelines of the NRC Regulatory Guides.

Results for 7 Day CT (Current Risk Profile Measures)

Risk Metric	Risk Metric Calculation Internal and External Events	Acceptance Guideline	
		Value	RG
ICLERP	3.45E-8	5E-8	RG 1.177

Therefore, the 7 day Completion Time (CT) for both divisions of igniters meets the Acceptance Guideline from R.G. 1.177 and would be acceptable for this base case (best estimate calculation).

Results for 48 hour CT (Proposed Risk Profile Measures)

Risk Metric	Risk Metric Calculation Internal and External Events	Acceptance Guideline Value	RG
ICLERP	9.86E-9	5E-8	RG 1.177
ΔLERF	(-)1.20E-8/yr	1E-7/yr	RG 1.174

Therefore, the 48 hour Completion Time (CT) for both divisions of igniters meets the Acceptance Guidelines from R.G. 1.177 and RG 1.174 and would be acceptable.

3.7 SUMMARY AND CONCLUSION MARK III IGNITERS

The Incremental Conditional Large Early Release Probability (ICLERP) defined in RG 1.177 represents a risk metric that can be used to assess the risk significance of changes in the Completion Time.

As can be seen by the calculations, the reduction in the Completion Time (CT) from 7 days to 48 hours as proposed by the BWROG results in a reduction in the ICLERP from 3.45E-08 to 9.86E-09. Both ICLERP and ΔLERF results are below the Acceptance Guidelines from RG 1.177 and 1.174, respectively.

Therefore, either Completion Time of 7 days or 48 hours is acceptable using RG 1.174 and RG 1.177 acceptance guidelines although there is less margin for the 7 day CT.

Figure 3-2
Core Damage Frequency
{{{The contents of this figure are unclassified sensitive information}}}

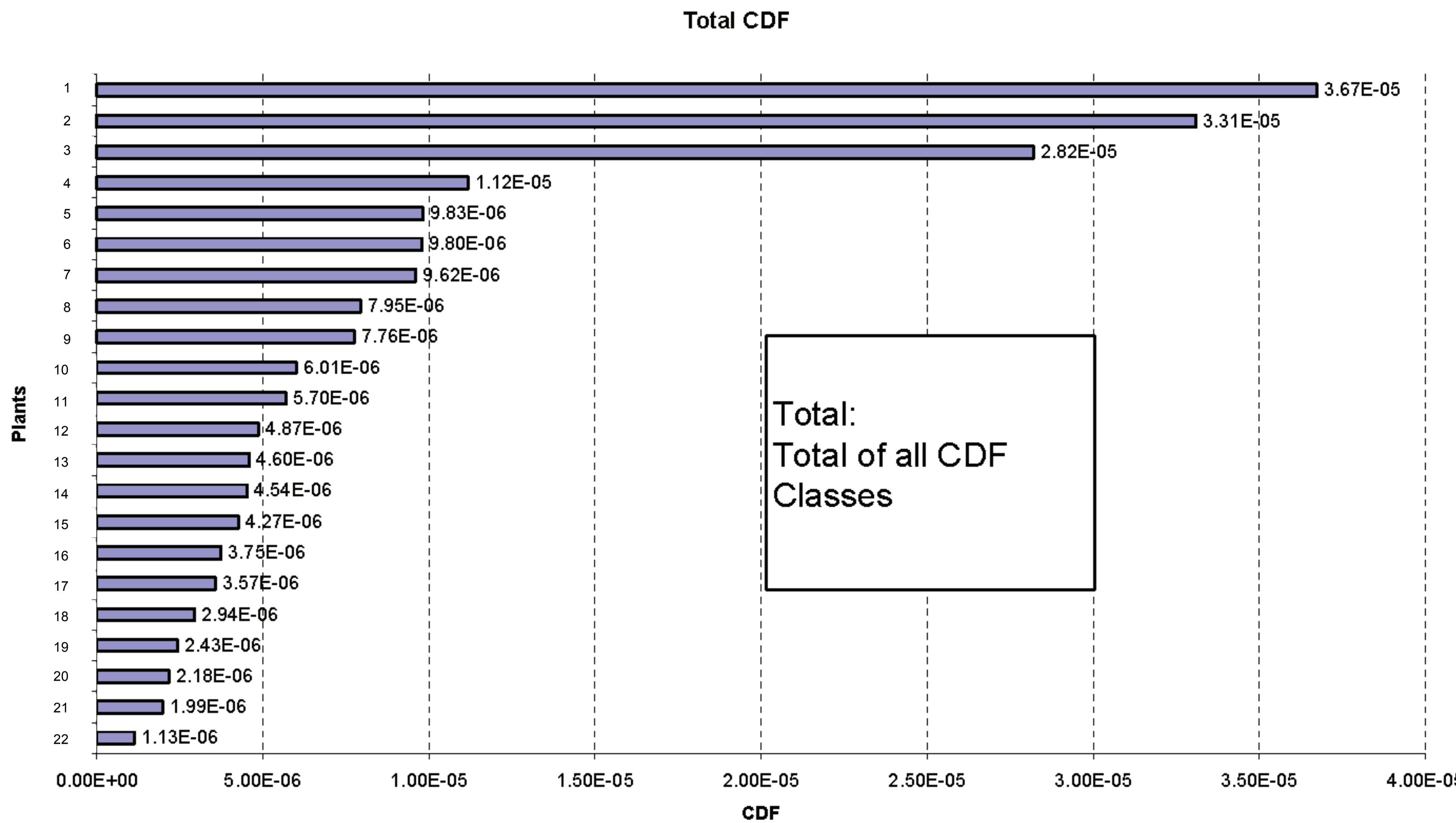

Figure 3-2 Core Damage Frequency
(Figure 5-1 from NEDO-33215)

Table 3-2

SEISMIC CDF FOR BWRS PERFORMING A SEISMIC PRA[1]
(Taken from NUREG-1742 [7])

Plant	Mean Seismic CDF	
	EPRI or Other	LLNL
Plant A (Mark II)	2.10E-05	2.10E-05[2]
Plant B (Mark I)	1.06E-06	3.60E-06
Plant C (Mark II)	7.60E-07	7.60E-07[2]
Plant D (Mark II)	2.50E-07	1.20E-06
Plant E (Mark I)	3.62E-06	6.36E-06
Average	5.34E-06	6.58E-06

(1) Plant F (Mark I) seismic evaluation has been eliminated from this evaluation because it is considered an outlier and the result of a conservative seismic assessment not representative of other BWRs.

(2) The Plant A and Plant C units did not have LLNL mean seismic CDFs quoted, therefore the EPRI or other values have been used as surrogates.

Table 3-3

SUMMARY OF MARK III FIRE CDFS
(Taken from NUREG-1742 [7])

Plant Name	Methodology Used	Fire CDF Report in the IPEEE	Fire CDF after RAIs completed
Plant G	PRA	3.26E-06	3.64E-06
Plant H	FIVE, PRA	8.76E-06	8.89E-06
Plant I	FIVE, PRA	3.27E-05	3.27E-05
Plant J	PRA+	2.25E-05	2.25E-05
Average		1.68E-5	1.69E-05

Table 3-4

COMPARISON OF AVERAGE CDF FOR MARK III BWRS USING AVAILABLE PUBLISHED INFORMATION

HAZARD	AVERAGE CDF (per yr)	CONTRIBUTORS
Internal Events	6.47E-6[(1)]	Spectrum of contributors involving: • Short term SBO • Long term SBO • Loss of DHR • Loss of makeup • ATWS
Seismic	6.58E-6	Dominated by LOOP, SBO, and events with degraded containment that lead to LERF regardless of containment inerting status. This is reinforced because offsite protective measures for evacuation are likely severely impeded by the seismic event.
Fire	1.69E-05	Dominated by loss of DHR sequences or long term Station Blackout that have the opportunity for effective evacuation.

(1) Not used in this analyses.

Table 3-5

SUMMARY OF COMPLETION TIME (CT) FOR BEST ESTIMATE EVALUATION

System	Completion Time (CT)	RG 1.177 Acceptance Guideline Comparison	
		Calculated ICLERP	Guideline ICLERP
Both Hydrogen Igniter Divisions Proposed	48 hours	9.86E-09	5E-08
Current	7 days	3.45E-08	5E-08

Section 4
CONCLUSION

This section provides the summary and conclusions resulting from the probabilistic risk assessment associated with the removal of the hydrogen recombiner and reduction in allowed technical specification completion time for igniters (Mark III plants).

4.1 PROCESS

The analysis approach is to perform a best estimate probabilistic risk evaluation for a typical Mark III plant for the Technical Specification CT associated with having both divisions of igniters unavailable. This best estimate calculation is then supplemented by several sensitivity calculations to demonstrate a range of possible risk metrics.

The intent of this process is to demonstrate that the proposed combustible gas CT of 48 hours for the igniters (both divisions) results in acceptable risk metrics and a public safety benefit – not a risk increase relative to the current Technical Specification CT of 7 days.

4.2 OVERVIEW

The postulated risks that may exist are larger if the Technical Specification remains unchanged. Failing to change the Technical Specification would appear to be contrary to the NRC goal of minimizing the risk associated with the subject igniter CT condition as discussed in the SER. [1]

4.3 RESULTS CONCLUSION

Table 4-1 summarizes the probabilistic risk assessment base case (best estimate) with and without external events included to assess the benefit of the proposed

Technical Specification change. The cases in Table 4-1 show that the critical risk metric, ICLERP, for the proposed CT is: (1) within the acceptance guidelines of RG 1.177; and, (2) is significantly lower than the ICLERP risk measure for the current CT of 7 days.

A more compelling consideration is that ICLERP is always reduced for the proposed Technical Specification relative to the existing Technical Specification. Therefore, the reduction in CT is a positive safety enhancement independent of the modeling assumptions. The ICLERP remains well within the acceptance guidelines from Regulatory Guide 1.177 for the best estimate case.

4.4 COMPENSATORY MEASURES

As part of the resolution to GSI 189, the BWROG Mark III plants have agreed to implement measures to provide alternate power supplies to the igniters.

These alternate power supplies will be implemented on a plant specific basis and will generally require crew actions for alignment. These methods will further reduce the probability of having an accident with the igniters unavailable for operation.

Therefore, the risk metrics assessed for the different Completion Time options and the different sensitivity cases can be viewed as conservative.

Table 4-1

SUMMARY OF CASES EVALUATED FOR IGNITER UNAVAILABILITY

Cases	Description	ICLERP Risk Metric Existing 7 Day CT	ICLERP Risk Metric Proposed 48 Hr CT
Best Estimate Base Case (with External Events)	Use example Mark III Base PRA Analysis. Igniter unavailability leads to containment and DW failure similar to NUREG-1150. Assume certain Level 1 accident sequences may preclude LERF contribution based solely on timing of release. RPV pressure at breach has no impact on Cond. LERF due to H_2 ignition (NUREG-1150 assumption)	3.45E-8	9.86E-9
Best Estimate Internal Events	Internal Events only Use example Mark III Base PRA Analysis. Igniter unavailability leads to containment and DW failure similar to NUREG-1150. Assume certain Level 1 accident sequences may preclude LERF contribution based solely on timing of release.	1.04E-8	2.99E-9

Section 5
REFERENCES

[1] Drouin, Mary, et al., Feasibility Study for a Risk-Informed Alternative to 10 CFR 50.44: "Standards for Combustible Gas Control System in Light-water-cooled Power Reactors", Office of Nuclear Regulatory Research, August 2000.

[2] "RES PROPOSED RECOMMENDATION FOR RESOLVING GENERIC SAFETY ISSUE 189: 'SUSCEPTIBILITY OF ICE CONDENSER AND MARK III CONTAINMENTS TO EARLY FAILURE FROM HYDROGEN COMBUSTION DURING A SEVERE ACCIDENT' ", memo from Ashok C. Thadani (Office of Nuclear Regulatory Research) to Samuel J. Collins (Office of Nuclear Reactor Regulation), dated December 17, 2002.

[3] Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants, NUREG-1150, December 1990.

[4] Evaluation of Severe Accident Risks: Grand Gulf, Unit 1, NUREG/CR-4551, Vol. 6, Rev. 1, Part 1, December 1990.

[5] Canavan, K., Aggregation of Quantitative Risk Assessment Results: Comparing and Manipulating Risk Metrics, EPRI 1010068, December 2005.

[6] BWROG MSPI Cross Comparison, NEDO-33215.

[7] Perspectives Gained From the Individual Plant Examination of External Events (IPEEE) Program, USNRC, Office of Nuclear Regulatory Research, NUREG-1742, Vol. 2, April 2002.

[8] Safety Evaluation, U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Technical Specification Task Force Change TSTF-478, Revision 1, "BWR Technical Specification Changes That Implement the Revised Rule for Combustible Gas Control".

[9] Memorandum to Nuclear Regulatory Commissioners from L.A. Reyes (EDO), STATUS OF STAFF ACTIVITIES TO RESOLVE GENERIC SAFETY ISSUE 189, "SUSCEPTIBILITY OF ICE CONDENSER AND MARK III CONTAINMENTS TO EARLY FAILURE FROM HYDROGEN COMBUSTION DURING A SEVERE ACCIDENT", dated June 14, 2005.

[10] Basis Document for Large Early Release Frequency (LERF) Significance Determination Process (SDP), NUREG-1765, Division of Risk Analysis and Applications, Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, December 2002.

3.6 CONTAINMENT SYSTEMS

3.6.3.1 Primary Containment and Drywell Hydrogen Ignitors

LCO 3.6.3.1 Two divisions of primary containment and drywell hydrogen ignitors shall be OPERABLE, each with > 90% of the associated ignitor assemblies OPERABLE.

APPLICABILITY: MODES 1 and 2.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One primary containment and drywell hydrogen ignitor division inoperable.	A.1 Restore primary containment and drywell hydrogen ignitor division to OPERABLE status.	30 days
B. Two primary containment and drywell hydrogen ignitor divisions inoperable.	~~B.1 Verify by administrative means that the hydrogen control function is maintained.~~ ~~AND~~ B.1~~2~~ Restore one primary containment and drywell hydrogen ignitor division to OPERABLE status.	~~1 hour~~ ~~AND~~ ~~Once per 12 hours thereafter~~ 48 hours ~~7 days~~
C. Required Action and associated Completion Time not met.	C.1 Be in MODE 3.	12 hours

B 3.6 CONTAINMENT SYSTEMS

B 3.6.3.1 Primary Containment and Drywell Hydrogen Ignitors

BASES

BACKGROUND

The primary containment and drywell hydrogen ignitors are a part of the combustible gas control required by 10 CFR 50.44 (Ref. 1) and GDC 41, "Containment Atmosphere Cleanup" (Ref. 2), to reduce the hydrogen concentration in the primary containment following a degraded core accident. The hydrogen ignitors ensure the combustion of hydrogen in a manner such that containment overpressure failure is prevented as a result of a postulated degraded core accident.

10 CFR 50.44 (Ref. 1) requires boiling water reactor units with Mark III containments to install suitable hydrogen control systems. The hydrogen ignitors are installed to accommodate an amount of hydrogen equivalent to that generated from the reaction of 75% of the fuel cladding with water. This requirement was placed on reactor units with Mark III containments because they were not designed for inerting and because of their low design pressure. Calculations indicate that if hydrogen equivalent to that generated from the reaction of 75% of the fuel cladding with water were to collect in primary containment, the resulting hydrogen concentration would be far above the lower flammability limit such that, without the hydrogen ignitors, if the hydrogen were ignited from a random ignition source, the resulting hydrogen burn would seriously challenge the primary containment.

The hydrogen ignitors are based on the concept of controlled ignition using thermal ignitors designed to be capable of functioning in a post accident environment, seismically supported and capable of actuation from the control room. Ignitors are distributed throughout the [32] regions of the drywell and primary containment in which hydrogen could be released or to which it could flow in significant quantities. The hydrogen ignitors are arranged in two independent divisions such that each containment region has two ignitors, one from each division, controlled and powered redundantly so that ignition would occur in each region even if one division failed to energize.

When the hydrogen ignitors are energized they heat up to a surface temperature ≥ [1700]°F. At this temperature, they ignite the hydrogen gas that is present in the airspace in the vicinity of the ignitor. The hydrogen ignitors depend on the dispersed location of the ignitors so that local pockets of hydrogen at increased concentrations would burn before reaching a hydrogen concentration significantly higher than the lower flammability limit. Hydrogen ignition in the vicinity of the ignitors is assumed to occur when the local hydrogen concentration reaches [8.0] volume percent (v/o) and results in [85]% of the hydrogen present being consumed.

BASES

APPLICABLE SAFETY ANALYSES	The hydrogen ignitors cause hydrogen in containment to burn in a controlled manner as it accumulates following a degraded core accident (Ref. 3). Burning occurs at the lower flammability concentration, where the resulting temperatures and pressures are relatively benign. Without the system, hydrogen could build up to higher concentrations that could result in a violent reaction if ignited by a random ignition source after such a buildup. The hydrogen ignitors are not included for mitigation of a Design Basis Accident (DBA) because an amount of hydrogen equivalent to that generated from the reaction of 75% of the fuel cladding with water is far in excess of the hydrogen calculated for the limiting DBA loss of coolant accident (LOCA) pursuant to 10 CFR 50.46. ~~The hydrogen concentration resulting from a DBA can be maintained less than the flammability limit using the hydrogen recombiners.~~ However, the hydrogen ignitors have been shown by probabilistic risk analysis to be a significant contributor to limiting the severity of accident sequences that are commonly found to dominate risk for units with Mark III containment. The hydrogen ignitors satisfy Criterion 4 of 10 CFR 50.36(c)(2)(ii).
LCO	Two divisions of primary containment and drywell hydrogen ignitors must be OPERABLE, each with more than 90% of the ignitors OPERABLE. This ensures operation of at least one ignitor division, with adequate coverage of the primary containment and drywell, in the event of a worst case single active failure. This will ensure that the hydrogen concentration remains near 4.0 v/o.
APPLICABILITY	In MODES 1 and 2, the hydrogen ignitor is required to control hydrogen concentration to near the flammability limit of 4.0 v/o following a degraded core event that would generate hydrogen in amounts equivalent to a metal water reaction of 75% of the core cladding. The control of hydrogen concentration prevents overpressurization of the primary containment. The event that could generate hydrogen in quantities sufficiently high enough to exceed the flammability limit is limited to MODES 1 and 2. In MODE 3, both the hydrogen production rate and the total hydrogen produced after a degraded core accident would be less than that calculated for an accident in MODE 1 or 2~~the DBA LOCA~~. Also, because of the limited time in this MODE, the probability of an accident requiring the hydrogen ignitor is low. Therefore, the hydrogen ignitor is not required in MODE 3. In MODES 4 and 5, the probability and consequences of a degraded core accident are reduced due to the pressure and temperature limitations.

Therefore, the hydrogen ignitors are not required to be OPERABLE in MODES 4 and 5 to control hydrogen.

BASES

ACTIONS

A.1

With one hydrogen ignitor division inoperable, the inoperable division must be restored to OPERABLE status within 30 days. In this Condition, the remaining OPERABLE hydrogen ignitor division is adequate to perform the hydrogen burn function. However, the overall reliability is reduced because a single failure in the OPERABLE subsystem could result in reduced hydrogen control capability. The 30 day Completion Time is based on the low probability of the occurrence of a degraded core event that would generate hydrogen in amounts equivalent to a metal water reaction of 75% of the core cladding, the amount of time available after the event for operator action to prevent hydrogen accumulation from exceeding the flammability limit, and the low probability of failure of the OPERABLE hydrogen ignitor division.

B.1~~ and B.2~~

With two primary containment and drywell igniter divisions inoperable, one igniter division must be restored to OPERABLE status within 48 hours. In this condition, the ability to prevent an uncontrolled hydrogen ignition is reduced. However, severe accident management strategies employ other methods to control hydrogen concentrations and lower containment pressure to prevent over pressurization of the drywell and containment. In addition, the random ignition sources which could ignite the hydrogen after a buildup could also cause ignitions that help prevent the buildup of detonable hydrogen concentrations. The 48 hour Completion Time is based on the low probability of the occurrence of a degraded core event that would generate hydrogen in amounts equivalent to a metal water reaction of 75% of the core cladding and the amount of time available after the event for operator action to prevent hydrogen accumulation or reduce containment pressure.

~~With two primary containment and drywell ignitor divisions inoperable, the ability to perform the hydrogen control function via alternate capabilities must be verified by administrative means within 1 hour. The 1 hour Completion Time allows a reasonable period of time to verify that a loss of hydrogen control function does not exist. The verification may be performed as an administrative check by examining logs or other information to determine the availability of the alternate hydrogen control capabilities. It does not mean to perform the Surveillances needed to demonstrate OPERABILITY of the alternate hydrogen control capabilities. If the ability to perform the hydrogen control function is maintained, continued operation is permitted with two ignitor divisions inoperable for up to 7 days. Seven days is a reasonable time to allow two ignitor divisions to be inoperable because the hydrogen control function is maintained and because of the low probability of the occurrence of a LOCA that would generate hydrogen in the amounts capable of exceeding the flammability limit.~~