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# LICENSING TOPICAL REPORT

# GENERIC GUIDELINES AND EVALUATIONS FOR GENERAL ELECTRIC BOILING WATER REACTOR THERMAL POWER OPTIMIZATION

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## IMPORTANT NOTICE REGARDING CONTENTS OF THIS REPORT

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# ABSTRACT

This document presents the generic guidelines, evaluations, criteria, process, and scope of work required by the Nuclear Regulatory Commission (NRC) to grant approval of anticipated specific applications for increases in the authorized thermal power levels of General Electric (GE) Boiling Water Reactor (BWR) plants. These power increases would be the result of obtaining and applying a reduced thermal power uncertainty to the appropriate analyses and evaluations that support the Operating License (OL) of the plant. This document addresses a Thermal Power Optimization (TPO) Program, which covers uprates up to 1.5% of the current licensed thermal power (CLTP), consistent with the magnitude of a thermal power uncertainty reduction for which a plant could obtain approval. NRC approval of this generic guideline is desired in order for utilities to move forward with thermal power uncertainty reduction-based power uprate programs. The specific criteria, methods, assumptions, and scope identified for approval are listed in the appendices to this report.

Implementation of this generic approach should reduce the uncertainty and level of effort for evaluation and approval by both the utilities and the NRC. An increase in the electrical output level at a BWR power station is primarily accomplished by supplying higher steam flow to the turbine-generator. In a TPO uprate, this is accomplished without any increase in reactor vessel dome pressure.

BWR plants, as currently licensed, have safety system and component capability for operation at least 1.5% above the CLTP level as proposed in this document. Continuing improvements in the analytical techniques based on more realistic assumptions and models, plant performance experience, and the latest fuel designs have resulted in significant increases in the calculated operational margins related to safety analyses. This available safety analysis margin, combined with the as-built equipment, system, and component capability, provides BWR plants with the potential for the ≤ 1.5% increase in thermal power planned for a TPO uprate without any Nuclear Steam Supply System (NSSS) hardware modifications (except for rescaling of some power-related signals and setpoints).

Several BWR plants have already been authorized to increase their thermal power above the original licensed thermal power (OLTP) level. When such a previous uprate has been accomplished, the ≥ 102% safety analysis basis has been reestablished above the uprated power level. Thus, all GE BWR plant designs are expected to be able to implement a TPO uprate, if they desire, whether or not the plant has previously been uprated. This generic report addresses power increases of ≤ 1.5% of CLTP, which will produce about a 2% increase in steam flow to the turbine-generator.

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# 1.0 INTRODUCTION

This document presents the generic guidelines, evaluations, criteria, process, and scope of work required by the Nuclear Regulatory Commission (NRC) to grant approval of anticipated specific applications to increase the authorized thermal power levels of General Electric (GE) Boiling Water Reactor (BWR) plants. These power increases would be the result of obtaining and applying a reduced thermal power uncertainty to the appropriate analyses and evaluations that support the Operating License (OL). This document addresses a Thermal Power Optimization (TPO) Program, which covers uprates up to 1.5% of the current licensed thermal power (CLTP), consistent with the magnitude of a thermal power uncertainty reduction for which a plant could obtain approval. NRC approval of this generic guideline is desired in order for utilities to move forward with thermal power uncertainty reduction-based power uprate programs. The specific criteria, methods, assumptions, and scope identified for approval are listed in the appendices to this report.

A mutually accepted approach will be beneficial for the NRC and licensees, in that an up-front basic understanding of the uprate licensing process will permit more efficient preparation and review of specific uprate applications. Such an increase in thermal power has proven to be a valuable source of additional electric power capacity with no significant modification to the existing plant and without compromise to the public health and safety. Supplemental reports are also possible to provide additional bounding generic results for specific areas of BWR evaluation. Review and acceptance of these submittals will reduce the plant-specific review scope for all BWRs that are within the bounding evaluations.

## 1.1 BACKGROUND

The TPO program is a GE power uprate program to obtain approval from the NRC to apply a reduced reactor thermal power uncertainty (less than the historical allowance of ≥ 2%) for 10 CFR 50, Appendix K and Regulatory Guide (RG) 1.49 (Reference 1) analyses. The objective of the TPO program is to provide safety evaluations and consultation to support a utility in its request for a related amendment to a plant OL for an increase in reactor thermal power consistent with the magnitude of the thermal power uncertainty reduction obtained. The magnitude of the plant-specific thermal power uncertainty reduction is dependent on several factors, including the design and accuracy of the plant feedwater (FW) flow measurement instrumentation.

A plant's current OL is supported by a number of analyses and evaluations performed with a reactor thermal power uncertainty of ≥ 2%, either through 10 CFR 50, Appendix K or RG 1.49. By applying the reduced reactor thermal power uncertainty to those analyses, the utility may justify increasing the reactor thermal power level and still remain within the boundaries of these specific analyses. However, other safety and engineering analyses and evaluations, which also support the current OL, were performed at either the nominal reactor thermal power level without an adder for thermal power uncertainty, or through statistical application of this uncertainty. Therefore, to support an increase in the reactor thermal power, these other analyses and evaluations must be either re-performed or dispositioned for application to the increased reactor thermal power level.

Because a power uprate based solely on a reduction of the plant's thermal power uncertainty will result in a small increase in average maximum thermal power, GE provides this document to demonstrate that most of the effects of this small increase can be bounded by previous generic and plant analyses. This allows many of the tasks to be dispositioned or evaluated generically for a reactor thermal power of $\leq$ 1.5%, thus reducing the amount of plant-specific tasks to be performed. The TPO program is based on the generic guidelines approved by the NRC for previous BWR power uprate programs (e.g., References 20 and 21) with simplifications to the required scope of work as a result of the generic evaluations. Where necessary, a discussion of the effect of a mixed core (GE fuel and non-GE fuel) on the TPO uprate is provided.

Performing BWR evaluation tasks generically is not a new concept for a power uprate. Previous BWR power uprate projects approved by the NRC include many generic evaluations. With only a 1.5% increase in thermal power targeted for TPO, rather than the typical 5% or larger uprate already approved and implemented for many BWRs, the number of tasks that can be handled on a generic basis increases.

## 1.2 PROJECTED APPLICATION

Several BWR plants are interested in using a reduced thermal power uncertainty to increase their licensed thermal power ratings. The most likely method that a licensee will use to seek TPO uprate approval will be through the addition of improved FW instrumentation.

It is anticipated that the NRC will receive TPO uprate license amendment applications for these plants. The generic guidelines and evaluations contained in this TPO Licensing Topical Report (TLTR) will assist the NRC and the utilities in the preparation, review, and approval of these uprate requests.

## 1.3 STRATEGY TO ACHIEVE HIGHER POWER

Previous applications to expand the BWR operating domain (power/core flow map) have been submitted and approved for many plants. Increased operational flexibility has been provided primarily by permitting operation at maximum licensed thermal power with core flow more than and/or less than original rated flow (Figure 1-1). These changes have "widened" the BWR power vs. flow operating domain, and significantly improved plant capacity factors. It is generically assumed that plant-specific TPO submittals will maintain the currently-licensed operating domain options, with licensed power level being the only change. Because the licensing process involved with these performance improvements has been previously determined, it is not addressed in this TLTR, except to point out the areas of a TPO-based power uprate that are related to the operating domain.

The strategy for a TPO-based power uprate increases the core flow along the Extended Load Line Limit Analysis (ELLLA) or Maximum Extended Load Line Limit Analysis (MELLLA) rod line. This allows attainment of up to a 1.5% increase in thermal power over CLTP. The increased power is achieved for a range of core flow from the new full power point along the maximum previously licensed rod line up to the maximum licensed core flow. The maximum core flow may be an increased core flow (ICF) option if the plant is so licensed. MELLLA and ICF are not required for TPO uprate operation, but they are beneficial, and will be included if previously licensed for a plant. BWR/6 plants use the term MEOD, which is the combination of both the

MELLLA and ICF extensions to the operating range. Control rod patterns are usually adjusted with less than rated core flow and are to be maintained at or below the current operating rod pattern/flow control lines.

The power increase is achieved by increasing core flow along existing flow control lines, as shown in Figure 1-1. Generic TPO power uprate will not increase the maximum licensed value of core flow. The normal operating pressure of the vessel dome will be maintained equal to the pre-TPO uprate pressure, simplifying many aspects of the uprate evaluation process.

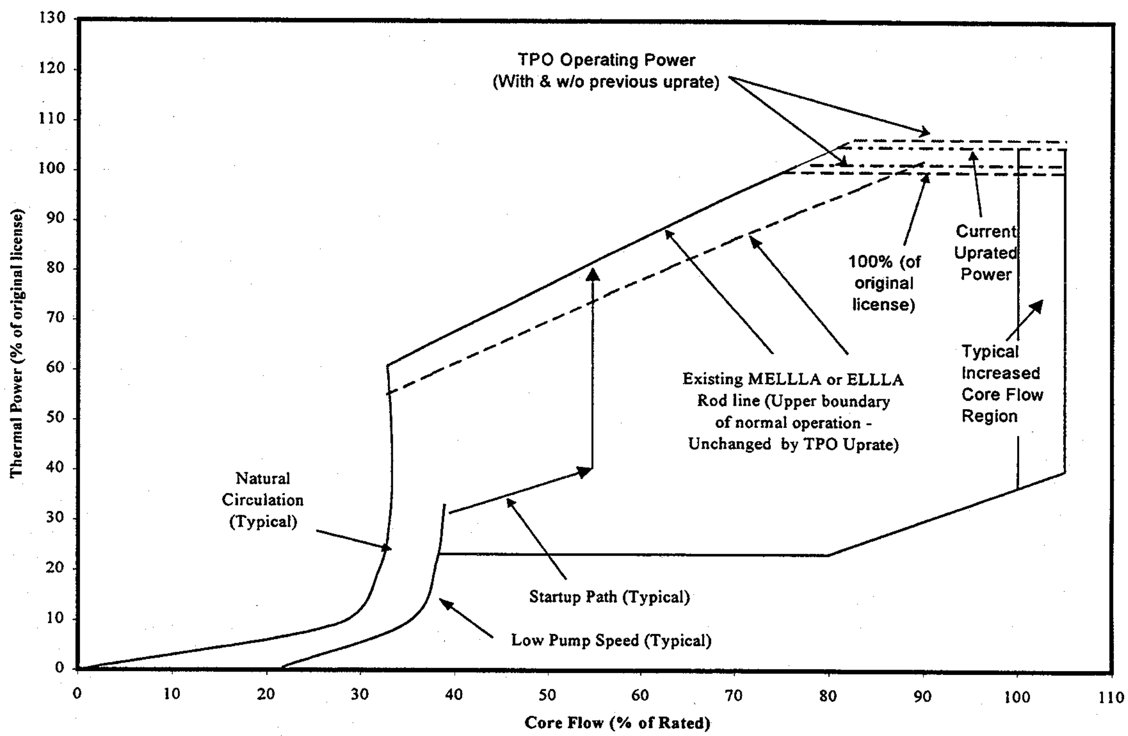


**Figure 1-1. Typical TPO-Based Power Uprate (+1.5% Thermal Power) Power/Flow Map**

# 2.0 PURPOSE

This document provides (1) generic guidelines for the process of preparing and submitting license amendments to the NRC for uprating GE BWRs based on a reduction of the plant's thermal power uncertainty, (2) generic evaluations of numerous systems and plant analyses that are not significantly affected by a ≤ 1.5% TPO uprate, and (3) a generic approach for the licensing criteria, uprating process, evaluation methodology, and scope of plant-specific submittals.

These guidelines and evaluations have been formulated to minimize uncertainties in the regulatory area and are based on:

- NRC-approved GE Licensing Topical Reports (LTRs) for Stretch Power Uprate (SPU, ~105% of original licensed thermal power (OLTP)), and Extended Power Uprate (EPU, up to 120% of OLTP) (References 20 and 21, respectively).
- Completed, NRC-approved, power uprate analyses to support SPU and EPU OL amendment submittals.
- NRC's rule change to 10 CFR Part 50, Appendix K to allow holders of operating licenses for nuclear power plants to reduce the assumed thermal power uncertainty used in ECCS performance evaluations (Reference 26).

NRC review and approval of the specific areas provided in the appendices to this document will provide acceptable generic licensing criteria, methodology, test requirements, and a defined scope of analytical and equipment review required for a thermal power uncertainty reduction-based power uprate.

# 3.0 LICENSING APPROACH

The licensing evaluations and reviews for uprating a BWR plant, as a result of reducing the plant's thermal power uncertainty, will be conducted in accordance with the specific criteria listed in Appendix B to this document. Systems and plant analyses, which are generically evaluated and dispositioned herein, will only be addressed in the TPO Safety Analysis Report (TSAR) to the extent that a plant-specific confirmation is provided.

Plant Technical Specifications will be affected in only a few areas, including those containing numerical references to rated power or parameters, which are a function of power. Examples range from the definition of Rated Thermal Power (RTP) to specifications covering Operating Limit Minimum Critical Power Ratio (OLMCPR). Other specifications that may potentially be affected are those that involve instrument setpoints. In most cases, plant-specific evaluations will define necessary changes, which will be reported in the plant-specific application. Recalibration of the power range monitors will be done so that the uprated power indicates 100%, and the setpoints of high power alarms and trips relative to licensed thermal power are not expected to change. Appendix F discusses specific aspects of setpoint adjustment.

A plant seeking a TPO uprate is expected to request an amendment to its OL consistent with the considerations that govern its current OL (i.e., there is no change in the 10 CFR 50.2 design bases for the plant with the only exception being the licensed power level). No significant increases in the amount of effluents or radioactive material discharged from a facility are anticipated due to a TPO uprate. Consideration of potential significant hazards will establish that operation of the facility in accordance with the proposed amendment would not:

(1) Involve a significant increase in the probability or consequences of an accident previously evaluated; or

(2) Create the possibility of a new or different kind of accident from any accident previously evaluated; or

(3) Involve a significant reduction in a margin of safety.

In general, the anticipated effect of TPO uprate on the bounding licensing criteria is as shown in Table 3-1. Many of these safety parameters will have no change for TPO uprate because they are bounded by the previous analyses performed with power uncertainty allowance ≥ 102% of CLTP. The other estimates are based on typical plant configurations and latest analytical methods. The results for specific plant analyses may differ; however, any differences are not expected to be significant.

## Table 3-1

## ANTICIPATED EFFECT OF TPO UPRATE ON BOUNDING LICENSING CRITERIA

| Key Licensing Criteria | Effect of a ≤ 1.5% Thermal Power Increase | Explanation of Effect (Report Section) |
|---|---|---|
| LOCA challenges to fuel (10 CFR 50 and 10 CFR 50, Appendix K) | No increase in PCT, no change of maximum LHGR required. | Previous analysis accounted for ≥ 102% of licensed power, bounding TPO operation. No vessel pressure increase. (Appendix D) |
| Change of Operating Limit MCPR | [ ] | Minor increase due to slightly higher power density and increased MCPR safety limit (slightly flatter radial power distribution). (Appendix E) |
| Challenges to RPV overpressure | No increase in peak pressure. | No increase because previous analysis allowed ≥ 102% overpower, bounding TPO operation. (Appendix E) |
| Primary containment pressure during a LOCA | No increase in peak containment pressure. | Previous analysis allowed ≥ 102% overpower, bounding TPO operation. No vessel pressure increase. No increase in energy to the pool. (Appendix G) |
| Pool temperature during a LOCA | No increase in peak pool temperature. | Previous analysis allowed ≥ 102% overpower, bounding TPO operation. No vessel pressure increase. No increase in energy to the pool. (Appendix G) |
| Offsite Radiation Release, design basis accidents | No increase (remain within 10 CFR 100). | Previous analysis allowed ≥ 102% overpower, bounding TPO operation. No vessel pressure increase. (Appendix H) |
| Onsite Radiation Dose, normal operation | ~1.5% increase, must remain within 10 CFR 20. | Slightly higher inventory of radionuclides in steam/FW flow paths. (Appendix H) |
| Heat discharge to environment | ~1°F temperature increase. | Small % power increase. (5.9) |
| Equipment Qualification | Expected to remain within current pressure, radiation, and temperature envelopes. | No change in Harsh Environment terms (bounded by previous design using ≥ 102% power); minimal change in normal operating conditions. (5.11.2) |
| Fracture Toughness, 10 CFR 50, Appendix G | < 2°F increase in $RT_{NDT}$. | Small increase in neutron fluence. (Appendix I) |
| Stability | No direct effect of TPO uprate because applicable stability regions and lines are rescaled to preserve MWt-core flow boundaries as applicable for each stability option. | No increase in maximum rod line boundary. Characteristics of each reload core continue to be evaluated as required for each stability option. (5.3.4) |
| Anticipated Transient Without Scram (ATWS) peak vessel pressure | Slight increase, must stay within existing ASME Code “Emergency” category stress limit. | Slightly increased power relative to SRV capacity. (Appendix L) |
| Vessel and NSSS equipment design pressure | No change. | Comply with existing ASME Code stress limits of all categories. (Appendices I and J) |

# 4.0 TPO UPRATING PROCESS

Approval of this generic report, and the guidelines, process, and evaluations contained herein and in the appendices is vital to the planning and performance of a TPO power uprate project, which is based on thermal power uncertainty reduction. Approval of this guideline and the documented evaluations ensures that acceptable scope and documentation are defined for straightforward utility preparation and NRC review of the license application.

The power uprate process for the TPO program is captured in four phases: (1) Definition, (2) Evaluation, (3) Review, and (4) Implementation. A brief description of these four phases is provided in the following paragraphs.

## 4.1 DEFINITION PHASE

The Definition Phase is where the project-specific aspects of the TPO program are defined. These aspects include a division of responsibility for the scope of work, project schedule, and project deliverables. This TLTR provides the basis for the total scope of work required to implement a thermal power uncertainty reduction-based power uprate.

## 4.2 EVALUATION PHASE

The Evaluation Phase is where engineering and safety evaluations are performed to support plant-specific aspects of a thermal power increase for the plant. A TSAR, and other documentation required to support an OL amendment request, will be prepared based on the results of these evaluations for submittal to the NRC. These evaluations may have been performed previously for generic application to multiple plants, or they will be performed on a plant-specific basis with the results applicable to that plant only.

### 4.2.1 Generic Evaluations

To reduce the number of plant-specific evaluations necessary to support a TPO uprate, many of the power uprate tasks are performed generically. If an individual plant's design and operating conditions are consistent with that used to evaluate the tasks, the plant can apply the results of these generic evaluations to support their plant-specific TPO uprate.

The generic evaluations documented herein are performed to support a ≤ 1.5% increase in the reactor thermal power. The actual thermal power increase that a plant can realize depends on the magnitude of the thermal power uncertainty reduction approved by the NRC for the utility. For example, if the utility can obtain acceptance of a 1% thermal power uncertainty (a 1% reduction), the plant's thermal power level could be increased by 1% before reaching the limit of the current evaluation of record based on historical Appendix K and RG 1.49 assumptions. Those evaluations allowed for at least 2% power measurement uncertainty. If, for another example, the utility can obtain acceptance of a 0.6% thermal power uncertainty (a 1.4% reduction), the plant's thermal power level could be increased by 1.4% before reaching the limit of the current evaluation of record for Appendix K and RG 1.49 based evaluations.

To maximize the effectiveness of these generic evaluations for application across the BWR fleet, performing the evaluation to support a 1.5% increase in thermal power allows for the evaluation to only be performed one time, and bounds the results that would be obtained for smaller increases in thermal power.

Examples of initial thermal power levels to be considered in the evaluations include:

- A plant currently licensed at its OLTP level (100%) and wishing to uprate to ≤ 101.5% of the CLTP level.
- A plant currently licensed at 1XX% of OLTP and wishing to uprate to ≤ 101.5% of the CLTP level.

However, the generic applicability of this TLTR is limited to a maximum TPO RTP of 120% of OLTP. Plants seeking to apply a TPO uprate to a previous uprate that would result in the licensed thermal power (LTP) in excess of 120% of OLTP must provide plant specific evaluations for those evaluations not performed at 102% of LTP.

The methodology for the evaluation of a TPO uprate is based on one of the following three approaches:

(a) The existing evaluation was conducted at ≥ 102% of CLTP, which bounds the TPO power uprate.

(b) A plant-specific evaluation was conducted at the TPO conditions.

(c) The generic evaluation presented in the TLTR is applicable. If the plant specific TPO uprate percentage exceeds the TLTR's generic evaluation basis of 1.5% (e.g., 1.7%), confirmation of the validity of the generic evaluation will be provided in the TSAR.

The applicability and validity of each evaluation for a TPO uprate from the CLTP level will reflect the basis for the existing evaluation and the capability of the plant. The TSAR will delineate which of the above three approaches apply for each evaluation topic.

Additional details about the generic evaluations can be found in Section 5.

### 4.2.2 Plant-Specific Evaluations

For those tasks that could not be evaluated generically, a plant-specific evaluation will be performed. Tables B-3 and J-3 (Appendices B and J) list the areas identified for plant-specific confirmation of acceptable safety compliance. These plant-specific evaluations will be performed at a thermal power level consistent with the thermal power uncertainty reduction achieved for that plant. This may be less than the 1.5% thermal power increase assumed in the generic evaluations.

### 4.2.3 Mixed Core Evaluations

The overall characteristics of BWRs with non-GE fuel and alternate (accepted) analysis methods are expected to be similar to the GE results and conclusions contained in the TLTR. For cases where the plant contains some or all non-GE fuel, the TPO license application will provide information regarding vendor analytical methods, results, and fuel specific acceptance criteria.

Changes in the vendor cycle license methodology may not be exactly equivalent and may require supplemental information to support the transition. For example, vendor analyses may be based on an arbitrary equilibrium cycle or on a cycle specific design.

Regardless, the licensing basis for mixed core evaluations will be clearly defined in the TPO license application.

### 4.2.4 Operating License Amendment Request

A plant-specific TSAR, which contains the summary and conclusions of the engineering evaluations, will be generated, using the generic outline given in Appendix A. The TSAR will address all the safety aspects of operating at TPO uprate conditions and planned operating strategy. The TSAR will include applicable results from the plant-specific engineering evaluations. Appendix B presents the licensing approach in more detail, as well as generic evaluations of some relevant licensing requirements such as RGs and General Design Criteria. The TSAR will address plant-specific licensing issues and provide confirmation of licensing issues that have been generically dispositioned. The TSAR also will identify deviations from these generic guidelines that may be desired by the utility, and will provide justification of the plant-specific approach.

The TSAR will accompany the Licensee's application for an increase in the authorized power level, along with any revisions to the plant's Technical Specifications. In its final form, this set of documents will target a specific fuel cycle in which TPO uprate operation is planned. Cycle-specific operating limits and evaluations of limiting events will be provided separately, according to current reload analysis and documentation practice. Cycle-specific information will be maintained at the pre-TPO uprate conditions until the TPO uprate license amendment is approved. The TPO uprate application will address those modifications, if any, that are essential to the plant safety functions.

## 4.3 REVIEW PHASE

In the Review Phase, the NRC performs a review of the Licensee's application for the OL amendment and its supporting documentation, with the objective of issuing a Safety Evaluation Report (SER) and OL amendment authorizing the increase in thermal power. Any Requests for Additional Information (RAIs) made by the NRC will be handled in this phase.

## 4.4 IMPLEMENTATION PHASE

In the Implementation Phase, the utility will implement any changes to procedures, documentation, software configuration management, training, surveillance, testing, and hardware necessary to achieve the increased power level. No plant modification is expected to be required for TPO, with the exception of some minor setpoint changes and APRM rescaling for the new RTP level. Some of these changes may be accomplished during the refueling outage prior to the first cycle of operation at the TPO uprate condition. Actual operation at the TPO uprate condition, and control system and core monitoring testing (Section 5.11.9 and Appendix L) will be initiated after NRC approval of the OL amendment. This implementation may be mid-cycle at the time of license approval because of the small changes associated with TPO uprate (e.g., no vessel pressure increase).

# 5.0 SCOPE

Previous BWR uprate licensing efforts encompassed a broad scope of analyses and evaluations to support and justify safe operation at the higher thermal power level and the resulting higher electrical output (e.g., References 20 and 21). These efforts covered a detailed review of plant design and operation with respect to regulatory requirements applicable to the plant at the time of the uprate. The previous evaluations covered equipment performance, actual versus projected operating conditions, and transient and accident evaluations.

This TLTR applies a similar, systematic approach for a TPO uprate for BWR plants. This TPO uprate program is intended for implementation whether or not a plant has previously incorporated a power uprate program. The magnitude of the changes introduced by a TPO uprate is significantly smaller than previous uprate efforts because they reflect only the relatively small increase in operating power due to improved FW and power measurement accuracy. This generic TLTR and any supplemental generic report(s) will be referenced without further evaluations to the extent that they are applicable by plant-specific submittals for a TPO uprate.

The primary focus of any power uprate licensing evaluation is on the affected bounding events and operating conditions that establish plant compliance with the applicable safety requirements and factors that may affect core operating limits. The evaluation also covers other associated issues such as environmental considerations at the increased power level.

Appendix A provides the format for a typical TSAR. This outline reflects the scope of the TSAR. It is anticipated that all TSARs will follow this format with little or no exception.

The TPO uprate effort covers NSSS and BOP systems and components that are potentially affected. The systems that are not power related or are insignificantly affected by the small increase in the power level associated with a TPO uprate are identified in this review process. A generic list of these systems is presented in Tables J-1 and J-2 of Appendix J. They need not be evaluated further in the TSAR. Systems and components that are generically evaluated and dispositioned herein (or in a supplemental document) will only be included in the TSAR to the extent that confirmation will be provided of the applicability of the generic conclusions.

A similar assessment of safety analysis tasks was performed. Many analysis areas are either not affected or are not significantly affected by TPO uprate. Tables B-1 and B-2 of Appendix B list those areas of evaluation. As in the system and component evaluation, these tasks will only be included in the TSAR to the extent that confirmation will be provided of the applicability of the generic conclusions.

For those tasks that could not be dispositioned generically, a plant-specific evaluation will be performed. Tables B-3 and J-3 (Appendices B and J) list the areas identified for plant-specific confirmation of acceptable safety compliance. These plant-specific evaluations will be performed at a thermal power level consistent with the thermal power uncertainty reduction achieved for that plant.

The remainder of this section provides generic evaluations and descriptions of the tasks to be reported in a licensing application for a TPO uprate. The associated appendices list the specific bases to be generically approved for application to all uprate plants.

## 5.1 REACTOR OPERATING CONDITIONS

One of the first tasks of any uprate effort, including the small changes associated with TPO, is to establish thermal-hydraulic parameters for the plant at the TPO RTP level. Table 5-1 shows typical values for a BWR plant. These parameters are generated for TPO by performing coordinated reactor and turbine-generator heat balances that relate the reactor thermal-hydraulic parameters to the increased plant FW and steam flow conditions. Input from actual plant operation is considered (e.g., steam line pressure drop) to match expected TPO uprate conditions.

The thermal-hydraulic parameters define the conditions for operation of the plant at TPO RTP, including reactor vessel pressure and FW temperature. For all standard TPO uprates, the operating vessel dome pressure remains the same as the pre-TPO uprate operating pressure (turbine inlet pressure will drop slightly). These conditions are used to establish the range of operating conditions to be considered in subsequent analyses and will be presented in the plant-specific TPO uprate application with comparison to the conditions previously analyzed and licensed. Appendix C presents generic assumptions and bases to be used to establish TPO uprate operating conditions that relate to the licensing evaluations.

## 5.2 POWER/FLOW MAP

Previous analyses for nearly all plants have established flexible power/flow operating maps which allow full power to be achieved and maintained over a significant range of core flow, as a result of incorporation of the operational options included in licensed performance improvement packages. Fuel cycle economy and operational flexibility are improved by allowing rated power operation over a wider range of core flow. Figure 5-1 illustrates the way a TPO uprate would be accomplished for a plant that has previously implemented the MEOD option. The power versus flow operating map for the plant clearly demonstrates the TPO uprate operating region. The MEOD operating option includes the MELLLA region (characteristically defined by the operating point at 100% of OLTP and 75% of rated core flow), and the ICF region (plant-specific operation at greater than rated core flow). Direct application of the generic TPO uprate guidelines is constrained within the limits of the current maximum rod line to provide a flow control line that extends to the new power level. For generic TPO uprate, only the top, maximum licensed power portion of the operating map is increased to the higher power level. At the new licensed power, the full power portion of the operating map will have a slightly (~2%) reduced core flow range relative to the pre-TPO uprate range.

Each plant has a defined power/flow operating range. Examples of ranges that have been expanded beyond the original design are Extended Load Line Limit Analysis (ELLLA) and MELLLA (described above and shown in Figure 5-1). For a generic TPO uprate, power is increased along the existing rod line/operating boundary, constrained by the previous existing operating boundary (in terms of MWt) and by the new licensed power level boundary. This approach significantly simplifies the generic evaluation of TPO uprate while introducing only a small plant operating flexibility penalty. A revised power/flow map, similar to Figure 5-1, will be provided in the TSAR to clearly define the proposed new operating range for the plant. The power/flow map will include the following information:

(1) The current MWt value.

(2) The uprated TPO MWt value.

(3) The maximum SLO MWt value.

(4) The minimum core flow at the pre-TPO and TPO power levels on the extended MELLLA or ELLLA boundary line.

In addition, the TSAR will indicate that the absolute power for SLO conditions remains unchanged from pre-TPO conditions.

The performance of the jet pumps and recirculation system is considered in generating the power/flow map for TPO uprate operation; however, very minor effect is expected for the small changes introduced by TPO uprate.

The primary approach to achieving a higher thermal power level is to increase core flow along previously established rod lines. This is illustrated in Figure 5-1 as increasing power along the control rod/load line above the currently licensed operating point. This strategy allows the plant to maintain all or most of the existing available core flow operational flexibility. The strategy to use the current maximum rod line boundary as a constraint is consistent with applicable guidelines for assuring that adequate reactor stability is maintained (Section 5.3.4).

Evaluations have previously been performed to demonstrate safety in all operating portions of the current power/flow map. The information in this TLTR, reload analysis for the TPO fuel cycles, and the TSAR combine to confirm continued compliance with this commitment. The constraints on the TPO uprate power/flow operating map described above were selected so that there would be no significant challenge to these evaluations.

At the end of a fuel cycle, full power is maintained by increasing core flow (toward the maximum achievable flow in Figure 5-1). No increase in the previously licensed maximum core flow limit is generically associated with TPO uprate, and that is the basis of this generic uprate evaluation (Appendix C). When end of full power reactivity condition (all rods out) is reached, end-of-cycle coastdown may be used to extend the power generation period even though rated power can no longer be sustained. On the power/flow map, this is along the right side of the core flow range toward the final power before shutdown for refueling. Some plants augment the power level during this period by reducing the temperature of the FW flow (Final Feedwater Temperature Reduction (FFWTR)). If previously licensed, the TSAR will include consideration of FFWTR. If not previously licensed for the plant, it will not be discussed in the TSAR. FFWTR is not a required part of the generic power uprate guideline.

## 5.3 ACCIDENTS AND TRANSIENTS

As part of the TPO uprate licensing process, the applicable plant Updated Final Safety Analysis Report (UFSAR) analyses will be evaluated. Many BWR transient and accident safety analyses already include an allowance for power uncertainty which bounds the range of power increase being sought in this generic TPO uprate program (≤ 1.5%). Such safety analyses are discussed in the appendices and identified as containing previously documented bases that bound the TPO uprate (Appendix B, Table B-1).

The safety analyses that are based on more nominal licensed power assumptions include two groups: (1) those which may be sensitive to the TPO uprate, and (2) those which can be shown by previous analysis to be insignificantly sensitive to the TPO power change. These two groups are also discussed and identified in the appendices (Appendix B, Tables B-2 and B-3).

Where applicable, results of these generic evaluations may be referenced and may not be included explicitly in the TSAR. Where necessary (according to the evaluations provided in the following sections and the appendices), analyses of limiting accidents and transients are to be performed at the uprated conditions to show continued compliance with applicable regulatory requirements. Such analyses will be performed using NRC-approved computer codes. The assumptions and scope of the analysis will be consistent with the plant's current licensing bases (with the exception of the licensed power level). For example, previously licensed operating options such as Single recirculation Loop Operation (SLO) will be included. See the appendices for specific assumptions, methodology and scope applicable in each area of evaluation.

### 5.3.1 ECCS-LOCA Performance Analyses

ECCS-LOCA 10 CFR 50, Appendix K performance analyses have previously been performed for ≥ 2% above the CLTP level at or above the operating pressure conditions for TPO uprate. Therefore, it has already been demonstrated that the 10 CFR 50.46 requirements will continue to be met consistent with the TPO uprate conditions (power and pressure) and the reduced power uncertainty capability of the plant. The previous analyses established the limiting single-failure combination and the limiting break size for each plant. The LOCA-ECCS analysis has been performed with the SAFER/GESTR-LOCA methodology as documented in References 2 and 31, or an alternate NRC approved methodology for 10 CFR 50.46 ECCS performance analyses.

The Nominal analysis aspects of the SAFER/GESTR-LOCA methodology are insignificantly affected by the proposed TPO uprate. For most plants, acceptable statistical margins remain for application of the previous Upper Bound Peak Cladding Temperature (PCT) analyses to the TPO uprated conditions. [ ] nominal LOCA-ECCS calculations to a TPO uprate of ≤ 1.5% is shown in Table D-1 of Appendix D. [ ]

[ ], plant-specific evaluations will be performed to assure that the NRC SER requirements will continue to be met at TPO uprate conditions (Appendix D). These results, if needed, will be included in the TSAR.

Emergency Core Cooling System (ECCS) performance is based on existing Technical Specifications that are not being changed by the TPO uprate. The current ECCS-LOCA analysis already includes consideration of previously licensed Technical Specification operational options (selected by the utility) for equipment out of service (e.g., an Automatic Depressurization System

(ADS) valve and/or Single-Loop Operation (SLO)) and/or equipment performance relaxation (e.g., ECCS flow rate or injection time relaxation). Because no changes in ECCS equipment performance are included with a TPO uprate, no additional analysis related to current plant operational options is required in the TSAR.

No changes to the fuel operating limits will be necessary for any fuel types applicable at the time of the uprate. Appendix D lists the generic bases for ECCS-LOCA analysis and evaluation.

### 5.3.2 LOCA Containment Performance Analyses

Previous plant-specific licensing analyses have shown acceptability of the containment capability including consideration of at least 2% power above the previously licensed power level. Therefore, these evaluations already bound the conditions associated with the TPO uprate (≤ 1.5% power with no increase in reactor operating pressure). The areas that are included in the previous bounding analyses are:

- Containment pressures and temperatures
- LOCA containment dynamic loads
- SRV containment dynamic loads
- Subcompartment pressurization

Section 5.10 also discusses containment capability, and Appendix G presents this generic approach for TPO applications.

In summary, containment response (peak pressure, temperature, and loads) to a postulated LOCA event have previously been performed considering at least 2% power above the CLTP conditions. Therefore, there is no increase in LOCA containment loads and the previous analyses bound the TPO uprate conditions (with no increase in reactor operating pressure). See Section 5.10 for further discussion of these areas and Appendix G for generic bases to be applied.

### 5.3.3 Transient Analyses

A review of the plant UFSAR and reload transients has been conducted using information from [

]

Compliance with the fuel thermal margin requirements and other applicable transient criteria for a TPO uprate are ensured by this process. Consideration of operational options (e.g., SLO) and/or equipment out-of-service options (e.g., an inoperable safety/relief valve (SRV)) will be included in the TPO uprate evaluation; however, no significant effect is expected on these options for the small power change introduced by a TPO uprate (≤ 1.5% power change). The following description addresses the transient analysis methods that are used in the TPO reload analysis (or which would be used if plant operational changes beyond this generic guideline are coupled with the TPO uprate application). In some such cases, similar to previous GE BWR uprate submittals, alternate methodology (approved by the NRC for fuel cycle-specific transient analysis) may be used. Appendix E lists the specific aspects of plant transient evaluation that are included in the TPO generic uprate basis.

Of primary importance is the evaluation of transient events that are most limiting from the viewpoint of fuel thermal margin. These events are identified in Section 4.3.1.2 of GESTAR (Reference 3) and Appendix E, Table E-1, along with applicable analysis model references. For uprates of only ≤ 1.5%, [ ]. Table E-2 describes the small changes calculated [ ]. As discussed in Appendix E, the [ ] limiting cases to an uprate of the magnitude proposed for TPO provides justification [ ] for these events in the TPO submittal. Normal reload analyses at the TPO uprated conditions are still required (documented separately).

Appendix E discusses the GE transient methodology paths that are to be used for TPO reload fuel thermal margin evaluation (or if additional features beyond this generic guideline are being licensed with the TPO uprate). The NRC-approved methods are identified as GENESIS and GEMINI (Reference 6). The more complete, one-dimensional core transient model, ODYN (References 4 and 5) may be used, if analysis is performed, for all plant transients. A more limited, point-kinetics model (REDY, References 8, 9 and 10) may also be applied for some transients, as in the original plant FSAR. Specific procedures for the transient calculation of minimum critical power ratio (MCPR) using the improved SCAT computer code (Reference 13) are also defined in Section 4.3.1.2 of GESTAR.

The evaluation of these most limiting events for the TPO uprate power conditions has previously included consideration of the most limiting conditions on the operating power/flow map (Figure 5-1) to assure that fuel operating limits continue to be met.

The safety analysis section of the UFSAR includes a broad set of transient events that is usually subdivided in accordance with these categories:

(1) Decrease in Core Coolant Temperature
(2) Increase in Reactor Pressure
(3) Decrease in Reactor Core Coolant Flow Rate
(4) Increase in Core Flow Rate
(5) Increase in Reactor Coolant Inventory
(6) Decrease in Reactor Coolant Inventory
(7) Increase in Reactivity
(8) Increase in Core Coolant Temperature

For the generic TPO uprate, all of these categories of events are insignificantly affected. The more limiting ones are described in Table E-2. Application of the setpoint methodology referenced in Appendix F ensures that the frequency of transients is not increased as a result of operation after a TPO power uprate. TPO uprates of up to 1.5% do not cause any previously non-limiting anticipated operational occurrences (AOO) to become more limiting than those analyzed for each reload.

For certain event evaluations (e.g., analyses of the loss of FW flow, and the ASME overpressure transient in Section 5.5.1), analyses have already been performed at ≥ 102% of the CLTP level; therefore, these events also need no additional analysis for a TPO uprate.

The transients associated with Category 1 (Decrease in Core Coolant Temperature) are represented in the limiting case by the loss of an FW heater, which is analyzed as a quasi-steady-state 3D event. The FW controller failure (maximum demand) also represents a challenge to the reactor that is related to this area, but is usually considered as an increase in reactor coolant inventory. A decrease in coolant temperature causes an increase in reactor power. Maintaining the core within the MCPR and Linear Heat Generation Rate (LHGR) operating limits while changing the initial power by ≤ 1.5% in a TPO uprate will not produce any significant reduction in the transient thermal margin [ ]. The limiting cases shown in Appendix E (Table E-2) provide information [ ] to show that the effect of a TPO uprate bound the events in Category 1. Providing the cycle-specific analysis consistent with the first cycle in which the TPO uprate is to be implemented will confirm this conclusion and provide assurance of acceptable operating limits for this category of transient events. The events included in the power uprate basis are the limiting cases for this type of disturbance as documented in GESTAR.

Category 2 transients (Increases in Reactor Pressure) are primarily represented in the power uprate analysis guideline by the turbine trip and load rejection transient events with the assumed failure of the turbine steam bypass function. The FW controller failure (maximum demand) event also includes some aspects of this area, because it involves a turbine trip (from high water level). For BWR/6 plants, the UFSAR and reload evaluations also include the downscale failure of both turbine pressure regulators. The analyses of these events [ ] show that the effect of a ≤ 1.5% uprate will have [ ] on the thermal margin calculated for the limiting event(s). Appendix E (Table E-2) provides information [ ] to show that the effect of a TPO uprate is not significant for these events. Therefore, it is concluded that the cycle-specific reload analysis of the limiting events in this category is sufficient for ensuring that the required fuel thermal margins will be maintained.

From the viewpoint of peak pressure, these RG 1.70 UFSAR Chapter 15 events are shown to be well within the applicable ASME overpressure criteria for events in the "Upset" category. The bounding analysis for the ASME evaluation has already been analyzed at least 2% above the previous licensed power, so that it remains bounding for a TPO uprate. This conclusion is also discussed in Section 5.5.1 and Appendix E.

Category 3 (Decreases in Reactor Core Coolant Flow Rate) is not limiting for any GE BWR. These events are not re-evaluated for reloads (Reference 3) and are not included in the TSAR, because the change in operating power conditions is ≤ 1.5% and TPO operation is constrained to previously licensed control rod operating lines (Section 5.2 and Appendix C).

Category 4 (Increases in Core Flow Rate) is represented by the re-evaluation of the core flow based requirements for the OLMCPR. This is implemented at each plant through the core flow-dependent adjustments to the full-power/full-core flow OLMCPR. Other core flow increase events are not limiting, especially for uprates of ≤ 1.5%. It is not necessary for any recirculation flow controller failure event to be reanalyzed for the generic TPO uprate; however, the flow-dependent operating limits will continue to be confirmed for each plant cycle reload (Appendix E). This is consistent with the scope of analysis agreed upon in Table E-1 of Reference 21 [ ].

Category 5 (Increase in Reactor Coolant Inventory) is bounded by the FW controller failure (maximum demand) event. Increasing the initial power by ≤ 1.5% will have minimal effect on the fuel thermal margin maintained during this event, [ ]. Appendix E (Table E-2) shows that the effect is [ ], and no generic reanalysis of this case is needed in the TPO submittals. Cycle-specific reload analysis for the first applicable cycle will ensure that adequate fuel thermal margin is maintained for TPO and the specific fuel load that is employed.

Category 6 (Decrease in Reactor Coolant Inventory) is bounded by the evaluation of the loss of all FW flow event. As discussed in Appendix E, this case has already been analyzed from at least 102% of CLTP with failure of the larger of the two systems which provide inventory protection for this transient: RCIC or HPCI(S). Mitigation of a loss of FW flow event in some BWRs is provided by the Isolation Condenser (IC) System instead of the RCIC or HPCI(S) Systems. In the IC plants, the inventory is maintained in an isolated reactor condition by this closed-loop system that removes decay heat by condensing reactor steam and returning the coolant to the vessel.

Category 7 (Increase in Reactivity) is represented by evaluation of the rod withdrawal error transient. Analysis of this event has been shown to be dependent primarily on the details of the cycle-specific fuel loading pattern and operating sequence, and not significantly affected by previous power uprate steps. It is concluded that the cycle-specific evaluation performed for each reload ensures that adequate fuel thermal margin is maintained for this event, as shown in Appendix E (Table E-2).

No BWR events are limiting for transients in Category 8 (Increase in Core Coolant Temperature).

A list of bounding transients is documented in GESTAR for previously licensed operation. Appendix E provides a discussion of those events from the viewpoint of the small effect expected for a TPO power uprate. Table E-1 quantitatively documents [ ] of the fuel operating limits for a TPO power increase of ≤ 1.5% based on analyses [ ]. Cycle-specific reload event analyses will confirm that adequate operating limits are maintained for the limiting events on a plant-specific, reload-specific basis. The TPO uprate transient analysis will not be addressed in the TSAR because the results of this analysis will be transmitted to the NRC as part of the reload core design process.

### 5.3.4 Thermal-Hydraulic/Neutronic Stability

Evaluations are conducted for each fuel type/configuration as described in Section S.4 of GESTAR - U.S. Supplement (Reference 14) to show continued compliance with generic fuel design stability criteria. The NRC Safety Evaluation Report on "BWR Owners Group Long-Term Stability Solutions Licensing Methodology" (Reference 19) describes additional measures to ensure stable operation of BWRs. Plant-specific evaluations are performed for each fuel cycle to ensure that the applicable stability criteria are met; the plant-specific evaluations for the first TPO uprated cycle will account for the TPO power change. Power uprates defined by these generic guidelines are consistent with both References 14 and 19. The same constraints as previous GE generic power uprate programs on possible expansion of the high-power/low-core-flow portion of the operating range are considered in the TPO power uprate process and in defining the plant operating procedures. These constraints are maintained even though TPO uprate is much smaller than the previously approved uprates.

Appendix C defines the specific guidelines to be followed so that TPO uprate operation remains within the maximum control rod line boundary currently licensed for each plant. TPO power uprate applications will not introduce any flow control rod lines that are above the currently licensed boundary. With the same rod line boundary, there is minimal effect on stability beyond normal cycle-to-cycle reload core characteristic variations that are evaluated with the reload, as needed, for the applicable stability option for each plant. Expansion of the flow range beyond these guidelines for any plant may be licensed separately, but it is not a required generic part of these uprate guidelines. Figure 5-1 demonstrates a typical power uprate operating range for TPO uprate plants. It does not introduce any higher rod pattern above that range previously licensed for the plant.

These guidelines will be used for selecting the operating range for implementing each TPO uprate. The specific ranges previously licensed for each product line will be maintained so that the power uprate will have no detrimental effect with regard to stability. Each TPO uprate application will utilize the latest information available at the time of the submittal. In this way, the TPO uprate will maintain stability protection at the same level as agreed upon for non-uprated or previously uprated operation of the applicable plant (see Appendix C for the specific requirements of this generic constraint).

Where applicable, the exclusion region boundaries are rescaled such that the absolute power and core flow boundaries are the same as the current boundaries. The maximum operating rod line is not increased. Therefore, TPO uprate will not by itself significantly affect stability. Reload stability evaluations will continue to ensure acceptable stability performance and protection for future cores operating in TPO uprated cycles.

### 5.3.5 Anticipated Transient Without Scram

Evaluation of this postulated event is performed to show continued compliance with the NRC rule on Anticipated Transient Without Scram (ATWS). ATWS rule compliance primarily involves alternate shutdown equipment that has been previously installed at each unit. The equipment will remain and its performance will not change because operating conditions (operating pressure, SRV setpoints, and maximum rod line) do not change for the TPO uprate.

A bounding case evaluation at TPO uprated conditions is provided in Appendix L based on the [ ], showing that adequate overpressure protection will be maintained for the limiting case in each BWR product line. No changes in pressure setpoints of the safety/relief valves and/or high pressure recirculation pump trip are expected for TPO uprates. Appendix L describes the generic guidelines related to evaluation of this special postulated event.

TPO power uprate operation does not significantly affect the long-term ATWS response (i.e., suppression pool cooling for a postulated isolation event) because it does not involve a uniquely higher rod line. Therefore, the power level following the ATWS recirculation pump trip is unchanged from TPO operation.

## 5.4 RADIOLOGICAL CONSEQUENCES

Radiological consequences due to postulated accident events, as documented in the UFSAR, have previously been evaluated and analyzed to show that the NRC regulations are met for 2% above the previously licensed power conditions. Therefore, the radiological consequences associated with a postulated accident from TPO uprate conditions are bounded by the previous analyses. The evaluation/analysis was based on the methodology, assumptions, and analytical techniques described in the RGs, the Standard Review Plan (where applicable), and in previous Safety Evaluations (SEs), including consideration of the reduced power uncertainty factor. The following aspects of the radiological consequences are included in the evaluations:

- Source terms
- Offsite doses
- Control Room and Emergency Response Facility habitability
- Accidents as described in the UFSAR (e.g., LOCA, control rod drop, fuel handling, main steam line break)

During normal operation, the radiation levels in the plant are the result of direct and scattered radiations from the reactor core and from radioisotopes carried in the reactor water, steam, or radwaste process. In all cases, these sources are approximately proportional to the core thermal power.

The effect of TPO uprate on the Normal operational sources will be no more than proportional to the amount of the uprate (≤ 1.5%). As explained in Appendix H. the BWR design basis coolant concentration and offgas release rate were based on conservative plant data of older design, which can accommodate an increase of this magnitude. For equipment environment qualification and personnel shielding, the plant design basis usually included sufficient safety margin. Therefore, no adverse effects are expected for this small change in operating conditions.

## 5.5 NSSS COMPONENTS

A comprehensive evaluation of plant specific NSSS components and systems will be performed to confirm the acceptability of the small additional duty effects identified in this document for operation at TPO uprate conditions. This evaluation is designed to confirm the expectation that there is no significant effect of a ≤ 1.5% increase of licensed power level and the associated increases in steam and FW flow rates. No change in vessel dome pressure is planned for a TPO uprate, and there are no significant changes in system temperatures, as shown in Table 5-1 for typical Pre- and Post-TPO Operating Conditions. Safety aspects of equipment performance, as well as operational capability, are identified in the appendices. To the extent possible, this review is done generically in this TLTR. Systems for which a plant-specific evaluation is required are listed in Table J-3; the results of the evaluation will be provided in the TSAR.

### 5.5.1 Reactor Vessel and Internals

The reactor pressure vessel and internal components such as the jet pump assemblies, jet pump sensing lines, lower plenum components, FW spargers, fuel bundles, steam separators, and the steam dryers will be evaluated at the limiting conditions of TPO uprate operation.

#### *5.5.1.1 Reactor Core Coolant Hydraulics and Internal Pressure Differences*

Analyses have been performed for the CLTP as well as at 102% of CLTP and maximum flow conditions. These analyses determined the core flow split among the fuel bundles and the core bypass region, steam conditions, core average void fraction, core pressure drop distribution and total core pressure drop. The outputs from these evaluations were used for evaluations of all in-vessel equipment (e.g., reactor internal pressure drop analysis), as well as for current analysis of the effects of core coolant hydraulics and pressure drop loads during plant transients and accidents. Standard core design and reload methodology have been applied in this area. The Emergency and Faulted load evaluations for TPO uprate are bounded by the analyses performed at 102% of the CLTP conditions. In most respects, the internals conditions are more strongly affected by the maximum licensed core flow rate than by the power level; the maximum flow rate is not to be changed for TPO uprates (unless separately identified and evaluated). Table I-1 documents the reactor internals pressure drop sensitivities calculated for normal operation [ ]. It is concluded that there are no significant changes in core coolant hydraulics and reactor internal pressure differences for TPO. No plant-specific analyses are required except for documented confirmation of the normal operating pressure drop differences calculated at normal, full power operation before and after TPO. These conclusions are for current BWR fuel types; a new fuel type will be evaluated upon its introduction, per current procedures described in GESTAR (References 3 and 14).

#### *5.5.1.2 Structural Assessment*

A review will be conducted to assess the effect of increased power, FW flow and temperature, steam flow, and pressure drop conditions on the reactor vessel, internals, and nozzles. In general, very few reanalyses are expected to be required because no increase in vessel pressure or operating temperature (except an FW temperature increase of < 2°F and recirculation/core inlet flow temperature increase of < 1°F) is planned with the TPO uprate. Evaluation of limiting individual components will be included in the TSAR to document the justification for compliance at TPO uprate conditions. If needed, reanalyses will be performed to show continued compliance with the existing criteria and standards at the TPO uprate conditions. It is expected that the vessel FW and main steam nozzles and the FW sparger are the only components that may require any reanalysis because of the slightly different operating temperature and flow. However, even those components are not expected to have significant effect, and existing margins may justify qualitative evaluations. The results of the system/component evaluations will be presented in the TSAR. Appendix I provides the specific methods that have been accepted for application in this area. In cases where the modifications or repairs have been made to the RPV components or internals, the assessment will be made against the current configuration of the reactor. No change in the present conservatively established surveillance intervals is necessary, given the very small change in vessel conditions caused by a TPO uprate.

#### *5.5.1.3 Reactor Vessel Internals Vibration Assessment*

A review will be performed for limiting components to ensure that the reactor vessel internals design continues to comply with the existing structural requirements at the slightly changed operating conditions for TPO uprate. There is no change in the maximum core flow for TPO uprate. Hence, components such as the jet pump assemblies, jet pump sensing lines, lower plenum components, fuel bundles, and in-core instrumentation will see no significant change at the TPO uprate operating conditions because there is no significant change in the flow patterns in these areas. The FW spargers, steam separators, and steam dryer will be evaluated at the slightly higher FW and steam flows planned for TPO uprate. Baseline vibration data available from the specific unit and/or from another unit of the same or similar design will be used in the evaluation.

The evaluation process for the FW and steam flow components will include plant startup data, dynamic structural analysis and, if necessary, fatigue usage factor determination.

#### *5.5.1.4 Reactor Vessel Overpressure Protection*

Evaluations and analyses for the CLTP have been performed with at least 2% overpower allowance to demonstrate that the reactor vessel conformed to ASME Boiler and Pressure Vessel Code and plant Technical Specification requirements. No increase in reactor operating pressure is proposed for TPO uprate. Therefore, the existing analysis already bounds the proposed TPO uprate power and pressure conditions. No increases in protection setpoints (e.g., SRV setpoints) and no changes in any applicable valve out-of-service options are proposed for TPO uprate. The ODYN transient analysis model has normally been used by GE for evaluating ASME upset limit compliance. This model has been shown to be conservative for overpressure evaluations (References 4 and 5). For some plants, alternate methodology (approved by the NRC for ASME overpressure protection analysis) has been used.

The worst transient event with failure of any direct scram signal has traditionally been evaluated to bound all ASME Upset category events (usually the MSIV closure with position switch scram failure is the limiting case). Credit is only taken for ASME-qualified SRVs and indirect scram signals (not directly associated with the cause of the event).

A discussion of overpressure protection will only be included in the TSAR to the extent that confirmation will be provided of the applicability of the generic conclusions (i.e., the current analysis at 102% of CLTP bounds the TPO license conditions). Standard analysis is sufficient at the time of each TPO uprate fuel reload according to current practices (Appendix E).

#### *5.5.1.5 Reactor Vessel Fracture Toughness*

Reactor pressure vessel embrittlement is caused by neutron exposure of the wall adjacent to the core (the "beltline" region). TPO uprate will result in a very small increase in the operating neutron flux at the RPV wall, which will slightly increase the integrated fluence over time. Thus, the effect of TPO uprate on reactor vessel fluence is estimated to have negligible effect on vessel fracture toughness. Typically, the fast neutron fluence originally documented in the FSAR was based on a generic calculation (for a typical BWR of the appropriate size), which included large safety factors. Evaluations currently utilize the results of in-vessel surveillance sample flux wire measurements. Operating fluence values will increase approximately proportional to the power increase, because the core radial and axial power distributions are not expected to be significantly affected by the fuel loading pattern for TPO uprate. The estimated TPO uprate fluences will be reviewed to ensure that there is no unacceptable effect on vessel fracture toughness. The fracture toughness requirement of 10 CFR 50, Appendix G states that beltline materials must maintain upper-shelf energy (USE) in the transverse direction throughout the life of the vessel of no less than 50 ft-lb. or that the USE will provide margins of safety against fracture equivalent to those required by Appendix G of Section XI of the ASME Code. Potential changes in the nil-ductility transition temperature ($RT_{NDT}$) due to fluence will be evaluated according to RG 1.99, Revision 2.

Increased fluence from a power uprate could cause an increase in the 32 effective full power year (EFPY) shift, and consequently, a change in the adjusted reference temperature, which is the initial $RT_{NDT}$ plus the shift. However, the effect of the small TPO uprate on the shift is expected to be negligibly small (e.g., < 2°F). The existing requirements are expected to include sufficient margin for this effect, and no change to the existing vessel pressure temperature curves is expected. The plant-specific submittal will document confirmation of this evaluation. Therefore, the required system hydro test temperatures are estimated to have no effect due to TPO uprate for a typical plant. Plant-specific confirmation of these expectations will be included in the plant-specific TPO uprate application.

#### *5.5.1.6 Steam Separators and Steam Dryer*

The slightly higher steam flow rate (< 2%) through the dryers and separators will have a negligible effect on the quality of steam line flow [

] The results of the evaluation will be included in the TSAR.

Steam dryer and separator loads have also been evaluated and found to have negligible effect from the small (< ~2%) steam flow increase for TPO uprate. Plant-specific confirmation of the applicability of this assessment for plant-specific equipment will be documented in the TSAR. Appendix I includes generic estimates of the small changes in component pressure drop expected for a TPO uprate up to 1.5% power increase. The effect of higher steam flow and steam dryer pressure drop on the water level in the dryer skirt, and its potential effect on transient water level response, is considered to be negligible (< 1 inch) for the small magnitude of the TPO uprate.

### 5.5.2 NSSS Piping

Evaluations have been performed to show that the potential effect of the slightly higher (< 2%) steam flow and FW flow rates due to TPO uprate with no vessel dome pressure increase is expected to be negligible for the nuclear island portion of all piping except affected portions of the FW lines, main steam lines, and piping connected to the main steam lines. FW temperature will increase (< 2°F) and FW line pressure will increase slightly (< 2 psi) at the reactor FW nozzle (due to higher FW sparger pressure drop at the higher flow rate). The very small changes in temperatures (< 2°F) and pressures (< 1 psi) for the recirculation piping are also negligible for thermal expansion, dynamic loads, and (as applicable to the plants current licensing basis) vibration effects. The range of recirculation flow conditions will not be significantly changed for a TPO uprate. There is no increase in the Technical Specifications for the maximum recirculation drive loop flow rate, which has been established based on system testing. Operational data and design basis information will be utilized to the extent that applicable information is available on the specific unit or a representative unit for the unit size and design.

These conclusions are also applicable to licensed non-standard operating modes (e.g., one MSIV closed). Appendix K defines the specific methods and assumptions to be applied to the evaluation of the affected piping. These methods have been used generically in this area of evaluation for previous BWR power uprates (References 20 and 21). Therefore, a plant-specific NSSS piping evaluation for only the affected areas (i.e., FW lines, main steam lines, and piping connected to the main steam lines) will be included in the TSAR.

## 5.6 NSSS SYSTEMS

Analyses and/or evaluations of various affected NSSS systems will be performed to verify their continued operational capability to meet the existing design and safety requirements. Specific generic aspects of system evaluation are presented in Appendix J to this document. These evaluations include the systems listed in the following sections. The TSAR will include a summary of the applicability of these generic discussions.

### 5.6.1 Neutron Monitoring System

Following the standard practice for BWR power uprates, the APRMs are re-calibrated to indicate the new 100% TPO uprate power level. The APRM high flux scram and the upper limit of the rod block setpoints, expressed in units of percent of licensed power, will not be changed. The flow-biased APRM trips, expressed in units of absolute thermal power (i.e., MWt), will remain the same. Thus, the MCPR reduction or MLHGR ratio to the limiting value will be unchanged for potential transient increases of power from the operating limit to the APRM rod block alarm or flow-referenced scram trip. The generic approach for TPO uprates will follow this previously approved practice. Appendix F addresses the setpoint methodology to be applied to power uprate adjustments.

No IRM-APRM adjustment is necessary to ensure that overlap with the SRMs and APRMs is adequate. The IRM channels will have sufficient margin to the upscale scram trip on the highest range when the APRM channels are reading near their downscale alarm trip because the change in APRM scaling is so small for TPO uprate. Plants that utilize a Wide Range Neutron Monitor (WRNM) will also require no adjustment.

The neutronic service life of the LPRM detectors and radiation level of the TIP will not be affected significantly due to the small TPO power increase. It will not change the number of cycles in the lifetime of any of the detectors.

### 5.6.2 Recirculation System

The planned approach to achieve an increase in rated power requires no increase in the maximum core flow. Operation will primarily be on extensions of existing rod lines, as discussed in Section 5.2. No significant reduction of the maximum flow capability of the Recirculation System will occur due to TPO uprate because of the very small change in core pressure drop (< ~0.3 psid) at the new operating condition (Appendix I, Table I-1). The TPO operating conditions will be evaluated to confirm the expectation that no significant increase in recirculation system vibration will occur. No change is requested in the Technical Specification for the maximum allowable recirculation drive flow, which has been established from plant data (noted in Section 5.5.2).

### 5.6.3 Control Rod Drive and CRD Hydraulic Systems

The Control Rod Drive (CRD) and CRD Hydraulic Systems and supporting equipment will not be affected by the TPO uprate. Operating pressure and temperature conditions are not changed for this equipment. The CRD Hydraulic System performance is independent of power level.

Operation with no increase in the reactor vessel pressure will have no effect on the performance of the CRD System.

No further evaluation of CRD performance needs to be included in any plant-specific TPO uprate application, as indicated in Appendix J to this document. The increased power level will have a consequential, small effect on control blade lifetime. This factor will continue to be tracked per current standard practice for each plant. Shutdown margin capability is included in each reload evaluation. TPO uprate (≤ 1.5%) is not expected to change the cycle lifetimes of any blades.

### 5.6.4 Residual Heat Removal System

The Residual Heat Removal (RHR) System is designed to restore and maintain the coolant inventory in the reactor vessel and to remove sensible and decay heat from the primary system and containment following reactor shutdown for both normal and post accident conditions. The RHR system is designed to function in several operating modes, including Low Pressure Coolant Injection (LPCI), Shutdown Cooling (SDC), Suppression Pool Cooling (SPC), Containment Spray Cooling, (CSC), and Fuel Pool Cooling Assist modes.

The ECCS performance of the LPCI mode during a LOCA is evaluated starting from at least 102% of the CLTP condition. A TPO uprate does not increase the power level for this safety evaluation basis for the ECCS functions of the system. Acceptable compliance with all required criteria is maintained as previously documented for accident events using the approved SAFER/GESTR-LOCA methodology (References 2 and 31).

The sizing basis of the RHR heat exchanger is different for the various BWR product lines. For example, for BWR/6 plants, the RHR heat exchanger is sized on the basis of post-LOCA containment cooling requirements and is oversized for the SDC mode functions. For BWR/6 plants, the basis of the heat exchangers already includes 102% of CLTP and bounds the effect of a TPO uprate.

The RHR heat exchangers are sized for the SDC mode for BWR/3 (where applicable), and all BWR/4 and 5 plants. In normal use of the SDC mode, the RHR shutdown cooling subsystem is activated after a normal blowdown to the main condenser. Some BWRs include emergency shutdown cooling as a defined scenario in which one train of the RHR SDC mode is used after rapid initial vessel depressurization. It continues heat removal and cooldown to cold shutdown conditions. The emergency shutdown scenario is more limiting. Current analysis of this case has assumed 102% of the CLTP level; therefore, the TPO uprate will not increase the analysis core thermal power and decay heat, which are the primary parameters for this case. The current time to achieve emergency cooldown will remain unchanged for plants designed for this basis. The time for cooldown in the normal sequence will increase, but this change has no significant effect on plant safety. If included in the plant's licensing basis, confirmation of the initial power level for the emergency shutdown cooling scenario will be provided in the TSAR.

No hardware or operational effect on the RHR shutdown cooling subsystem resulting from operation at the TPO uprate power level is anticipated, because there is no change to the operating conditions for the system in either the standby or active mode. Appendix J describes the generic guidelines for the evaluation of the SDC mode.

The SPC and CSC modes of the RHR System are evaluated as part of the containment analyses. The containment analysis is performed starting from at least 102% of the CLTP condition.

The fuel pool cooling assist mode provides supplemental fuel pool cooling in the event that the fuel pool heat load exceeds the heat removal capability of the Fuel Pool Cooling system. A plant-specific analysis of this RHR mode will be provided in the TSAR as discussed in Section 5.10.8.

### 5.6.5 Standby Liquid Control System

The ability of the Standby Liquid Control System (SLCS) to perform its intended safety function to shutdown the reactor during a postulated ATWS event depends on its shutdown capability and its injection capability. The SLCS shutdown capability is a function of fuel design and not a function of power level. TPO uprate will not require an increase in shutdown concentration or boron enrichment requirements. SLCS shutdown margin is confirmed for each reload core (see Section 5.7.1 and Appendix L.3). The TSAR will document this confirmation.

For a TPO uprate, SLCS injection capability is a function of RPV pressure. The key parameter affecting RPV pressure during SLCS operation is the SRV opening setpoints, which are not changed for the TPO uprate. The SLCS relief valve margin can be generically dispositioned as being adequate for the TPO uprate [

]. In addition, if a plant specific ATWS evaluation is performed for TPO, the adequacy of the SLCS relief valve margin will be confirmed using the plant specific results.

Confirmation of the adequacy of the SLCS injection capability, including the SLC relief valve margin, will be included in the TSAR.

### 5.6.6 Reactor Water Cleanup System

The flow rate through the Reactor Water Cleanup (RWCU) System is not significantly affected by reactor power and recirculation flow conditions (recirculation flow temperature increases by < 1°F). Therefore, an increase in rated power will not affect the system capability. Operation at TPO RTP will produce an insignificant effect on the quantity of fission products, corrosion products, and other soluble and insoluble impurities in the reactor water. Reactor water chemistry is typically well within fuel warranty and Technical Specification limits on effluent conductivity and particulate concentration, and, thus, no changes will be made in water quality requirements. Reactor water chemistry excursions usually coincide with power changes, not steady-state operation at a particular power level. It is concluded that the RWCU System will have sufficient capacity for reactor operation at the uprated power level and no modifications are required.

### 5.6.7 HPCI(S) and RCIC Systems

The capability of the HPCI(S) and RCIC Systems to meet their design requirements at the TPO uprate power level has been generically evaluated. Both the HPCI(S) and RCIC Systems will have the capability to deliver their required flow, because there is no change in the operating pressure or pressure setpoints of the SRVs for a TPO uprate.

The capability of the turbine-driven systems (HPCI and RCIC) to successfully develop the horsepower and speed required by the pumps is unchanged for a TPO uprate. As in the previous generic BWR uprate guidelines, the improved turbine startup logic available on most plants is expected to be capable of acceptable startup for all conditions associated with TPO uprate conditions. The HPCI(S) System remains capable of providing LOCA mitigation because it has already been evaluated for at least 102% of CLTP (Appendix D).

The current RCIC and HPCI(S) System evaluations remain satisfactory for RCIC-only or HPCI(S)-only inventory supply during loss of all FW flow transients because that analysis has previously been performed at 102% of CLTP (Appendix E). The margin to the required Condensate Storage Tank inventory will not be significantly affected by the TPO uprate.

### 5.6.8 Nuclear System Pressure Relief and Automatic Depressurization System

For TPO uprate, the capacity of the existing set of safety/relief valves (SRVs) is sufficient to meet all overpressure protection requirements. Opening pressure setpoints will not change, preserving current simmer margin during TPO uprate operation. Overpressure transients, including cases with direct scram failed, have already been analyzed at 102% of CLTP. Therefore, compliance with the required ASME criteria continues to be satisfied for the new TPO uprate conditions. If the unit has any SRV out-of-service options in the Technical Specifications, they also remain unaffected by a TPO uprate. Confirmation of the continuing adequacy of overpressure protection for each plant cycle is provided by bounding ASME Upset transient analyses. Appendix E includes generic overpressure protection evaluation.

The performance of the existing Automatic Depressurization System (ADS) valves also remains unchanged because the current LOCA small break analysis bounds TPO uprate operation. Generic evaluation is presented in Appendix D.

### 5.6.9 Containment Isolation System

The ability of containment isolation valves and operators to perform their required functions under the TPO uprate flow rates and pressure differences (steam lines and FW lines) will not be affected because the accident evaluations have already been evaluated at 102% of CLTP. No increase is proposed for the operating pressure conditions. Similarly, no changes to potential harsh environmental conditions will occur because they were also based on 102% of CLTP conditions. The currently documented accident conditions remain bounding.

### 5.6.10 Core Spray System

The ECCS performance of the low pressure Core Spray (LPCS or CS) System during a LOCA has already been evaluated for 102% of the CLTP condition. A TPO uprate does not increase the power level for this safety evaluation basis for the ECCS functions of the system (Appendix D). Acceptable compliance with all required criteria is maintained as previously documented for accident events using the approved SAFER/GESTR-LOCA methodology (References 2 and 31).

## 5.7 REACTOR CORE DESIGN AND FUEL

The reactor core and fuel performance characteristics during TPO RTP operation will be assessed as part of the fuel reload analysis. In addition to the slightly higher core thermal power that affects the core and the fuel performance, TPO uprate operation also results in slightly increased steam void content. The power distribution in the core may be changing to allow increasing overall core power while limiting the absolute power in any individual fuel bundle. Evaluations of core performance will be provided with the reload submittal that implements TPO uprate for a specific cycle (Appendix E).

### 5.7.1 Shutdown Margin and Hot Excess Reactivity

All minimum shutdown margin requirements apply to cold shutdown (≤212°F) conditions and will be maintained without change. Checks of cold shutdown margin based on Standby Liquid Control System boron injection capability and shutdown using control rods with the most reactive control rod stuck out are made for each reload analysis. TPO uprate has no significant effect on these conditions, but they will continue to be confirmed and maintained during the reload core design process, as in all fuel cycles.

Reload fuel cycle analysis and core and fuel design for operation at the TPO RTP level will optimize the energy requirement and power distribution so that excess reactivity, hot and cold reactivity requirements, and the core and fuel performance characteristics can be met through fuel loading strategy and control rod patterns.

New fuel designs are not needed for a TPO uprate to ensure adequate safety. However, slightly higher batch fractions, for example, may be used to provide additional operating flexibility and maintain fuel cycle length. All fuel and core design limits will continue to be met by control rod pattern adjustments.

### 5.7.2 Thermal Limits

The thermal limits include allowances for the combined effects of the gross and local power density distributions, control rod pattern, and reactor power level adjustments during plant operation on the fuel heat flux and temperature. Thermal-hydraulic design and operating limits ensure an acceptably low probability of boiling transition-induced fuel cladding failure occurring in the core at any time, even for the most severe postulated operational transients.

Limits are also placed on the peak bundle heat generation rates in order to meet peak fuel cladding temperature limits for the loss-of-coolant accident (LOCA) and/or fuel mechanical design bases for transient events.

The reload core designs for operation at the TPO RTP level will take into account the above limits to ensure acceptable differences between the licensing limits and their corresponding operating values. The core average power density is increased proportionally by power uprate, which, in turn, will affect operating flexibility, reactivity characteristics, and energy requirements. For a TPO uprate, this effect is not a significant fuel design challenge.

Operating limits are established to assure that regulatory and safety limits are not exceeded for a range of postulated events (e.g., transients, LOCA as discussed in Appendices D and E). Cycle-specific core configurations will continue to be evaluated for each reload to confirm the TPO uprate capability and to establish or confirm cycle-specific limits. Reload analyses include limiting transient evaluations to determine Minimum Critical Power Ratio (MCPR) and Maximum Linear Heat Generation Rate (MLHGR) operating limits for all fuel types included in a specific cycle. Evaluations are also made to confirm that the core operating states are within the fuel mechanical design basis (e.g., fuel rods bowing and channel wall pressure difference).

The Minimum Critical Power Ratio (MCPR) and Maximum Linear Heat Generation Rate (MLHGR) operating limits will be examined for the first applicable reload cycle to ensure compliance throughout the TPO uprate power/flow operating range.

#### *5.7.2.1 Minimum Critical Power Ratio Performance*

A TPO uprate would result in a slight decrease in steady-state operating MCPR, if no change in rod pattern, fuel design, or core design is made. For TPO uprate operation, core and fuel designs can be developed which will provide completely adequate operating MCPR margins, and core operations will not be restricted.

The plant-specific Safety Limit MCPR (SLMCPR) is confirmed for each core reload using a Monte Carlo analysis that assumes the core is operating on thermal limits. A core power distribution that maximizes the number of fuel assemblies near those limits is assumed. This procedure is defined in References 3, 14, and 28. The appropriate SLMCPR will be determined with TPO operating conditions. GE standard analysis will continue to derive the SLMCPR using the conservative, NRC-approved uncertainty factors in Reference 28. An acceptable utility option would be to request that the improved FW measurement uncertainty factors for the plant be used to achieve a small SLMCPR benefit [ ] as discussed in Appendix E, Section E.2.5.

#### *5.7.2.2 Maximum Linear Heat Generation Rate Performance*

Similar to the steady-state operating MCPR performance, a TPO uprate would result in a small change in steady-state operating MLHGR, if there are no compensating changes in core and fuel design, or rod pattern. For MLHGR performance, an optimized rod pattern can help to enhance the available margin.

The fuel thermal-mechanical limits at TPO uprate conditions will be confirmed to be within the fuel design criteria as part of the first TPO uprate core reload analysis (Appendix E). The TPO uprate operating range will be evaluated to ensure the adequacy of the applicable power- and flow-dependent MCPR and MLHGR limits (e.g., $MCPR_f$, $MCPR_p$, $MLHGR_f$, and $MLHGR_p$) using existing procedures defined in GESTAR (References 3 and 14).

### 5.8 CONTROL AND INSTRUMENTATION

The control and instrumentation signal ranges and setpoints will be evaluated in order to make necessary modifications due to changes in power, neutron flux, turbine inlet pressure (dome pressure is unchanged), steam flow, and FW flow. Improved accuracy of the instrumentation used to monitor the FW flow rate is the principal factor that has led to the TPO uprate. Precise installation and maintenance of any instrumentation in its plant-specific configuration is essential for operation at the TPO RTP level.

Appendix C (C.2.2) discusses the expected performance of the pressure control system to maintain acceptable control at TPO operating conditions. TPO uprate testing (Appendix L, Section L.2) describes the testing to be performed to confirm adequate control as TPO RTP conditions are achieved. There is no significant effect of TPO uprate on the pressure control function of the turbine bypass valves. The bypass valves are used during plant startup and shutdown, and the need for bypass performance does not change from previously demonstrated experience.

Appendix F.4 provides additional discussion for adjustment of other Instrument setpoints that may be related to uprating the power level of the unit. There are few instrument changes necessary for a TPO uprate because of the small change and because reactor operating pressure is not changed.

The GE generic setpoint methodology (References 16 and 32) or an equivalent plant-unique alternative is still applicable for a TPO uprate. An analysis will be performed to determine the setpoint changes (if required) for various systems, including:

(1) ***High Neutron Flux Scram and Alarms -*** The power signals will generally be re-scaled to the new rated value and the setpoint (expressed in percent of rated thermal power) will generally remain unchanged (e.g., indicated power will be 100% at TPO RTP and the high neutron flux scram remains at about 120% of the TPO RTP). The flow- referenced setpoints (expressed in units of absolute thermal power (i.e., MWt)) will remain unchanged (Appendix F.4).

(2) ***Reactor Vessel High Pressure Scram and Recirculation Pump Trip –*** No changes are expected for these setpoints because there is no change in reactor operating pressure. (Appendix F)

(3) ***Safety/Relief Valve Setpoints –*** No changes are expected for the SRV setpoints because system operating pressure will not be changed. Previous ASME Upset criteria compliance analysis assumed 102% of CLTP, so it already bounds a TPO uprate (Appendices E and F.4). Therefore, the current SRV configuration provides acceptable overpressure protection.

(4) ***Main Steam Line Isolation on High Steam Flow High Radiation (if applicable), and High Steam Tunnel Temperature -*** These setpoints (as applicable to the specific plant) will be increased by the amount of the uprate conditions in order to maintain margin for avoiding inadvertent isolations. Setpoint selection will, however, be constrained to maintain satisfactory assurance that the isolation will occur for the main steam line break accident (high flow) or required leak detection (high temperature). It is not planned to change high flow isolations in auxiliary lines (such as RCIC), because flow conditions will not change there. (Appendix F.4)

(5) ***First-Stage Turbine Pressure Setpoint for Activation of Turbine-Generator Trip Scram -*** The basis for this setpoint is primarily to allow operational flexibility so that scram may be avoided during turbine-generator trips at low power. Because the actual bypass capacity is not being changed, the setpoint will be maintained at its current value, in terms of steam mass flow, minimizing the potential for hardware change. The basis statements for this setpoint will be revised to reflect the new percent of rated relationship (Appendix F.4).

(6) ***Feedwater Flow Setpoint for Recirculation Cavitation Protection -*** The current value of this setpoint is also to be maintained in terms of the actual FW flow rate. This is because the cavitation requirement is satisfied by the actual flow rate, not based on a percentage

of rated flow. Therefore, the setpoint relative to rated power may optionally be left unchanged or reduced slightly (Appendix F.4).

(7) ***Low Steam Line Pressure Setpoint for Initiation of MSIV Closure in RUN Mode -*** The pressure setpoint will not change in a TPO uprate. The small TPO uprate change in steam line pressure near the turbine (where this sensor is located) will not change significantly compared to the non-limiting nature of the Pressure Regulator Failure (Open) transient, which uses this function to mitigate the event. Its backup function for LOCA events is also maintained satisfactorily with the unchanged setpoint (Appendix F.4).

(8) ***Power Threshold above which Fuel Thermal Margin Monitoring is Required –*** The value of approximately 25% of rated thermal power traditionally used for this administrative threshold will be maintained in most cases for TPO uprate conditions. [

] (Appendix F.4).

## 5.9 ENVIRONMENTAL EFFECT EVALUATION

Evaluations will be performed to show that the higher power level does not result in a significant adverse environmental effect. The primary change will be a small increase in the normal amount of heat discharged from the condenser circulating water system. Where coolant is returned to a river, lake or ocean, the change is estimated to be an increase of less than 1°F. The integrated effect of cooling tower units will be even less. The unique site conditions will be evaluated and documented in the TSAR. Any changes necessary in the Environmental Protection Plan and environmental permits will be submitted and approved prior to operation at the TPO uprate condition.

## 5.10 BALANCE-OF-PLANT SYSTEMS

System reviews will be performed to determine the capability of various balance-of-plant (BOP) systems and components to ensure that they are capable of safely delivering the increased power output. Although no significant effect on plant safety is expected associated with these systems, the evaluations will be documented in the TSAR because these systems are more plant unique. The systems that receive a major review are described in the following sections.

### 5.10.1 Turbine-Generator

Thermodynamic and mechanical review and/or analysis will be performed to assure that the turbines can pass the higher steam flow rates with adequate design and pressure control. System evaluations (using the observed steam line pressure drop) will confirm that adequate flow margin remains at the TPO uprate condition to assure that good operational pressure control is maintained (as discussed in Section 5.8 and Appendix C.2.2). Pressure control testing will be performed as TPO RTP conditions are achieved for the first time (as discussed in Appendix L.2). As discussed in Section 5.8, TPO uprate has no effect on the requirements for the turbine bypass valves.

In general, the turbine-generator mechanical and electrical design has considered the Valves Wide Open (VWO) capability of the unit; therefore, it is expected that the small change for TPO uprate will be achievable. No significant modifications to Turbine-Generator hardware are expected for the TPO uprate (e.g., adjustments to generator stator cooling may be made).

Similarly, VWO capability has generally been considered in the design of the moisture-separator or moisture separator reheater systems, therefore, review of this equipment is expected to easily accommodate TPO uprate operating conditions. Similar reviews are expected to show that the main transformer and turbine-generator supporting systems (e.g., the Turbine Building Closed Cooling Water System) are capable of sustaining the TPO RTP level without any modifications.

### 5.10.2 Primary Containment System

The previous licensing application(s) have shown acceptability of the containment capability including consideration of at least 2% power above the previously licensed power level. Therefore, these evaluations already bound the conditions associated with the TPO uprate (with no increase in reactor operating pressure). The areas that have been included in the previous bounding evaluation of the containment capability are:

- Containment pressures and temperatures during limiting events
- LOCA containment dynamic loads
- SRV containment dynamic loads
- Subcompartment pressurization (as applicable)

In summary, containment response (peak pressure, temperature, and loads) and radiological evaluation of a postulated LOCA event have previously been performed considering at least 2% power above the CLTP conditions. Therefore, there is no increase in LOCA containment loads and the previous containment evaluations bound the TPO uprate conditions (with no increase in reactor operating pressure). See Sections 5.3.2 and 5.4, and Appendices G and H for further discussion of these areas.

### 5.10.3 Feedwater and Condensate System

A plant-specific review will be performed to ensure that the FW heaters, heater drains, condensate demineralizers, and the pumps (FW and condensate) are capable of providing the slightly higher TPO uprate flow rates. The review will also include an evaluation of the performance of the FW control valves and/or FW turbine controls to maintain adequate water level control at the TPO uprate conditions (testing defined in Appendix L). The amount of flow increase associated with TPO uprate is within the usual control flow margin of these systems, so it is expected that the TPO uprate can be accommodated without modifications.

Plant data and design/rating information will be used from existing pumps, valves, demineralizers, turbines, and motors to ensure that operation at the TPO uprate flow is acceptable. The margin between operating conditions to any potential trip will be evaluated so that there is no significant increase in the expected frequency of loss of FW flow events. Changes in potential FW system run-out and potential loss of FW heating events will have very small effect due to TPO uprate [ ]. These events will be evaluated during the first TPO uprate reload analysis to confirm that adequate fuel thermal margins are maintained (Section 5.3.2 and Appendix E).

### 5.10.4 Condenser and Plant Cooling Water Systems

Current condenser and steam jet air ejector (SJAE) performance will be evaluated to assess the ability to support operation at the TPO uprate steam flow rate. The performance of the condenser and SJAE systems is expected to accommodate the slightly increased power conditions for most of the year. Slightly more degraded condenser vacuum conditions may limit plant power level during hot weather. No changes will be made to the present plant heat sink maximum temperature limits.

A plant-specific review will be performed to determine the effect of TPO uprate on operation of various plant cooling systems. No changes are expected, because plant operating temperatures are nearly unchanged. The current performance of the normal and emergency service water systems, RHR service water, and the Turbine Building Closed Cooling Water System (TBCCW) will be evaluated to assure that they are able to support any slightly increased duty without degrading the safety of the plant. Results of these plant-specific evaluations will be included in the TSAR.

### 5.10.5 Circulating Water System and/or Cooling Tower

A plant-specific review of current performance of the circulating water system and/or cooling tower will be used to evaluate the expected performance under the TPO uprate thermal loads. Similar to the main condenser, these systems may operationally limit the power level during hot weather, but no safety effect exists as long as the plant is operated within the applicable Technical Specifications. The results from these reviews will also be used in performing the Environmental Evaluation for the plant (Section 5.9). Results of these plant-specific evaluations will be included in the TSAR.

### 5.10.6 Electrical Systems

Plant-specific evaluations will be performed to demonstrate that the electrical systems and components (including transformers) are capable of operating under increased electrical output and increased plant load conditions. It is expected that the small TPO increase in power will be within the capability of all electrical systems. Results of the following plant-specific evaluations will be included in the TSAR.

1. Electrical grid stability: The grid stability analysis will be evaluated and revised, if necessary. Any plant changes to control the reactive power will be identified in the TSAR.

2. Main generator: If the protective relaying for the main generator and main power transformer require modification, such changes will be identified.

3. The increased normal operating loads depend on the specific plant design and may include the recirculation pumps, condensate pumps, condensate booster pumps, motor driven FW pumps, and circulating water pumps. These additional loads may affect the ratings of the isophase bus, main power transformer, and startup/auxiliary transformers. Any changes will be identified.

4. Balance of plant loads: A plant-specific evaluation of the AC power system will be performed to assure an adequate AC power supply to the safety systems.

### 5.10.7 Emergency Diesels, M-G Sets, and Batteries

A plant-specific review will be performed to determine the effect of higher power level on the diesels, motor-generator (M-G) sets, and emergency batteries. In general, no load increase is expected, because the existing ratings and requirements for all safety-related systems and equipment are maintained. Plant-specific confirmation of these expectations will be included in the TSAR.

### 5.10.8 Spent Fuel Pool System

A plant-specific evaluation of the small increase to the spent fuel pool conditions due to TPO uprate (i.e., heat removal) will be performed and the results provided in the TSAR.

### 5.10.9 Radwaste System

There is no significant effect of TPO uprate on the Radwaste System. No significant increase in total treated material is expected, and it will be within the controlled capability of the system.

### 5.10.10 BOP Piping

Similar to NSSS piping (Section 5.5.2), evaluations are expected to show that the potential effect of the slightly higher (< 2%) steam flow and FW flow rates due to TPO uprate will be acceptable for BOP piping. The small changes in operating temperatures (< 2°F) and pressures (dome pressure unchanged, FW line pressure increased < 5 psi at the pump or FW control valve discharge and < 2 psi at the reactor FW nozzle) are expected to have an insignificant effect on erosion/corrosion and code design adequacy due to TPO uprate conditions, including thermal expansion and (as applicable to the plant's current licensing basis) vibration effects (Appendix K). In the TSAR, the licensee will provide a plant-specific evaluation of erosion/corrosion in the BOP piping to confirm the expectations and acceptability of current pipe monitoring programs.

### 5.10.11 Offgas System

There is no significant effect of TPO uprate on the Offgas System. Core radiolysis (formation of $H_2$ and $O_2$) will increase linearly with power (≤ 1.5%). The system will be able to maintain acceptable operation for this small change within the controlled capability of the system (Appendix J). Confirmation of this conclusion will be provided in the TSAR.

## 5.11 ADDITIONAL ASPECTS OF TPO UPRATE

### 5.11.1 10 CFR 50, Appendix R

The Appendix R requirements that were not previously analyzed for 102% of CLTP will be reviewed to ensure that these requirements continue to be met at the TPO RTP level. Section L.4 documents [ ]. It is shown that a TPO uprate of ≤ 1.5% will have a small effect on the required Appendix R scenarios. Should any plant project a violation of the applicable criteria from the information provided in Section L.4, a plant-specific evaluation will be provided in the TSAR.

### 5.11.2 Environmental Qualification Criteria

Review of compliance from the viewpoint of environmental qualification (EQ) criteria will be performed for safety-related equipment to show that equipment can perform its required functions under the TPO uprate condition. Each application will show that the existing environmental envelopes remain valid because no significant change in normal operating conditions is expected for a TPO uprate: operating temperature changes of < 2°F (FW lines) and < 1°F (recirculation drive loops), operating pressure < 1 psi (FW and recirculation discharge lines only due to slightly higher pressure drops at TPO FW flow rate and core pressure drop) and operating radiological changes of < 1.5%. Vessel dome pressure and other portions of the primary coolant pressure boundary remain at current operating pressure (or lower, e.g., main steam line). All harsh environmental design conditions are expected to have considered ≥ 102% of CLTP, although plant-specific confirmation needs to be provided in the TSAR. All environmental design bases are therefore expected to accommodate the small changes for TPO uprate operation, and this conclusion will be confirmed in the TSAR. If any area is found to exceed the current EQ basis, the reevaluation will be provided in the TSAR.

### 5.11.3 Emergency Operating Procedures

The BWR Emergency Procedure Guidelines (EPGs) will be reviewed to identify the effect (if any) on the plant Emergency Operating Procedures (EOPs) due to operating at TPO uprate conditions. The EPG/EOP action steps are unchanged because they are symptom-based, independent of reactor power level. However, certain threshold values for initiating mitigation actions (defined in the EPGs) are dependent upon power/decay heat levels. The EOP action thresholds are plant unique and will be addressed as needed by the utility, using standard procedure updating processes as done in previous BWR uprates. It is expected that a TPO uprate of ≤ 1.5% will have a negligible effect on any of the operator action thresholds, and no detailed information is required in the TSAR.

### 5.11.4 Requirements for Shutdown and Refueling

The current shutdown and refueling requirements are sufficient to accommodate the TPO uprate configuration. Shutdown margin (Section 5.7.1) is confirmed for each reload fuel cycle and will not be included in the TSAR.

Spent fuel pool cooling is discussed in Section 5.10.8. No effect other than procedural changes associated with the new value of rated power is expected for the TPO uprate.

### 5.11.5 Operator Training

Operating training requirements will be reviewed by each utility. Additional training required to operate the plant in TPO uprate conditions is expected to be minimal (e.g., only small power/flow map and flow-referenced setpoint changes), because there is no change in system operating pressure or water level. Small differences in EOP action threshold values (Section 5.11.3) may also be introduced.

### 5.11.6 Plant Life

The plant nuclear steam supply system (reactor pressure vessel, reactor internals, piping, and primary coolant pressure boundary) will be evaluated and monitored against criteria regarding the effect of the small TPO power uprate on age-related degradation (e.g., Section 5.5.1.5 for the reactor vessel). Equipment that is routinely replaced such as the fuel and the control rod drive mechanisms is not included in this evaluation.

It is concluded that the longevity of most equipment will not be affected by the TPO uprate because there is no significant change in the operating conditions for a constant-pressure TPO uprate. Those few components that might be affected already have effective plant programs in place to detect and mitigate age-related degradation. No additional maintenance, inspection, testing or surveillance procedures are required for the small change being introduced by TPO uprate. Current practices will be sufficient, even for equipment like the main transformer, which will operate under slightly higher loads at TPO uprate conditions.

### 5.11.7 Station Blackout

The Station Blackout (SBO) requirements, which are not previously analyzed for 102% of CLTP, will be reviewed to ensure that these requirements continue to be met at the TPO RTP level. Section L.5 of Appendix L documents [ ]. It is shown that a TPO uprate of ≤ 1.5% will have a small effect on SBO. Should any plant project a violation of the applicable criteria from the information provided in Section L.5 of Appendix L, a plant specific evaluation will be provided in the TSAR.

### 5.11.8 High Energy Line Break

Evaluation of the effect of TPO uprate conditions on environmental qualification has been generically evaluated (Section 5.11.2). There is no significant change because TPO uprate changes system operating temperatures and pressures only slightly: < 2°F and < 5 psi for FW lines only, and < 1°F and < 1 psi for recirculation lines only, due to slightly higher pressure drops at TPO FW flow rate and core pressure drop with current core flow. Vessel dome pressure and other portions of the primary coolant pressure boundary remain at current operating pressure or lower (e.g., main steam line). Therefore, the consequences of any postulated high energy line break (HELB) will not significantly change.

### 5.11.9 Power Uprate Testing

A testing plan will be included in the TPO uprate licensing application. No pre-operational tests are needed because no significant changes will be required for any of the plant systems or components. Guidelines for the TPO uprate ascension plan are given in Appendix L, Section L.2.

(1) Steady-state data is taken at previous rated thermal power so that operating performance parameters can be compared to conditions at TPO RTP.

(2) The power increase beyond the previous rating will be made along an established flow control/rod line in one (≤ 1.5%) change. Steady-state operating data will be taken at the new operating power level. Routine measurements of reactor and system pressures, flows, and vibration will be evaluated.

(3) Control system tests will be performed for the FW/water level controls and the pressure controls. These operational checks will be made at the previous rated power condition and at the new rated power condition to show acceptable adjustment and operational capability. The same performance criteria will be used as in the original power ascension tests.

(4) Large transient tests (e.g., isolation) will not be required for a TPO uprate (≤ 1.5%). Initial plant testing and experience during plant operation is considered to be sufficient.

#### 5.11.10 Power-Dependent Data Banks

Data banks for the process computer, safety parameter display, and control room operational indications/logs will be revised to correspond to the new rating just ahead of the actual cycle in which the TPO uprate is to be implemented.

#### 5.11.11 Probabilistic Safety Assessment

Each nuclear plant has completed an Individual Plant Examination (IPE) in response to Generic Letter 88-20. Most utilities completed their IPE by performing a Probabilistic Safety Assessment (PSA). A Level 1 PSA models the events that lead to core damage and calculates the core damage frequency. A Level 2 PSA models the core melt progression and containment failure and calculates the frequency and magnitude of radioactive release.

The PSA/IPE will not be updated, because the change in plant risk from the TPO uprate is insignificant. This conclusion is supported by the recently issued NRC Regulatory Issue Summary (RIS) 2002-03 (Reference 30). In response to feedback received during the public workshop held on August 23, 2001, the Staff wrote, “The NRC has generically determined that measurement uncertainty recapture power uprates have an insignificant impact on plant risk. Therefore, no risk information is requested to support such applications.” (Guidance G.9)

#### 5.11.12 Moderate Energy Line Break

Moderate energy lines are lines that do not meet the definition of high-energy lines. A TPO uprate does not change the process conditions for these lines. Therefore, the plant internal flooding protection and safe shutdown consideration are not affected.

#### 5.11.13 10 CFR 50, Appendix J

The 10 CFR 50, Appendix J testing program for containment isolation valves considers 102% of CLTP. Therefore, the existing Appendix J testing program will not be addressed in the TSAR.

### 5.12 SYSTEMS NOT AFFECTED BY POWER UPRATE

Appendix J discusses the systems and components that are not dependent or are not significantly dependent upon power level. No further evaluation of these systems need be included in plant-specific applications for TPO uprate.

**Table 5-1**

**REACTOR THERMAL-HYDRAULIC PARAMETERS**

**(TYPICAL BWR WITH 1.5% TPO UPRATE)**

| Parameter | Original Licensed Condition | 1.5% TPO Thermal Power Uprate |
|---|---|---|
| Thermal Power (MWt) | 2436 | 2473 |
| (Percent of CLTP) | 100 | 101.5 |
| Steam and FW Flows (million lb/hr) | 10.5 | 10.71 |
| (Percent of Current Rated) | 100 | 102 |
| Dome Pressure psia) | 1020 | 1020 |
| Dome Temperature (°F) | 547 | 547 |
| FW Temperature (°F) | 420 | 422 |
| Full Power Core Flow Range (million lb/hr) | (58 or 67)[1] to 85 | (60 to 69)[1] to 85 |
| (Percent of current rated) | (75 or 87)[1] to 110 | (77 to 89)[1] to 110 |
| Core Inlet Subcooling at rated core flow (Btu/lb) | 20.9 | 21.2 |
| Core pressure drop at rated core flow (psi) | 22.8 | 22.9 |
| Core average void fraction at rated core flow | 46 | 46.3 |

NOTE:

1. The lower end of the full power core flow range varies depending on the specific plant license. These values represent typical plant operating conditions.

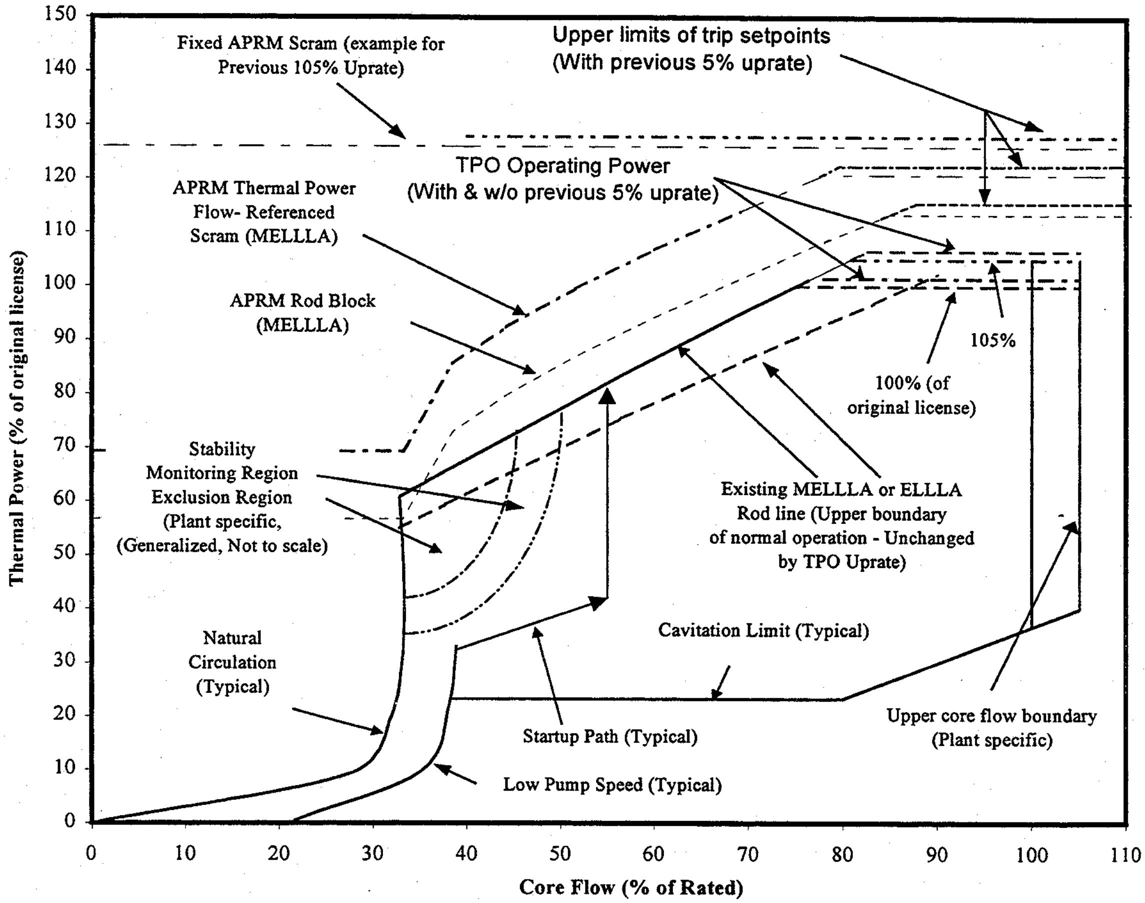


**Figure 5-1. Typical TPO Uprate Annotated Power/Flow Map**

# 6.0 CONCLUSION

This document provides GE's recommended scope of evaluation for a thermal power uncertainty reduction-based power uprate of a BWR up to 1.5% of the CLTP. This document provides generic evaluations and outlines an evaluation and analysis plan that is comprehensive, rigorous, and realistic for a TPO uprate. Specific generic methods, assumptions, and evaluations are presented in the appendices to this TLTR. Some areas are also identified for plant-specific confirmation of expected margin for acceptable achievement of a TPO uprate.

NRC approval of the guidelines and evaluations described in this document is requested to promote consistency in upcoming plant submittals and to reduce uncertainties in regulatory requirements associated with power uprate assessments. NRC review and approval for this generic approach will standardize the individual plant uprate applications to the maximum extent possible and significantly reduce NRC and industry resources required to address the applications anticipated in the next few years.

# 7.0 REFERENCES


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19. NEDO-31960-A, "BWR Owners Group Long-Term Stability Solutions Licensing Methodology," (and Supplement 1), April 1996.

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30. NRC Regulatory Issue Summary 2002-03, "Guidance on the Content of Measurement Uncertainty Recapture Power Uprate Applications," dated January 31, 2002.
31. NEDC-32950P, "Compilation of Improvements to GENE's SAFER ECCS-LOCA Evaluation Model," January 2000.
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# APPENDIX A

# PROPOSED PLANT-SPECIFIC TPO SAFETY ANALYSIS REPORT

This appendix presents a sample Table of Contents for a plant-specific Thermal Power Optimization Safety Analysis Report (TSAR). As discussed in Section 3, some items will not be discussed in the TSAR.

9.0 REACTOR SAFETY PERFORMANCE EVALUATIONS
- 9.1 Anticipated Operational Occurrences
- 9.2 Design Basis Accidents
- 9.3 Special Events
  - 9.3.1 Anticipated Transient Without Scram
  - 9.3.2 Station Blackout

10.0 OTHER EVALUATIONS
- 10.1 High Energy Line Break
  - 10.1.1 HELB Pressurization Events
  - 10.1.2 Pipe Whip and Jet Impingement Events
  - 10.1.3 Flooding Events
- 10.2 Moderate Energy Line Break
- 10.3 Environmental Qualification
  - 10.3.1 Electrical Equipment
- 10.4 Testing
- 10.5 Operator Training and Human Factors
- 10.6 Plant Life
- 10.7 NRC and Industry Communications
- 10.8 Emergency Operating Procedures

11.0 References

# APPENDIX B
# LICENSING APPROACH AND CRITERIA FOR TPO UPRATE

## B.1 LICENSING APPROACH

A plant-specific TSAR will generally reference this generic TLTR in order to focus the plant reviews on those issues that are either plant unique or cannot practically be addressed in a BWR bounding manner. The scope/content of this generic LTR is analogous to the generic LTRs (e.g., LTR-1 and ELTR-1, References 20 and 21), which are approved by the NRC for reference in the GE BWR Stretch Power Uprate (SPU, ~5% of OLTP) and Extended Power Uprate (EPU, up to 120% of OLTP) programs.

The purpose of this TLTR is to establish an agreed-upon scope and depth for plant-specific TPO submittals. Additionally, this TLTR defines the methodology, analysis assumptions, and acceptance criteria to be utilized in plant reports, and (with supplemental reports as needed) provides bounding generic evaluations of specific areas of plant safety design.

Follow-on supplemental reports may also be provided for any additional generic evaluations that may be desired to reduce the content of a TSAR. They will provide, as needed, additional generic bounding results for BWR plant licensing issues, analytical studies and equipment evaluations. The supplements will update, as needed for application of TPO uprate, the disposition and issue resolution initially provided in this TLTR and in previous GE BWR power uprate programs.

## B.2 LICENSING CRITERIA

The licensing evaluations and reviews for TPO uprating of a BWR plant will be conducted in accordance with the following criteria:

1) All safety aspects of a plant that are affected by a $\leq$ 1.5% increase in the thermal power level will be evaluated, including the Nuclear Steam Supply System (NSSS) and Balance-of-Plant (BOP) systems.
2) Evaluations and reviews will be based on licensing criteria, codes, and standards applicable to the plant at the time of the TSAR submittal; there is no change in the previously established licensing basis for the plant, except for the increased power level.
3) Evaluations and/or analyses will be performed using NRC-approved analysis methods for the UFSAR accidents, transients, and special events affected by TPO.
4) Evaluations and reviews of the NSSS systems and components, containment structures, and BOP systems and components will show continued compliance to the codes and standards applicable to the current plant licensing basis (i.e., no change to comply with more recent codes and standards will be proposed due to TPO).
5) NSSS components and systems will be reviewed to confirm that they continue to comply with the functional and regulatory requirements specified in the SAR and/or applicable reload license.

6) No safety-related hardware changes are needed for TPO uprate beyond potential setpoint changes. Any required (nonsafety-related) plant modifications will be minor in nature and will be designed to applicable design requirements and implemented in accordance with 10 CFR 50.59.

7) All plant systems and components affected by an increased thermal power level will be reviewed to ensure no significant increase in challenges to the safety systems.

8) A review will be performed to assure that increased thermal power level continues to comply with the existing plant environmental regulations.

9) An assessment, as defined in 10 CFR 50.92(c), will be performed to establish that no significant hazards consideration exists as a result of operation at the increased power level and submitted.

10) The individual plant license amendment submittal will request an increase in core thermal power level up to 1.5% of CLTP. However, some analyses may be performed at conservatively higher power levels.

11) Review of the latest UFSAR and of design changes/safety evaluations implemented, but not yet shown, in the UFSAR ensures adequate evaluation of the licensing basis for the effect of TPO through the date of that evaluation. Additionally, safety evaluations for changes not yet implemented will be reviewed for the effects of increased power.

A summary of the generic versus plant-specific safety analysis evaluations is provided in Tables B-1, B-2 and B-3. Each table entry references the sections of this TLTR that discuss the basis for that item. Table B-1 lists current safety analyses that are based on > 102% of CLTP. Safety analyses in this category already bound the requirements for safety evaluation of TPO uprate. They will not be reanalyzed.

Table B-2 lists the safety analyses that are not significantly affected by TPO uprate and the sections of this TLTR that discuss the basis for that categorization. [

]. In general, the TSAR will confirm that there is sufficient margin for the small changes identified in these evaluation areas. The exception to this process will be if an individual plant cannot confirm that there is sufficient margin in a safety analysis area for even the small incremental change(s) identified herein for TPO uprate. In this case, a plant-specific analysis will be performed and documented in the TSAR.

Table B-3 lists the areas of plant analysis and system evaluation that have not been generically dispositioned in this document. Plant-specific evaluations of these areas are expected to be included in the TSAR. This does not mean that they are unacceptable, only that it was simply not possible at this time to provide a generic bounding approach for these items. Many of them pertain to specific hardware components that require specific evaluation.

## B.3 DETERMINATION OF NO SIGNIFICANT HAZARDS CONSIDERATION

Plants seeking a thermal power uncertainty reduction-based power uprate are expected to request an amendment to their OL consistent with the considerations that govern their current license;

there is no change in the licensing basis for the plant except for the increased power level. No increases in the current limits that govern the amount of effluents or radiation emitted from the facility are requested for a TPO uprate. Consideration of potential significant hazards will establish that operation of the facility in accordance with the proposed amendment would not:

(1) Involve a significant increase in the probability or consequences of an accident previously evaluated; or

(2) Create the possibility of a new or different kind of accident from any accident previously evaluated; or

(3) Involve a significant reduction in a margin of safety.

Each plant-specific application for TPO uprate submitted under the guidelines of this document (TLTR) will include a detailed significant hazards consideration (SHC) assessment. The results of the SHC assessment at TPO RTP conditions will demonstrate that the OL amendment will not involve a significant hazards consideration.

Any change in probability of occurrence and consequences of an accident previously evaluated will be demonstrated as being minimal. As shown in Table 3-1, the increase in offsite radiation release is commensurate with the increase in power level and will remain well below the 10 CFR 20 and 10 CFR 100 criteria.

Implementation of TPO uprate will not create the possibility of a new or different kind of accident. An increase in power level will not allow for a new fission product release path, result in a new fission product barrier failure mode, or create a new sequence of events that result in fuel cladding failures.

Implementation of TPO uprate will not involve a reduction in a margin of safety. All applicable design basis code allowable values and plant safety limits will continue to be met. There will be no relaxation in the criteria used to establish safety limits or in the bases for limiting safety system settings.

A TSAR, coupled with the generic evaluations in this document and potential supplemental generic evaluations, will provide detailed, quantitative evaluations demonstrating that operation at the increased power level will not involve a significant hazard consideration.

## B.4 REVIEW OF NRC AND INDUSTRY GENERIC COMMUNICATIONS

SPU LTR2 and EPU ELTR2 (References 20 and 21, respectively) commit to a review of generic NRC and industry communications for SPU and EPU programs. To date, these reviews have not resulted in a single license amendment request, and thus, these reviews have never had a significant effect on any plant's licensing basis. A TPO uprate is mostly bounded by existing engineering and safety analyses (which are already based on 102% power), does not include a reactor vessel pressure increase (which could affect some of the engineering and safety analyses), and has significantly less effect on a plant than either an SPU or EPU. Therefore, with regard to a TPO uprate, a generic NRC and industry communications review was judged to be of insignificant value.

To validate the above judgment, a review (sensitivity study) of all the generic NRC and industry communications through December 1999, normally reviewed on a plant-specific basis for an EPU, was performed against the expected changes for a TPO uprate. For the concern addressed in each generic communication, the review resulted in one or more of the following findings:

- TPO is not applicable to the concern;
- The concern is already covered by an existing analysis, which is not affected by TPO;
- The concern is already generically addressed in this LTR; and/or
- The concern will be addressed as part of the standard TPO engineering and licensing process.

The review did not identify any case necessitating an additional separate plant-specific review for TPO. It is concluded that a plant-specific review of generic NRC and industry communications is not needed for a TPO uprate, and thus, this type of review will not be included in the TSAR.

## Table B-1

## CURRENT ANALYSES THAT ALREADY BOUND THE TPO UPRATE

## (TLTR section(s) that discuss each evaluation area)

| |
|---|
| Reactor Heat Balance for Safety Analyses (at 102% of CLTP) (5.1, Appendix C.2) |
| Design Basis Accidents (5.3.1, 5.3.2, 5.4, 5.10.2, Appendices D, G, and H):<br>- LOCA Inside Containment,<br>- Main Steam Line Break Outside Containment,<br>- Control Rod Drop Accident,<br>- Fuel Handling Accident |
| Vessel ASME Code Upset Criteria Overpressure Protection Analysis (5.3.3, 5.5.1.4, Appendix E) |
| Loss of FW Flow Transient Analysis (5.3.3, Appendix E) |
| Reactor vessel and internals loads and pressure drop evaluations for Emergency and Faulted conditions (post-BWR/3 plants) (5.5.1, Appendix I.2, I.3) |
| NSSS Safety-Related Systems (5.6, Appendices I, J, and K) |
| Harsh Environment Conditions (5.11.2) |
| Moderate Energy Line Break (5.11.12) |
| 10 CFR 50, Appendix J Testing (5.11.13) |
| Probabilistic Safety Assessment (PSA) (5.11.11) |

**Table B-2**

**ANALYSES THAT ARE NOT SIGNIFICANTLY AFFECTED BY A TPO UPRATE**

**(TLTR section(s) that discuss each evaluation area)**

| |
|---|
| Reactor vessel and component vibration and Normal and Upset thermal duty (no change in vessel dome pressure and operating temperature; FW temperature increase < 2°F; recirculation/core inlet temperature increase < 1°F). (5.1, 5.5.1, Appendices I.2 and I.3). |
| Reactor vessel fracture toughness and $RT_{NDT}$ shift. Confirm expectation that the TPO fluence increase is insignificant. (5.5.1.5) |
| Transient event analyses that establish reactor fuel operating limits ([ ] to the small change in power in a TPO uprate) [ ] and summarized in Appendix E. All limiting cases will continue to be evaluated for the first TPO uprate cycle and for each subsequent operating fuel cycle (5.3.3, Appendix E) |
| Steam Separator/Dryer operational performance [ ] (5.5.1.6) |
| NSSS and BOP Piping (5.5.2, 5.10.10, Appendix K) |
| High Energy Line Break evaluation (5.11.8, Appendix D) |
| Operator Training (5.11.5) |
| Reactor Controls and Instrumentation (except flow-referenced APRM setpoints) (5.8, Appendices C and F) |
| Reactor Recirculation System performance, including vibration evaluation (no increase in maximum flow) (5.6.2) |
| Normal Plant Operating Environmental effect (5.9, Appendix H) |
| RHR normal and emergency shutdown cooling (5.6.4) |
| ATWS peak vessel pressure analysis and longer-term ATWS response (e.g., suppression pool temperature, shutdown with liquid boron solution) (5.3.5, Appendix L.3) |
| Reactor vessel and internals loads and pressure drop evaluations for Emergency and Faulted conditions (pre-BWR/4 plants) (5.5.1, Appendix I.2, I.3) |
| Normal reactor operating environmental conditions (no change in reactor operating temperature except a very small increase (≤2°F) of FW temperature, environmental radiological conditions increased no more than the amount of the uprate) (5.4, 5.11.2, Appendices C and H). |
| Reactor Vessel and Internals – evaluation of plant-specific modifications, repairs, and/or known flaw indications (Appendix I.3) |
| Reactor Core and Fuel (5.7, Appendix E) |
| Appendix R Performance (5.11.1, Appendix L.4) |
| Plant Life (5.11.6) |
| LOCA-ECCS Nominal analysis and Upper Bound PCT (5.3.1, Appendix D) |
| Thermal Hydraulic Stability is not significantly affected. Operation remains within the operating range previously licensed (5.3.4, Appendix C) |
| Emergency Operating Procedure thresholds for actions (5.11.3) |

## Table B-3

## ANALYSES THAT REQUIRE UPDATING FOR TPO UPRATE

## (TLTR section(s) that discuss each evaluation area)

| |
|---|
| Reactor Heat Balances at TPO rated power conditions (5.1, Appendix C.2) |
| Reactor Power/Flow Operating Map (1.3 (Figure 1-1), 5.2 (Figure 5-1), Appendix C.2) |
| Reactor Controls and Instrumentation (flow-referenced APRM setpoints) (5.8, Appendix F.4) |
| Nominal LOCA evaluation [ ] (5.3.1, Appendix D) |
| Confirmation of acceptability of plant-specific environmental effect compliance (5.9) |
| Steam Separator/Dryer operational performance [ ] (5.5.1.6) |
| Appendix R (Fire event) evaluation [ ] (5.11.1, Appendix L.4) |
| Station Blackout event evaluation (if previous plant analysis not done at > 102% of CLTP [ ] (5.11.1, Appendix L.5) |

# APPENDIX C

# SPECIFIC ASSUMPTIONS AND BASES FOR TPO UPRATE OPERATING CONDITIONS

## C.1 SCOPE

This appendix defines the guidelines that will generically be used for the selection of the steady-state operating conditions for BWR Thermal Power Optimization (TPO) uprate of up to 101.5% of CLTP. It includes documentation of the bases and assumptions for each guideline. Also included are the guidelines associated with the selection of the power/flow map operating range for the unit after power uprate. Plants that make selections that differ from these bases (such as special operational features) will provide separate explanations and justifications in the plant unique licensing submittal.

## C.2 GUIDELINES FOR TPO UPRATE OPERATING CONDITIONS

The generic guidelines to be applied during establishment of TPO uprate operating conditions are listed with the pertinent bases, methods, and assumptions that apply to each one.

### C.2.1 TPO Uprate Core Thermal Power

The generic TPO uprate core thermal power level (MWt) to be proposed will be equal to or less than 101.5% of CLTP. The amount of the TPO uprate will be determined by the improved accuracy being claimed for the FW flow measurement instrumentation; this is the primary factor that enables a TPO uprate submittal.

Utilities that choose to apply for larger power uprate by combining a TPO uprate with another change will provide additional information to justify the combined effects.

Current heat balance methods will be used for definition of the TPO uprate operating conditions. A reactor heat balance will be prepared for the TPO uprate condition and included in the TSAR. The specific value of the TPO rated thermal power (RTP) level (MWt) will be calculated using the full, standard configuration of FW heaters in service, nominal (unchanged) dome operating pressure, and rated core flow.

End-of-cycle operation with FFWTR remains available as a special, plant-unique option. If previously applicable to the unit (and still desired), it will be reanalyzed up to the TPO RTP as part of the analysis defined in Appendix E. If not previously licensed, FFWTR will be treated as a new feature, outside this generic TPO uprate evaluation.

Similarly, other previously licensed Equipment-Out-of-Service contingency options (e.g., SRVs, FW heaters, recirculation pump) will be reassessed for applicability to TPO uprate operation as defined in Appendix E.

***Justification of TPO Uprate Core Thermal Power***

(1) Many BWR plants of all product lines have performed safety and operational evaluations that have led to approved licensed operation at power levels above OLTP.

The generic power uprate programs described in References 20 and 21 have made this process as consistent and resource effective as possible for the utilities and the NRC. This generic topical report is intended to provide similar assistance in the license approval process for TPO uprates.

TPO uprate operation is planned to be achieved along current operating rod lines. This approach is limited by the previously licensed maximum operating rod line for a plant. This constraint eliminates potential effects of TPO uprate on several areas (e.g., stability response) by not increasing reactor power in the lower core flow portion of the power/flow operating map beyond that previously licensed for the plant (Figure 5-1). The 1.5% uprate has minimal effect on other operational and safety performance characteristics of the Nuclear Steam Supply System (NSSS).

(2) In general, operating experience at all BWR plants has shown that the operating and safety margins included in the licensed power evaluations have been confirmed. Although plant unique conditions will be factored into each submittal, a TPO uprate is considered to be generically achievable for most plants without any significant modification of NSSS or BOP systems.

(3) The use of current operational heat balance methods to define the TPO uprate operating conditions is consistent with current UFSAR and reload practice. A reactor heat balance will be prepared for the TPO uprate condition and included in the TSAR.

(4) Use of the full, standard configuration of FW heaters in service to establish the specific value of the TPO RTP (MWt) is consistent with current UFSAR and reload practice. An increase of < 2°F in final FW temperature is expected. The TPO uprate design basis value for the FW temperature will be established through coordinated heat balances for the reactor and the turbine systems.

(5) The TPO RTP (as well as related steam and FW flow rates and electrical power level) is expected to be indicated in the main control room similar to current practice. That means that the TPO uprate operating parameters are expected to be indicated as 100% of the new licensed conditions wherever applicable (e.g., the indicated average power range monitor output signals). Similarly, licensing analysis documentation (e.g., reload licensing documents) will shift to the new licensed rating when it is approved.

### C.2.2 Operating Pressure

TPO uprate is to be accomplished with no increase above the current vessel dome pressure operating limits. This constraint minimizes the effect of the TPO uprate on reactor thermal duty, evaluations of environmental conditions, eliminates changes to all instrument setpoints related to system pressure, etc. This aspect of TPO uprate enhances the potential to implement TPO uprate on-line, as soon as licensing approval is received.

Satisfactory reactor pressure control capability is maintained by evaluating the steam flow margin available at the turbine inlet. The adequacy of pressure control will primarily be assured by use of data available from operation at the CLTP level and will be demonstrated as TPO RTP conditions are achieved (Appendix L). There is no effect of TPO uprate on the pressure control function of the turbine bypass valves.

***Justification***

(1) Maintaining the current vessel dome operating pressure and pressure actuation setpoints permits many aspects of reactor safety evaluation to remain equal to the current licensing basis for the plant. Many important functions are unchanged, such as the safety/relief valve loads (unchanged valve size and pressure opening setpoint). Implementation mid-cycle, on-line is achievable based on experience with several other BWR uprates.

(2) Satisfactory reactor pressure control (by the turbine pressure regulator and the turbine control valves) requires the design to provide adequate flow margin between the uprated operating condition and the steam flow capability of the turbine control valves at their maximum stroke. Most BWR plants have demonstrated acceptable pressure control performance with margin at current rated conditions. Acceptable flow margin is expected to be available to accommodate the relatively small (< 2%) increase in steam for any plant initiating a TPO uprate.

(3) Acceptable system pressure control is expected to be demonstrated during TPO implementation testing (possibly with minor tune-up of the controls). This operational aspect of TPO uprate is to be demonstrated at the TPO RTP conditions by performing controller testing equivalent to the testing done during the original startup of the unit (Appendix L).

(4) The bypass valves are used during plant startup and shutdown, and the need for bypass performance does not change from previously demonstrated experience.

### C.2.3 Power/Flow Operating Map

Figure 5-1 illustrates a typical BWR operating power/flow map and the generic approach for utilization of a TPO uprate. The power/flow map applicable for operation after TPO uprate is constrained by the following limits:

(1) The upper, full-power boundary will be limited to the TPO RTP level (identical to current practice, but for the higher TPO rating). Note that power is expected to be indicated as 100% of the new TPO rating.

(2) The right side of the operating range will be the same maximum core flow limit as currently licensed. After the TPO uprate, the currently licensed upper limit on core flow range remains unchanged. The TPO power increase does not introduce any significant change in the factors associated with producing or accommodating the maximum core flow basis for the plant. The maximum allowable recirculation drive loop flow (included in the plant Technical Specifications) is not increased.

(3) The lower core flow side of the operating map defines the acceptable power versus flow boundary for normal plant operation. This boundary is approximately equal to a constant-xenon rod line. The basis and the MWt power level along this boundary in a current plant license are not changed for a generic TPO uprate. The boundary is, however, extended along the same characteristic slope up to the TPO licensed power. For a TPO uprate of 1.5%, the core flow at this operating map "corner" is expected to be increased by approximately 2%. The following sections discuss this example in more detail.

(4) The plant may or may not have previously implemented the maximum expansion of the power/flow map licensed for its product line. The most expanded operating option currently licensed has been called the MEOD option for BWRs. This includes an ICF region and the MELLLA region. Licensing of MELLLA permitted reactor operation above the originally defined 100% control rod line (which passes through 100% of OLTP at 100% core flow). MELLLA is characterized by defining the operating boundary to be a control rod/load line that passes through 100% of OLTP at 75% of rated core flow. For pre-BWR/6 plants, MELLLA or ICF may have been implemented individually. An earlier operating option, Extended Load Line Limit Analysis (ELLLA), is characterized by a boundary limit similar to MELLLA, but defined by operation at 100% of OLTP at 87% of rated core flow.

(5) For effective implementation of TPO uprate, a plant is generally expected to have previously implemented the ELLLA operating region option or an ICF option so that a reasonable core flow range of operation at full power will be maintained. For any operating map, a TPO uprate of 1.5% will generically increase the core flow at the full power-low core flow “corner” by approximately 2%. As shown in Figure 5-1, this slightly narrows the core flow operating range for which full power can be achieved; however, this slight change is not expected to significantly penalize operation of most plants. For purposes of this TLTR, the full power operating window is characterized by the lowest value of core flow at which CLTP is approved. Values of this characteristic flow point are listed in Table C-1 for all pertinent BWR product lines. The flow range available for operation at the new TPO RTP level is slightly reduced on the lower side as shown in Figure 5-1. Table C-1 gives the previous and new lower core flow operating limits for all typical BWR plants, assuming a 1.5% TPO uprate.

(6) The boundaries on the lower part of the map are set to avoid cavitation in various parts of the recirculation system. They are based on the absolute values of flows and temperatures. Therefore, these lower boundaries may be moved “downward” slightly as the re-scaled power/flow map is prepared (e.g., an interlock at 30% of former rated FW flow may be set at 30%/1.015 after a 1.5% TPO uprate). Appendix F addresses such setpoints more extensively.

***Justification of Power/Flow Operating Range***

(1) Compliance with the TPO uprate maximum power limit (the top of the operating map) is unchanged from current Technical Specification practice. Analytical evaluations (described in other appendices to this document) account for the remaining uncertainty in the actual power level, within the improved accuracy capabilities of the FW flow instrumentation that form the basis of this TPO uprate topical report.

(2) By not changing the previously approved high core flow limit, TPO uprate operation does not introduce any significant changes in the evaluations associated with high core flow. The effects of changes in pressure drops, recirculation flow rates, the potential effects of recirculation flow-induced vibration, and the high flow dependency of some transient events insignificantly changed from the previously analyzed conditions. Confirmation of this expectation is addressed in other appendices that apply to specific areas of system and component performance.

(3) By constraining the plants to the currently-licensed, absolute upper flow control/rod line boundary, this TPO uprate approach avoids introduction of potential planned operation beyond the range already analyzed and experienced at the plant. The primary issues related to the upper rod line are core neutronic hydraulic stability, performance during postulated transients with failure of scram (ATWS), and potential hydrodynamic loads that are sensitive to higher subcooled conditions in the upper left part of the operating map. TPO uprate according to this generic approach will not challenge the planned operating range previously approved and utilized at the plant.

(4) The cavitation interlocks/boundaries that appear on the operating map are based on the absolute values of flows and temperatures. Therefore, they may be maintained at the same absolute limit as before. In the re-scaled power/flow map, they would appear to be lower, if unchanged in absolute units, but in reality they would be providing their cavitation function at the same operating point as before.

This generic approach is provided to consistently establish TPO RTP operating conditions.

## Table C-1

## LOWER LIMITS OF CORE FLOW RANGE AT RATED POWER*

| GE BWR Product Line | Approved Core Flow Lower Limit at OLTP | Approved Lower Limit at Stretch Power (original turbine/generator design, 5% uprate) | Examples of Lower Core Flow Limit at CLTP (Power, % orig) | New Lower Core Flow Limit at TPO (+1.5%) of CLTP |
|---|---|---|---|---|
| 2 | ** | ** | 85% (100% Power)** | 87% |
| 3 | ≥75% | ≥75%*** | 75% (100% Power) | 77% |
| 3 | ≥75% | ≥75%*** | 87% (110% Power) | 89% |
| 4&5 | ≥75% | ≥81% | 81% (105% Power) | 83% |
| 4&5 | ≥75% | ≥81% | 93% (113% Power) | 95% |
| 6 | ≥75% | ≥81% | 87% (110% Power) | 89% |

* See Figure 5-1 for graphical presentation of these limits. The examples represent power uprate via extensions of previously-approved flow control rod lines.

** Both domestic BWR/2 plants performed early uprates of ~20% and are currently licensed at their original turbine design conditions.

*** All BWR/3 plants were originally licensed at original turbine design conditions.

# APPENDIX D

# SPECIFIC ASSUMPTIONS AND BASES FOR ECCS-LOCA EVALUATIONS FOR TPO UPRATE

## D.1 SCOPE

This appendix provides the evaluation that will be applied generically for the approval of Emergency Core Cooling System (ECCS) performance analysis for a postulated loss-of-coolant accident (LOCA) from TPO uprate operating conditions. It includes documentation of generic bases, methods, and assumptions for the generic resolution of LOCA compliance for TPO uprate GE BWRs. Plants that evaluate LOCAs in a manner that differs from these guidelines will provide separate explanations and justifications in the plant-unique licensing submittal.

## D.2 ECCS-LOCA EVALUATION

This generic evaluation of ECCS performance for LOCA events at TPO uprate operating conditions lists the pertinent bases, methods, and assumptions that are applied.

### D.2.1 Licensing Requirements for ECCS-LOCA Evaluation

ECCS-LOCA analyses have previously been performed for all operating GE BWRs showing compliance to 10 CFR 50.46 criteria for CLTP conditions. LOCA cases have been analyzed using methods and assumptions that have been accepted by the NRC with respect to the requirements of 10 CFR 50, Appendix K. The existing Appendix K analyses include at least 2% overpower allowances according to the previous licensing requirements of 10 CFR 50, Appendix K and the guidelines of Regulatory Guide 1.49 (Reference 1).

The results of the ECCS-LOCA evaluation (using either methodology defined in D.2.3 or an alternate methodology, approved by the NRC for BWR LOCA 10 CFR 50.46 analysis) have usually been documented as a separate report that is referenced by the plant-specific UFSAR. Plant-specific TPO power uprate submittal reports may reference this generic evaluation to show that the previously-documented ECCS-LOCA results support the conclusion that operation at TPO RTP is acceptable from the viewpoint of ECCS-LOCA.

***Justification***

This evaluation is consistent with approved licensing requirements and practices.

### D.2.2 Operating Conditions for ECCS-LOCA Analysis

ECCS-LOCA Appendix K analyses have previously been performed with a core power at least 102% of the previous rated core thermal power level. The hot bundle(s) have also been initialized with the peak linear heat generation rate (LHGR) at 102% of the LHGR limit applicable to the fuel type. This previous approach was based on the guidance of Regulatory Guide 1.49 and the requirements of 10 CFR 50, Appendix K.

Under the revised ECCS rules introduced by the NRC (Reference 26), the amount of power uncertainty required for ECCS safety analysis can be based on the accredited accuracy of the power measurement instrumentation. In particular, the improved accredited accuracy of the FW flow measurement system is the primary basis for a TPO uprate submittal. The improved accuracy allows for a newly-defined rated power level that is closer to the power level previously assessed in the existing LOCA-ECCS analyses. For example, if the accuracy is improved so that only 0.8% power uncertainty allowance is required, the TPO uprate submittal will request that the rated licensed power level be increased to 0.8% below the previously analyzed power level (for this example: 102%/1.008 equals a 101.2% uprate).

This generic evaluation recognizes that the potential increase of rated power may approach or be bounded by a power measurement uncertainty as small as approximately 0.5%, allowing a potential increase of rated power of up to 1.5%. Therefore, this evaluation presented in this TLTR generically supports TPO power uprates as large as 1.5% above the CLTP level. The power level to be selected for each TPO uprate will be individually based on the accredited accuracy of the FW measurement system in service at the specific plant requesting TPO uprate.

It is the contention of this TLTR that the existing LOCA-ECCS analysis provides acceptably bounding results to show compliance with the requirements of 10 CFR 50.46 and 10 CFR 50, Appendix K for licensed power levels up to within 0.5% of the existing Appendix K analysis. The actual amount of uprate depends upon the accredited instrumentation accuracy.

The initial operating pressure, steam and FW flows, and FW temperature (factors which affect system inventory and energy) have already been chosen to bound the normal operating heat balance at TPO uprate conditions (Table 5-1).

***Justification***

(1) The elements of this evaluation are consistent with current licensing analysis practice and the new regulations (Reference 26). Operation up to a power level that is within the accepted accuracy of the power measurement instrumentation (primarily FW flow measurement) is in accordance with the revised NRC rule.

(2) Establishment of initial plant operating conditions by bounding the official heat balance conditions for TPO uprate conditions matches current licensing analysis practice.

### D.2.3 Computerized Methods for ECCS-LOCA Analyses

There are two sets of accepted GE methods for ECCS-LOCA analysis. From the viewpoint of generic methodology approval, either set of methods is considered to be acceptable for TPO uprate.

(1) The methods expected to be used for most power uprate submittals are the newer set of codes: LAMB/SCAT/SAFER/GESTR/(CORECOOL). This set is usually identified simply as SAFER/GESTR.

(2) The other set of methods that could also be used is the former set of codes: LAMB/SCAT/SAFE/REFLOOD/CHASTE.

Usual practice for a TPO uprate will be to reference the previous analysis of postulated LOCA-ECCS events. Should new analyses be performed (for other plant reasons, e.g., updating the analysis assumptions), it is expected that such new analyses would be performed with the SAFER/GESTR methodology. In such cases, the results would be documented in a separate licensing report for use ahead of or with the TPO uprate. If an alternate NRC-approved methodology for LOCA 10 CFR 50.46 analysis has previously been used (for analyses not provided by GE), a similar approach may be taken for TPO uprate if appropriately justified.

***Justification of Computerized Methods***

(1) The SAFER/GESTR methods have been documented in the reports listed in References 2 and 31. Both of these reports have received NRC approval for application of this technology to LOCA-ECCS evaluation. Many of the plants approaching TPO uprate have already shifted their LOCA licensing basis to this methodology.

(2) Use of the SAFER/GESTR methodology (as accepted) demonstrates compliance of the plants to 10 CFR 50.46 Licensing Basis criteria for PCT and other pertinent limits using 10 CFR 50, Appendix K model assumptions and inputs. Compliance of the Upper Bound PCT analysis has also been demonstrated using a nominal calculation and plant and model statistical uncertainty margins. [ ] nominal LOCA-ECCS calculations to a power uprate of 1.5% is shown in Table D-1. Information [ ] is listed, and the amount of PCT increase for the worst nominal LOCA case [ ].

(3) [

]

(4) The older set of methods (LAMB/SCAT/SAFE/REFLOOD/CHASTE) has also been documented by GE in Reference 15. The report and methodology has received NRC approval. This methodology (and its related predecessors) had been used for many plants as the basis for the original FSAR and Cycle 1 license for most plants. It is still the analysis of record for some of the plants that are considering a TPO uprate. The ≥ 2% power uncertainty allowance included in that methodology continues to provide acceptable protection margin within the reduced power uncertainty values introduced by the revised power measurement and the related revised licensing requirements.

(5) Use of the previous bounding analyses that were performed with either methodology to show ECCS-LOCA compliance to the licensing requirements for TPO uprate is consistent with current licensing bases.

### D.2.4 Break Spectrum, Worst Single Failure, and Loss of Offsite Power

The ECCS-LOCA analysis that bounds TPO uprate conditions includes consideration of the worst additional single-failure and postulated loss of offsite power. The most limiting break sizes and locations have already been evaluated to establish the bounding LOCA break spectrum. That break spectrum result continues to bound licensed operation after a TPO uprate.

***Justification***

This TPO uprate evaluation is consistent with the revised NRC rule (Reference 26), and the revised requirements of Appendix K. Analysis results remain in compliance with the criteria established in 10 CFR 50.46. It completely follows the revised licensing practice. No change occurs in the previous Appendix K break spectrum results.

### D.2.5 Plant Parameters for ECCS-LOCA Analysis

The current safety analysis parameters will apply after the TPO uprate because the current LOCA-ECCS analysis is to be applied. No changes are expected to be introduced by the TPO uprate process

***Justification***

Use of the same ECCS performance parameters is consistent with the plant Technical Specifications. If any changes are introduced, justification will be provided in the TSAR.

### D.2.6 The Effect of Non-GE Fuel on the ECCS-LOCA Analysis

There are four possible approaches for the ECCS-LOCA performance evaluation for other vendor's fuel:

(a) If GE performed the analysis of record for the other vendor's fuel using the SAFER-GESTR-LOCA methodology, then the approach described in this TLTR is directly applicable.

(b) If the analysis of record is based on an Appendix K evaluation model, then the analysis of record should be directly applicable to TPO conditions, based on reducing the required power uncertainty from 2%.

(c) If the analysis of record is based on an evaluation model that uses the approach described in SECY-83-472 (i.e., uses an approach similar to SAFER/GESTR-LOCA), then the licensing basis PCT should be directly applicable to TPO conditions because a SECY-83-472 evaluation model must comply with the Appendix K power uncertainty requirement. The plant-specific application would confirm this approach with the other fuel vendor and ensure that all conditions required for application of the evaluation model are satisfied.

(d) If the evaluation of record is based on a best-estimate evaluation model (i.e., one that uses the approach described in RG 1.157), the plant-specific application would provide the ECCS-LOCA performance evaluation for the other vendor’s fuel to support TPO.

***Justification***

The ECCS-LOCA analysis with non-GE fuel must follow one of the four approaches provided above to be acceptable. The TSAR will confirm the approach used for the plant-specific application.

## D.3 SUMMARY OF TPO UPRATE EFFECT ON ECCS-LOCA ANALYSIS

The current Appendix K safety analysis bounds TPO uprate because the current Appendix K LOCA-ECCS analysis has been performed at ≥ 102% of CLTP, and the vessel pressure is not increased for the generic TPO approach.

Small changes may occur in the Upper Bound PCT, which has been calculated from nominal conditions for the CLTP level. Table D-1 shows [ ] for TPO uprates of ≤ 1.5%. [ ] shown in Table D-1, a plant-specific analysis is not required and confirmation will be contained in the TSAR. [ ], then this area will be addressed in the TSAR.

**Table D-1**

**EVALUATION OF LOCA-ECCS EVENTS**

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* All results shown here are calculated with the approved GE SAFER GESTR-LOCA methodology.

# APPENDIX E
# TRANSIENT EVALUATIONS FOR TPO UPRATE

## E.1 SCOPE

This appendix provides generic evaluation of transient events for TPO uprated plants, and includes documentation of the bases and assumptions for each evaluation. The evaluation is [ ]. These generic results show that the effect of TPO uprate is small enough that no plant-specific transient analyses are required for the TSAR. It is sufficient for each plant to perform the standard reload transient analyses defined in GESTAR (References 3 and 14) (or equivalent) at the usual time just ahead of the first fuel cycle that will implement TPO uprate.

Also included are the transient analysis guidelines associated with the TPO uprate power/flow map operating range selected (see Appendix C). Plants that make selections that differ from these bases will provide separate explanations and justifications in the plant-unique licensing submittal.

## E.2 BASES FOR TRANSIENT EVALUATIONS

The generic approach applied in this evaluation of anticipated operational occurrences (AOOs) at TPO uprate operating conditions is provided. Plant-specific transient analyses of all bounding events will continue to be provided for each fuel cycle, including the first cycle of TPO operation. However, this appendix provides the pertinent generic bases, methods, and assumptions that show that the incremental change in transient performance for even the maximum (1.5%) TPO uprate does not significantly change the required fuel operating limits. This evaluation provides the basis for providing no additional transient analyses during TPO licensing until the standard process by which the fuel operating limits for each fuel cycle are administered.

In some cases, the current transient analysis may not have been done by GE. For those plants, equivalent approved methodology should have been used and documented in the current plant-specific reload license basis analysis. This TPO evaluation does not specifically justify the same reload analysis approach for plants with non-GE analytical methods, but a similar approach is expected to be possible for those plants.

### E.2.1 GE Analytical Methods Used for TPO Transient Evaluations

Two sets of GE methods are approved for evaluation of anticipated BWR transients. The methods are identified as GENESIS and GEMINI in GESTAR (Reference 3). Future methods approved by the NRC for reload transient analysis may also be applied to future power uprate analysis.

(1) GEMINI: The GE method used for most power uprate submittals is the newer transient evaluation approach identified as GEMINI in GESTAR. Some of the key elements of GEMINI are the use of GESTR fuel parameters (consistent with the SAFER/GESTR-LOCA basis and current fuel design technology), initial power equal to the increased license rating for MCPR analysis, and mean scram time (pre-BWR/6 plants). Statistical adjustments are made to the results that provide allowances for model and input uncertainties (including power) and scram time (for measured scram

times up to the Technical Specification limit for pre-BWR/6 plants). BWR/6 analysis uses the Technical Specification scram time and therefore only applies the model and input uncertainty adjustment factor.

(2) GENESIS: This older method is no longer in general use. It is described in the previous power uprate guideline documents (Appendix E of Reference 21).

These methods involve Statistical Adjustment Factors, Transient Reload Analysis, and the Safety Limit MCPR (SLMCPR).

*Statistical Adjustment Factors*: The standard TPO transient analysis approach will be to continue to apply the existing generic statistical adjustments during this evaluation and for reload analysis for TPO operation. Alternatively, plant and configuration-specific uncertainty adjustments may be derived using the smaller power uncertainty that is associated with the plant-specific FW measurement capability. If this approach is planned for any plant, the plant-specific TPO submittal will provide the additional information associated with that approach.

*TPO Reload Transient Analysis*: The first TPO transient analysis is to be performed at the time of the first TPO reload (rather than in the plant specific TPO uprate submittal) using the method of record for the applicable plant. [

]. The more precise analysis that is possible after the reload core is configured will provide the most meaningful results. At that time, the cycle-specific SLMCPR will also be available, so that the actual required Operating Limit MCPR (OLMCPR) can be established at that time. This process ensures that adequate fuel thermal margin will be maintained for TPO uprate operation.

*SLMCPR*: The current practice of establishing a plant- and cycle-specific SLMCPR will be continued. For a TPO uprate, the reduced average power measurement uncertainty may be included in the SLMCPR derivation. See Section E.2.5 for more information on SLMCPR.

***Justification of GE Transient Methods***

(1) Both GE methodologies (GEMINI and GENESIS) are approved by the NRC for use in transient licensing analyses (References 3 and 14). Their use for TPO reload analysis is consistent with current licensing practice. Use of the existing generic statistical adjustments during reload analysis for TPO operation is conservative because they have been derived considering 2% ($1\sigma$) power uncertainty. It maintains a standardized approach for any BWR, whether the improved FW measurement accuracy technique is utilized or not. The nominal licensed power conditions will continue to be used for the base calculations for transient analyses as defined in the current GE methodology. As noted above, this standard approach is not expected to introduce a significant penalty in the required OLMCPR. [ ]. If desired by the specific utility, however, plant- and configuration-specific statistical adjustment factors may be derived using the smaller power uncertainty that is associated with the plant-specific FW measurement capability. This approach would maintain the same methodology for deriving the factors as has been previously approved by the NRC. It may provide a small improvement in the required operating limits for that plant. The

TSAR will provide the additional information associated with that alternative approach, if selected.

(2) Performing the first TPO transient analysis at the time of the first TPO reload (rather than in the TSAR) is [ ]. Table E-2 lists the changes in OLMCPR results [ ]. The approximate change in the OLMCPR expected for a TPO uprate up to +1.5% power is also shown. That effect is concluded [ ], small enough that it is within the range of analysis variations seen from cycle to cycle, and no extra analysis is needed at the time of the TPO submittal. The transient analysis that is possible after the reload core is configured will provide the most applicable, meaningful results. The cycle-specific SLMCPR will also be available, so that the actual required OLMCPR can be established at that time. This process ensures that adequate fuel thermal margin will be maintained for TPO uprate operation.

(3) Future GE methods which are approved by the NRC for fuel cycle reload transient analysis can also form an acceptable basis for future reload transient evaluations at TPO uprate conditions.

### E.2.2 Transients to be Analyzed

Previous analysis has been performed for the limiting transient events, including consideration of 2% power uncertainty. These limiting events will be reanalyzed for TPO uprate at the time of normal reload preparation for the first fuel cycle to employ the uprate. That analysis is to include all events that establish the core thermal operating limits and the events that show bounding conformance to the other transient protection criteria (e.g., ASME overpressure limits). Table E-1 shows the minimum list of events to be included in the first reload for implementation of TPO uprate. Analysis of the list of transients provided in Table E-1 confirms that the existing set of reload analysis transients remains valid, and evaluates operational aspects of the TPO uprate.

***Justification***

(1) The primary source for this list of events is the standard transient licensing analysis scope established through GESTAR. This list of limiting events is still valid for a TPO uprate of up to 1.5%. The limiting event list is applied for all operating plants as reload cores are evaluated. It includes all events that can affect the OLMCPR for core operation during that fuel cycle. The reload evaluation for the first cycle that will implement TPO uprate will provide the specific analysis of these cases for conditions to be experienced for that cycle, including all the exposure history of the core up to that time.

(2) There is no significant change in the recirculation flow increase events and the flow-dependent operating limits due to TPO uprate because the maximum operating boundary at partial core flow is not being increased (same maximum rod line) and the upper limit on core flow runout is not being changed.

(3) Analysis of the closure of all MSIVs with high neutron flux scram will be performed for the first TPO reload (consistent with current reload analysis practice), because it has been shown to be the worst overpressure evaluation event in the ASME Upset category. This case (with no credit for direct scram from the MSIV position switches)

is the design and licensing basis for the safety/relief valves (SRVs). The new analysis will be performed from an initial power level consistent with the uncertainty for FW instrumentation capability defined by the utility. Any Technical Specification allowances for SRV(s) out of service will also be included in this evaluation. Where applicable, the initial pressure will be the Technical Specification Limiting Condition for Operation (LCO) consistent with the basis for basis for that Technical Specification item. Performing this overpressure case analysis at the time of the first (and subsequent) TPO reload is acceptable, because the current analysis has already included the assumption of 2% overpower, and that existing case bounds the TPO uprate except for the specific details of the new fuel load.

(4) Analysis of the loss of FW flow transient, previously evaluated for the plants (including the generic power uprate programs, References 20 and 21), is not required for a TPO uprate. The previous safety analysis of this event, showing that coolant is maintained above the top of the active fuel, already included conservatisms that included 102% of CLTP. Therefore, that analysis bounds reactor performance at TPO operating conditions because the new analysis conditions (e.g., at 0.5% above the new licensed power level for a TPO uprate of 1.5%) are the same as the current analysis. The limiting case assumes failure of the High Pressure Coolant Injection (HPCI) or High Pressure Core Spray (HPCS) System (as applicable). The minimum water level which results depends upon the existing capacity of the Reactor Core Isolation Cooling (RCIC) System and the basically unchanged inventory of water above the core to remain adequate to maintain water level inside the core shroud above the top of the active fuel (TAF). There is no change from the previous analysis because the decay heat of the safety analysis case is unchanged for TPO uprate conditions. Decay heat ≥ 1979 ANS 5.1 + 10% has been used for the transient safety evaluation (Reference 18).

The safety criterion for the loss of FW flow event (maintenance of adequate transient core cooling) is met by keeping the water level inside the core shroud above the top of the core. For BWR/4 and later plants, it is also operationally desirable to avoid initiation of the functions associated with the very low water level setpoint (Level 1, sensed level outside the core shroud near the TAF). Plants that have previously implemented a power uprate have more difficulty avoiding the nominal value of this setpoint, and may have shifted with respect to this operational goal to be like the pre-BWR/4 plants that cannot avoid this setpoint. The small changes introduced by a TPO uprate will not significantly change the ability of the plant to accommodate this operational goal.

### E.2.3 GE Computer Models for Analysis of Each Event

The specific GE computer models used for the analysis of each event (or previously approved optional models) are shown in Table E-1. For plants in which others supply the analysis, equivalent approved methods will be described in the TSAR.

***Justification***

The models listed in Table E-1 are based on the approved methods documented in GESTAR. Application of the more complete ODYN model will continue to be the main tool for analysis of fast transient events. Some of the added features in ODYN (over the older model REDY) include one-dimensional versus point neutron kinetics, and more detailed nodalization of the bulkwater/downcomer region. The 3-D BWR Simulator is used for quasi-steady-state events (e.g., the loss of an FW heater); it is the standard GESTAR approved method for such cases.

### E.2.4 Power Level for Transient Analyses

The specific power levels for each of the limiting events are also shown in Table E-1. The transient analyses provide assurance of adequate safety margin including the appropriate allowance for power measurement uncertainty – consistent with the revised instrumentation capability.

***Justification***

The power levels shown for the reload analyses are consistent with adjusted basis of current licensing requirements accounting for the new power measurement accuracy. They remain consistent with the basis of the standard procedures documented by GESTAR. Wherever GESTAR has not identified a specific power level for the analysis, power uncertainty equivalent to the remaining power measurement uncertainty will be chosen.

The PANACEA 3-D core simulator is applied to quasi-steady-state events, such as analysis of the loss of an FW heater, assuming an initial power of 100%. An appropriate power uncertainty at least equal to the remaining power measurement uncertainty is included in calculating the OLMCPR for these events within the GEMINI methodology. The other non-GEMINI evaluations (e.g., analyses of the loss of FW flow, inadvertent HPCI start (if not bounded by loss of FW heater), and the ASME overpressure transient in Section 5.5.1), have already been performed at 102% of CLTP, and acceptably bound the license analysis power level required after the TPO uprate.

The power level defined for the performance of the reload analysis for this set of limiting events will provide adequate assurance that all aspects of transient safety will be satisfied for TPO uprate operation. Table E-2 shows that [ ] is sufficiently small relative to the magnitude of TPO uprates up to 1.5%, so that it is acceptable to perform the analyses with the specific details available at the time of the first TPO reload. Selection of the set of events is also discussed in Section 5.3.3. Specific cycle confirmation will continue through the standard reload process.

### E.2.5 Safety Limit MCPR

The basis for the current SLMCPR is dependent upon the nominal average power level and the uncertainty in its measurement. Consistent with current practice, a revised SLMCPR will be calculated for the first TPO fuel cycle and confirmed for each subsequent cycle. It may include consideration of the improved FW measurement capability of the plant. The historical uncertainty allowance as discussed in GESTAR (Reference 3) assumed a 1$\sigma$ FW flow measurement uncertainty of 1.76%. That 1$\sigma$ uncertainty value for SLMCPR calculation was recently updated to 1.8% in Reference 28, and standard GE SLMCPR analysis for TPO plants will maintain the use of the 1.8% conservative uncertainty allowance. Use of the improved capability will be an acceptable utility option; however, it would provide only a very slight improvement [ ] in the SLMCPR for TPO operation. Using either method, the applicable SLMCPR results will be provided at the time of the first TPO reload analysis.

***Justification***

Standard GE SLMCPR analysis will continue to use the $1\sigma$; uncertainty value of 1.8% per Reference 28. This standard practice is conservative, and it is expected to produce only a very small penalty in the SLMCPR [ ]. If desired by a utility, the new FW measurement uncertainty may be included in the statistical calculation performed to establish the plant- and cycle-specific SLMCPR for TPO uprate fuel cycles. No other significant changes in core power distribution or other plant parameters are expected due to TPO uprate to affect the SLMCPR.

### E.2.6 Plant Modifications

No safety-related modification beyond instrument setpoint changes, or any significant plant nonsafety-related modifications are anticipated in a standard TPO uprate. Reactor operating pressure and water level will be maintained at their pre-TPO uprate values. There will be no effect on the transient analyses beyond normal cycle-to-cycle considerations.

***Justification***

The existing licensing transient analyses adequately reflect the TPO plant configuration, so that performing the normal set of reload analyses is sufficient.

## E.3 TPO Uprate Transient Evaluation Summary

[ ] all limiting transient events to the TPO uprate operating power change is shown to be very small. The change in the OLMCPR, if any, due to TPO uprate is [ ] as shown in Table E-2. For plants that are not making any exceptions to the standard TPO process defined in this TLTR, it is concluded that no transient analysis results are required at the time of the TSAR. Standard transient analysis for the first TPO uprate fuel cycle is sufficient.

## Table E-1

## TRANSIENT EVENTS ANALYZED FOR TPO RELOAD ANALYSIS

| | Event Type | Primary Model for Analysis* | Power Level (% Uprated) |
|---|---|---|---|
| A. | Fuel Thermal Margin Events | | GEMINI Method |
| 1. | Generator Load Rejection with Bypass Failure**** | ODYN | 100%** |
| 2. | Turbine Trip with Bypass Failure**** | ODYN | 100%** |
| 3. | FW Controller Failure-Max. Demand | ODYN | 100%** |
| 4. | Pressure Regulator Downscale Failure**** | ODYN | 100%** |
| 5. | Loss of FW Heater**** | REDY, ODYN or 3 D-Simulator | 100%** |
| 6. | Inadvertent HPCI Start (If not bounded by Loss of FW heater)**** | REDY or ODYN | 10y.z%*** |
| 7. | Rod Withdrawal Error | 3D-Simulator | Local limits |
| 8. | Slow Recirculation Increase ($K_f$, $MCPR_f$)**** | 3D-Simulator (equiv.) | Max rod line |
| B. | Limiting Transient Overpressure Events | | |
| 9. | Main Steam Isolation Valve Closure with Scram on High Flux (Failure of Direct Scram) | ODYN | ≥10y.z%*** |

* Model references for GE analysis: ODYN (References 4, 5, 6, 7, and 27); REDY (References 8, 9, and 10), 3D- Simulator (References 11 and 12). If analysis is done by others, alternate approved methods will be used and referenced.

**Power uncertainty allowance applied during application of GEMINI. Unless otherwise defined for plant-specific application, the historical 2% (1σ) uncertainty allowance will continue to be conservatively used. No significant penalty in fuel OLMCPR is expected [ ]. Plant-specific uncertainty allowance calculations may be applied consistent with the accepted FW measurement accuracy for the plant.

***For those analyses done above licensed power conditions, the initial power level will be "≥10y.z", where "y.z" is the remaining operating power uncertainty of the accepted FW measurement instrumentation for the plant. For example, if the remaining uncertainty is 0.8%, the analysis will be performed at ≥ 100.8% of the TPO licensed power level.

****These events are selected on a plant-specific basis, depending on which events have been limiting in the historical record for the plant. The TPO uprate will not change that pattern.

## Table E-2

## EVALUATION OF TRANSIENT MCPR EVENTS

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# APPENDIX F

# SPECIFIC ASSUMPTIONS AND BASES FOR CONTROL, INSTRUMENTATION, AND SETPOINT EVALUATIONS

## F.1 SCOPE

This appendix defines the generic guidelines for TPO uprate effects on controls, instrumentation, and setpoints. Many aspects of this area are operational and thus are not covered in depth here. Other aspects are discussed because they are coupled to the selection of the TPO uprate operating conditions in Appendix C. Other areas are clearly related to safety functions, especially the bases for setpoints. This appendix includes documentation of the most important bases and assumptions for each setpoint. Plants that use different guidelines, bases, or assumptions must provide separate explanations and justifications in the plant unique licensing submittal.

## F.2 GUIDELINES FOR CONTROLS

The generic guidelines applicable to plant control systems during evaluation of operation at TPO uprate conditions are listed with the pertinent bases, methods, and assumptions that apply to each one. It is recognized that most of the control systems are operational functions, rather than safety-related, but some of those key items are also included here for consistency among the plants in areas that generate common questions.

### F.2.1 Reactor Pressure Control

In this generic approach, reactor dome pressure will not be changed for TPO uprate operations. Adequate steam flow margin is assumed to be available between the turbine control valve operating point and the valves-wide-open condition for plants that will apply for TPO uprate. There will be a small (< ~2 psi) decrease in the pressure available at the turbine inlet for TPO RTP operation (Appendix C), but this change is not considered to be significant for pressure control performance. Demonstration of acceptable pressure control for TPO uprate operation will be performed as TPO uprate conditions are achieved (Appendix L).

***Justification***

Reactor system pressure is controlled by redundant turbine pressure regulators. This system does not perform any safety function, and it has demonstrated reliable, continuous control during plant operation. Its normal control function will only be affected by TPO uprate by the small amount needed to pass the slightly increased steam flow to the main turbine. The valve characteristics are non-linear, and good control capability is more difficult if all valves are too close to wide open. Design and operating information is used to establish the valve opening versus turbine inlet pressure conditions that are needed to ensure that sufficient margin remains. Operating experience has generally shown that sufficient margin exists for most plants for the small increase in steam flow (< 2%) planned for TPO uprate. The regulator will also be re-tuned, if necessary, to optimize control performance. Testing will be done as actual TPO RTP conditions are approached to ensure that acceptable control remains after uprate (Appendix L).

### F.2.2 Turbine Bypass System

No change is required to the Turbine Bypass System.

***Justification***

The primary role of the Turbine Bypass System is to provide a steam flow path for pressure control when the main turbine cannot accept all of the steam from the reactor. Although the bypass will be a slightly smaller fraction of the new rated steam flow, this function is still completely adequate during unit startup, as demonstrated by previous unit operation during synchronization and loading of the turbine/generator (T/G). Although the bypass provides some overpressure help following T/G trips, the safety/relief valves are designed to provide complete protection without any assistance from the bypass. The capacity will still clearly be sufficient to pass steam generated by decay heat (≤ ~6% of TPO RTP), thereby avoiding suppression pool heatup when the main condenser is available. Any role played by the bypass valves in the plant transient analysis is discussed in Appendix E together with the other analyzed transients. No significant effect of the bypass system on the transient results is expected.

No other duties are imposed on the bypass by TPO uprate operation.

### F.2.3 Feedwater/Water Level Controls

During TPO uprate operation, water level will still be maintained at the operating point by this basic operational control function.

The small magnitude of TPO uprate will not affect any of the spanning aspects of the system equipment. Simple adjustments to transmitters and other instruments (if any) will be sufficient to ensure that they can properly follow the slightly expanded FW flow range of operation (< 2%).

All plants have extra, normal FW flow range to adjust for operational transients. The existing FW capacity will be sufficient to provide acceptable water level adjustment for TPO operation. There will be no increase in the number of challenges to safety systems during anticipated transients because of TPO. Acceptable operational water level control will be demonstrated as TPO RTP is achieved.

***Justification of Feedwater/Water Level Controls***

(1) No safety-significant credit is taken for this control system in any licensing basis transient or accident event.

(2) The small TPO increase in steam flow through the steam separators and dryers will not significantly affect the water level. All water level setpoints (e.g., low level scram, low level alarm, high level alarm, and high level trip) will remain at their current setpoints.

(3) Testing of the plant during the initial ascension to TPO RTP will confirm adequate FW/level control (Appendix L).

### F.2.4 Recirculation Flow Controls

No changes are required to the reactor recirculation control system for TPO RTP operation.

***Justification***

(1) The operational core flow control range is not changed by power uprate.

(2) In most plants, manual flow control is the predominant mode for base-loaded operation of the plant. In BWR/5 and 6 designs, power (APRM) feedback may be active as an aid in trip avoidance. This function uses signals that will be properly rescaled for TPO uprate operation for any plant currently employing this option, requiring no change in the recirculation controls.

## F.3 GUIDELINES FOR INSTRUMENTATION

The generic guidelines applicable to plant instrumentation during evaluation of operation at TPO uprate conditions are listed with the pertinent bases, methods, and assumptions that apply. This section focuses on instrumentation that is related to the safe operation and shutdown of the plant, not the operational functions. Any plant-unique deviations from these guidelines will be explained and justified in the plant-specific submittal.

### F.3.1 Identification of Instruments Related to Safety Functions

There is no change to the designation of instruments that are (or are not) related to reactor safety.

***Justification***

No new safety functions are generically introduced by TPO uprate.

### F.3.2 Effect on Instrument Ranges

There will be no effect upon the range of any reactor instruments because there is no change of reactor pressure, temperature, water level, and core or jet pump flows. Nor will there be any effect upon the range of instruments that sense the flow, pressure, temperature, pump head, etc., of the systems that provide safety functions for the reactor (e.g., RHR-LPCI, LPCS, HPCI/S, Control Rod Drives). There will be no effect upon the range of instruments that sense reactor or containment conditions in order to initiate required safety functions, including the high steam line flow isolation instrumentation setpoint, which is generally to be left as-is for a TPO uprate. In specific cases where changes in operating conditions necessitate changes to the instrument ranges, instrument accuracy applicable to the new range will be determined and assessed using the setpoint methodology of Section F.4.1.

***Justification***

(1) No changes are being made to the operating pressure and temperature of the reactor.

(2) The pressures and temperatures during transient and accident events are constrained by unchanged peak value criteria.

(3) There is no generic change to the operating range of the reactor water level.

(4) There is no generic increase in the range of the core flow.

(5) The requirements for performance of safety system functions are not being increased. There is no effect upon the range of instruments associated with these systems.

(6) Instruments that sense abnormal reactor or containment conditions in order to initiate safety actions will maintain the same setpoints for their functions, and the range of the instruments will not change. This is primarily because there is no change in the peak transient of accident criteria for the measured parameter, which is the design basis of the instrument range.

## F.4 GUIDELINES FOR INSTRUMENT SETPOINTS

The generic guidelines applicable to instrument setpoints for operation at TPO uprate conditions are listed with the pertinent bases, methods, and assumptions that apply. In general, very few, if any, setpoint changes will be made for the small changes associated with TPO uprate with constant reactor dome pressure. This section focuses on instruments that are related to the safe operation and shutdown of the plant, not the operational functions. Any plant-unique deviations from these guidelines will be explained and justified in the TSAR.

### F.4.1 Generic Instrument Setpoint Methodology

GE has issued a generic setpoint methodology that has been applied at many plants (References 16 and 32). This methodology is equally applicable to the unit after the TPO uprate.

Equivalent setpoint methodology may also be applicable for uprate applications, but plant-unique justification may be required.

***Justification***

The GE methodology approach provides the techniques to establish setpoints, but does not define the specific setpoints for any plant. The values in the referenced topical report are simply examples that demonstrate the methodology. Application of this methodology ensures safety-related trip functions consistent with the Technical Specifications and safety analyses, and provides adequate margin for avoidance of unnecessary trips.

### F.4.2 Generic Approaches for Specific Setpoints

The following items present generic treatment of several instrument setpoints related to power uprate. If plants utilize these setpoints, they satisfy the requirements for the functions. If a different setpoint is chosen, the plant-specific submittal will provide explanation and justification.

#### F.4.2.1 Flow Referenced APRM Trip and Alarm Setpoints

The flow-referenced APRM trip and alarm setpoints will remain unchanged in units of absolute thermal power (i.e., MWt). However, these setpoints are usually expressed in units of percent of licensed power in the Technical Specifications. They will be decreased slightly (in percent of licensed power) by rescaling the setpoints to the new thermal power. Section 5 and Appendix C also describe this basis in terms of the power-flow operating map.

***Justification***

For all plants, the operating margin above the operating boundary is preserved, such that the plant's trip avoidance capability is unchanged in terms of absolute thermal power. This practice is identical, but of smaller magnitude, to the similar approach taken for MELLLA and MEOD plants in the generic BWR Power Uprate Program documented and approved by the NRC in References 20 and 21.

#### F.4.2.2 Fixed APRM Trip and Alarm Setpoints

The upper limits of the APRM trip and alarm setpoints expressed in units of percent of licensed power will not change. The limiting transient which relies on the fixed APRM trip (vessel overpressure protection transient with indirect scram, Appendix E) will be reanalyzed in the first TPO reload to ensure that the revised setpoint provides adequate protection.

***Justification***

This practice will maintain adequate operating and safety margins. The primary transient case that utilizes the fixed high neutron flux scram setpoint is the MSIV closure overpressure evaluation case. That case has already been analyzed assuming 2% initial overpower. As stated in Appendix E, it already bounds TPO operation sufficiently so that confirmation analysis at the time of the first reload is sufficient for this application.

#### F.4.2.3 Turbine First-Stage Pressure Signal Setpoint

The setpoint for the turbine-first-stage pressure signal that activates the Turbine/Generator (T/G) trip scram and recirculation trip at high power will be kept at the same value in terms of absolute main turbine steam flow (lb/hr), and indicated as a pressure signal (psig). No modifications to the turbine are expected to be made for a TPO uprate, so there will be no change in the first-stage pressure/steam flow relationship from previous plant operation. This approach minimizes potential changes to the plant instrumentation, and maintains the same steam flow range of trip avoidance as previous operation (within the unchanged turbine steam bypass system). It will be a slightly smaller setpoint value when expressed in terms of percent of the TPO uprate steam flow.

One other aspect of this setpoint can be resolved generically. Some units employ operational options for FW heater(s) to be out of service. The value of the first-stage pressure setpoint may be based on normal FW heating during normal operation, and reset accordingly when operation with an FW heater out-of-service (OOS) is required. Alternatively, some plants establish a conservatively low setpoint so that it covers normal operation and the approved range of FW heater(s) OOS. Either approach remains valid for TPO operation with the current setpoint unchanged.

***Justification***

The first-stage turbine pressure setpoint for activation of T/G trip scram and recirculation pump trip has been primarily based on operational (trip avoidance) considerations. The setpoint is chosen to allow operational margin so that scram may be avoided by transferring turbine steam to the turbine bypass system during T/G trips at low-power. The transient events associated with operation just below this setpoint have been shown to be non-limiting from a safety viewpoint and are not usually specifically analyzed in the UFSAR or in current reloads because they generally have ample margin. Special options, if applicable, will be evaluated on a plant-specific bases.

The first-stage turbine pressure value of the setpoint will remain at its current level (usually equivalent to turbine steam flow about 5% above the bypass capacity). This accomplishes the primary operational function, and avoids any change to the actual setpoint hardware. Note that if the setpoint is expressed as a percentage of the new TPO RTP conditions, it will be a slightly smaller value (e.g., about 29.6% for a 1.5% steam flow uprate for a plant where the previous setpoint was equivalent to 30%).

A plant may employ the operational option for FW heater(s) to be out of service or planned FFWTR to be used near end of cycle to extend full power operation. For either of these situations, the interpretation of the setpoint must consider the effect of FW temperature on the relationship between reactor power and steam flow. The reactor power that corresponds to the turbine first-stage steam flow (and pressure) equal to the setpoint is increased because of the effect of cooler FW flow on the reactor heat balance. In the partial power range near this interlock, the difference is small, but measurable. Using the first-stage pressure setpoint based on normal FW heating is considered to be acceptable because the T/G trip events in question are also milder due to the reduced steam flow that is shut off if the trip occurs and the subsequent milder vessel pressurization. Plant-specific reload analyses account for the manner by which this factor is included in the plant basis (as extra analysis margin or a setpoint change for this portion of the cycle. It is not affected significantly by TPO uprate, and will continue to be covered by reload analyses. The setpoint is not to be based on the case where the reactor is operating at the setpoint, but also with the bypass already open. This is not a normal operating mode for any plant.

#### F.4.2.4 High Reactor Pressure Scram Setpoint

The setpoint for high reactor pressure scram and the lowest-set safety/relief valves (SRVs) are not expected to be changed for a TPO uprate.

***Justification***

No change is expected because there will be no vessel dome operating pressure increase for a TPO uprate.

#### F.4.2.5 MSIV Closure on High Steam Flow Setpoint

The setpoint for initiation of MSIV closure on high steam flow may be raised to be equivalent to ≤ 140% of the TPO uprate steam flow rate in each steam line. However, this change is not considered to be necessary, because sufficient operating margin would usually exist if the setpoint is left unchanged.

***Justification***

The primary purpose of keeping the same basis (≤ 140%) for this setpoint would be to ensure that trip avoidance is maintained. If the setpoint is increased slightly for TPO operation, the absolute value of the trip setting will still provide high assurance of isolation protection for the main steam line break accident. The main steam line flow limiters will not be changed, so the maximum possible steam mass flow rate through a limiter will be the same after the uprate. If the setpoint is left as-is, sufficient trip avoidance margin will remain because of the small amount of steam flow increase for TPO uprate, and the large margin that exists to the setpoint during normal operation. The only operational conditions that could approach this setpoint involve closure of one of the MSIVs (e.g., during partial-power valve testing or infrequent operation with one steam line isolated).

### F.4.2.6 Feedwater Flow Setpoint for Cavitation Protection

The basis for the FW flow setpoint used for recirculation cavitation protection in the lower part of the power/flow map (Figure 5-1) is also usually expressed in terms of percent of rated flow (or power). The current value of this setpoint will be maintained in terms of the actual FW flow rate represented by the current setpoint; it will appear to be reduced when expressed in terms of percent of TPO uprate flow or power.

***Justification***

This setpoint basis is chosen because the cavitation requirement is satisfied by the actual flow rates, regardless of the relationship to rated flows. Therefore, the relative setpoint (as it appears on the power/flow operating map) will be reduced slightly in proportion to the new rated power.

### F.4.2.7 Low Steam Line Pressure Setpoint

The low steam line pressure setpoint for initiation of MSIV closure in RUN Mode will be maintained at its current value for power uprate.

***Justification***

The change in steam line pressure near the turbine (where this sensor is located) will decrease slightly due to the higher steam flow, but will not change significantly compared to the non-limiting nature of the Pressure Regulator Failure (Open) transient, which uses this function to mitigate the event. Its backup function for LOCA events is also maintained satisfactorily with the unchanged setpoint.

### F.4.2.8 MSIV Closure on High Steam Line Radiation/High Steam Tunnel Temperature

The setpoints for initiation of MSIV closure on high steam line radiation (if applicable) or high steam tunnel temperature will remain unchanged. There will be no loss of protection of significant loss of margin for trip avoidance compared to CLTP operation.

***Justification***

The setpoints for initiation of MSIV closure on high steam line radiation (if applicable) or high steam tunnel temperature will remain unchanged because there is sufficient margin to the radiation setpoint (if applicable) to accommodate the small increase due to TPO uprate, steam line temperature is unchanged (constant vessel dome pressure), and the increase in FW temperature is very small. There will be no significant loss of margin for trip avoidance compared to CLTP operation. The current setpoints will maintain the safety functions within the current design and licensing bases.

### F.4.2.9 Rod Worth Minimizer Low Power Setpoint

The low power setpoint at which rod patterns are enforced is usually expressed in terms of percent of rated power. The current value of this setpoint will be maintained in terms of the absolute power, and its value relative to licensed power will be reduced. It is conservative to keep the existing percent of rated power setpoint after TPO uprate.

***Justification***

This setpoint basis is the power level above which voids in the core will sufficiently mitigate the control rod drop event, such that enforcement of low worth control rod patterns is not necessary. These core conditions are functions of absolute power, therefore, the relative setpoint (as it appears on the power/flow operating map) will be reduced slightly in proportion to the new rated power.

### F.4.2.10 Low and High Water Setpoints

The low reactor water level setpoints for scram, high pressure injection and ADS/ECCS will be maintained equal to the current setpoints. The reactor high water setpoints for trip of the main turbine, FW pumps, and, if applicable, scram will not be changed. The small TPO increase in reactor power does not result in a significantly increased frequency of scram, equipment trip, or ECCS actuations. For most plants, the setpoint methodology defined in References 16 and 32 will be continued. Maintaining the current setpoints will maintain acceptable trip avoidance and safety system performance.

***Justification***

These setpoints optimize the operational capability of the plant to avoid trips, giving the known accuracy of the water level instruments, while maintaining acceptable safety system performance. Water level change during operational transients (e.g., trip of a recirculation pump, FW controller failure, loss of one or all FW pumps) will only be slightly affected by the TPO power uprate. The most challenging event, trip of one FW pump, will not be significantly changed because the maximum operating rod line is not being increased; therefore, the final power level will remain the same relative to the remaining FW flow. Trip avoidance will not significantly change, and [ ].

### F.4.2.11 Power Threshold above which Fuel Thermal Margin Monitoring is Required

The value of approximately 25% of rated thermal power traditionally used for this administrative threshold will be maintained in most cases for TPO uprate conditions. [ ]

***Justification***

This guideline preserves the threshold for monitoring fuel thermal margin equal to the current basis for the plant [ ].

# APPENDIX G

# METHODS AND ASSUMPTIONS FOR TPO UPRATE CONTAINMENT EVALUATION

## G.1 SCOPE

This appendix outlines the methods, approach and scope of plant-specific containment analyses, which have been used in support of TPO uprate. The methodology and results of previous analyses have been reported in previous plant-unique licensing documentation and in Appendix G of previous generic GE BWR power uprate topical reports (References 20 and 21). In this appendix, the same key assumptions and methods used for the analyses are summarized. In general, the previous containment evaluations are bounding for TPO uprate because they have previously considered ≥ 2% power uncertainty as required by previous methodology. Although the nominal operating conditions will be increased slightly because of this TPO uprate, the required bounding conditions for the limiting analytical cases remains the same as previously documented. The focus of this evaluation is to document that there is no effect of TPO uprate on containment pressure and temperature response and dynamic loads due to LOCA and SRV actuation.

Containment Systems are described in the plant UFSAR (RG 1.70 SAR Section 6.2). The accident response analysis is also discussed in the plant UFSAR (RG 1.70 SAR Subsection 6.2.1) wherein plant response to various large and small LOCAs is evaluated and the short and long-term containment pressure and temperature responses are presented.

The TPO uprate containment LOCA evaluation concludes that there is no need for re-performing structural analyses because the bounding events remain unchanged from previous analyses at ≥ 102% of present licensed power. Design values for containment pressure and temperature and dynamic loads have sufficient margin so they do not have to be increased to cover TPO uprate.

## G.2 CONTAINMENT LOCA PRESSURE AND TEMPERATURE RESPONSE

The effects of TPO uprate conditions on LOCA containment pressure and temperature are bounded by the previous analysis performed at ≥ 102% of CLTP. The analyses may have implemented the more current input assumptions documented in Appendix G of References 20 and 21. Short-term containment pressure and temperature response analyses have been performed using the approved GE code, M3CPT (Reference 17). In some cases, a more detailed computer model of the NSSS (LAMB or TRACG, References 15 and 22, respectively), which have more detailed RPV models than M3CPT, may have been used to determine more realistic RPV break flow rates for input to the M3CPT code. The LAMB code has been reviewed by the NRC for application to LOCA analysis in accordance with 10 CFR 50, Appendix K. The TRACG code is currently under review by the NRC as part of the Simplified Boiling Water Reactor Program.

Long-term containment pool heatup analysis for the limiting SAR events has been performed to show acceptable pool temperatures considering limits due to:

- Containment design temperature

- Net positive suction head
- Equipment design or qualification temperatures (i.e., pump seals, piping design temperature)

These analyses have been performed using the GE computer code SHEX, which is based on models described in Reference 17. Decay heat inputs are conservatively based on 1979 ANS 5.1 results (Reference 18).

## G.3 CONTAINMENT DYNAMIC LOADS

### G.3.1 LOCA Containment Dynamic Loads

The short-term containment pressure, temperature and vent flow have been calculated for up to 102% of CLTP with M3CPT. The previous analysis bounds the TPO conditions for LOCA dynamic design loads; they are not affected by TPO uprate.

### G.3.2 SRV Containment Dynamic Loads

The SRV opening setpoint pressures are not increased for TPO uprate. Therefore, the SRV loads associated with SRV actuations following initiation of an event are unchanged by TPO uprate.

There is no change in limiting case break flow conditions due to TPO uprate because the analysis basis is bounded by the previous cases. Therefore the analytical or experimental basis for the LOCA subcompartment pressurization dynamic loads and the basis for suppression chamber/wetwell loads remain consistent with the evaluation for CLTP conditions.

### G.3.3 Subcompartment Pressurization

The subcompartment pressurization loads continue to remain within allowable structural limits for a TPO power uprate because the changes are within existing margins because of the very small changes to operating conditions associated with TPO uprate with no dome pressure change. There is no significant change because TPO uprate only changes system operating temperatures and pressures slightly: < 1°F (recirculation lines), < 2°F (FW lines only), < 5 psi (FW lines only), and < 1 psi (recirculation discharge lines only) due to slightly higher pressure drops at TPO flow rates. Vessel dome pressure and other portions of the primary coolant pressure boundary remain at current operating pressure (or lower, e.g., main steam line). Therefore, subcompartment pressurization (for those plants where it is a part of the design basis) will not significantly change.

# APPENDIX H

# METHODS AND ASSUMPTIONS FOR RADIOLOGICAL EVALUATIONS OF TPO UPRATE

## H.1 SCOPE

This appendix describes the methodology and assumptions for the evaluation of radiological effects for TPO uprate up to 1.5% above CLTP. The following effects are considered in evaluating the power uprate: (1) plant operations and maintenance, (2) normal operational environmental releases from the plant, (3) irradiation effects on vessel and vessel internals, (4) offsite doses from design basis accident events, (5) control room habitability under accident conditions, and (6) equipment qualification.

## H.2 ASSUMPTIONS

The evaluation of a TPO uprate assumes that: (a) the reactor core design undergoes small modifications to accommodate the small (≤ 1.5%) change in power, and (b) the core design is accomplished with fuel bundles of the same type. These assumptions impose no significant limitations on the ability of the core designers to achieve TPO uprate operating conditions within current core operating margins.

The basic premise of the TPO uprate radiological/radiation evaluations is that, with few exceptions, the radiological data/dose are changed by the magnitude of the change in the radiation source.

## H.3 METHODOLOGY

The current radiological calculations have been based on the methodology, assumptions and analytical techniques described in the Regulatory Guides (RGs), the Standard Review Plan (where applicable), and in previous Safety Evaluations (SEs).

The radiation sources that have been used for evaluation fall into two broad classes. The first class is applicable to normal operation, and includes normal operating radiation levels from the reactor core and design basis concentrations of radioactive isotopes in the steam and reactor water. The second class of radiation sources represents the integrated inventory of radioactive fission products in the fuel at the end of a fuel cycle.

The normal operation releases from the plant consist of the gaseous releases from the offgas system and all applicable plant structures. These releases are proportional to any increases in the steam and reactor coolant concentrations. The concentration of noble gases in the steam is assumed to remain constant for a TPO uprate, [ ] (References 20 and 21). The standard offgas rate used by GE is 3700 Mbq/sec (0.1 Ci/sec) after 30 minutes holdup. This offgas level was selected in the early 1970's as a conservative annual average estimate for plant design. Experience has shown this offgas rate to be very conservative, therefore, no revision in offgas rate will be considered as a result of TPO uprate.

The design basis concentrations in the reactor coolant are calculated values. The iodine and fission product concentrations in the water, like the offgas rates, are conservative based on past fuel experience. Therefore, no change in iodine or particulate activity released to the reactor coolant is considered for TPO uprate.

The total N-16 activity per unit time delivered to the turbine building is expected to be approximately proportional to the power increase. The N-16 activity per unit mass entering the steam lines is not expected to change significantly as a result of power uprate. The increase in normal site boundary air scattered dose is expected to be nearly proportional to the power increase.

The radioactive fission product inventory used for TPO uprate evaluations, accident events, or equipment qualification is based on the existing plant design basis. This inventory has been generated based on basic assumptions for end of fuel cycle final exposure, initial U-235 enrichment, and effective full power irradiation period. For example, [

]

This is considered to be a conservative inventory for the current core designs. The isotopic inventory is typically normalized to power and expressed in unit of Curies per megawatt (Ci/MWt). Therefore the same inventory is applicable for TPO uprate because the total Curie associated with TPO is automatically adjusted with the power.

In addition to the design basis events that release fission products, there are also design basis events that release reactor coolant. These events are evaluated using the iodine concentration in the reactor water defined by the Technical Specifications. These events do not change because the mass of coolant lost does not change for a constant reactor pressure TPO uprate.

The previous analysis for the plants bounds the accident source terms for a TPO uprate because they were evaluated with consideration of at least 2% overpower uncertainty. With operation at TPO conditions, the bounding set of power level assumptions remains the same as the previous analysis because or the reduced uncertainty.

Individual plant evaluations will be made to confirm the applicability of the appropriate bases for the specific plant license. However, on a generic basis, radiation effects can be resolved on a ratio of the sources, after criteria listed above are verified to apply to the plant under consideration.

# APPENDIX I

# METHODS AND ASSUMPTIONS FOR VESSEL AND COMPONENTS EVALUATIONS

## I.1 SCOPE

This appendix describes the methods and assumptions used for the evaluations of the reactor vessel and components. Analyses are performed to ensure that the reactor vessel and internal components continue to comply with the existing structural requirements for a TPO uprate. As described below, the following evaluations discuss compliance of the designs to the existing requirements:

- Reactor Vessel Analysis
- Internal Components Analysis

## I.2 REACTOR VESSEL ANALYSIS

The analysis of the reactor vessel validates the use of existing vessel components for uprated conditions by ensuring that the requirements of the ASME Boiler and Pressure Vessel Code are still met. The analysis is performed for the following operating conditions:

- Design Conditions
- Normal and Upset Conditions
- Emergency and Faulted Conditions

### I.2.1 Design Conditions

For TPO uprate, the reactor pressure vessel design requirements are bounded by the design requirements specified in the current (original or modified by a power uprate analysis) reactor pressure vessel purchase documents.

### I.2.2 Normal and Upset Conditions

TPO uprate involves no change in the following normal operating conditions (pressure, temperature in the saturated portion of the vessel, total core and recirculation flow, and static mechanical loads). Small changes are introduced by TPO uprate in the steam and FW nozzle flows (< 2%), FW nozzle fluid temperature (< 2°F), the temperature of the fluid flowing through the recirculation loop nozzles (< 1°F), and the temperature in lower portion of the vessel (< 1°F). The current basis for upset transient conditions continues to bound the transient conditions anticipated for TPO operation.

The component stress reports and design specification will be reviewed to identify those operating parameters and components that may be influenced by TPO uprate conditions. The current analysis is bounding with respect to the operating pressure and the temperature in the saturated portions of the vessel. The very small temperature changes (< 1°F) of the flow in the FW and recirculation nozzles and in the subcooled regions of the vessel during normal TPO operation are considered to be acceptable. These changes are bounded by partial power operational considerations and by the FW heater out-of-service option in place for nearly all plants. This will be confirmed in the TSAR, and, thus, no new evaluation is expected to be required.

However, if a new evaluation is required in the unexpected case that an area of the current analysis does not have margin for these small changes, the following procedure will be implemented for those components that are influenced by TPO operating conditions:

(1) [ ]

(2) An evaluation of fatigue will be performed for the components with a fatigue usage greater than 0.5 and will be calculated at the limiting section of each component. The fatigue usage will be revised [ ] the stresses used to calculate $S_{alt}$ from the "original" report. The new $S_{alt}$ values will then be used to calculate a usage factor that will be shown to meet the requirements of the ASME Code.

(3) Elastic-plastic analyses, such as Ke and thermal ratcheting, will be performed as needed.

### I.2.3 Emergency and Faulted Conditions

TPO uprate does not cause any changes in the emergency and faulted conditions for BWR/4/5/6 plants because those evaluations have previously been performed at ≥ 102% of CLTP. That analysis bounds the analysis conditions required for such cases under TPO operation because of the smaller overpower uncertainty that is required. The same analyzed conditions are sufficient for TPO evaluation. Therefore the existing Emergency and Faulted stress analysis continues to meet the requirements of the ASME Code. The current assessment of the "original" Certified Stress Report will continue to apply for these plants.

Pre-BWR/4 plants may include equivalent bounding evaluations, but confirmation of that basis will be included for TPO operation in the TSAR.

## I.3 INTERNAL COMPONENT ANALYSIS

The reactor internals are evaluated for any increase in reactor internal pressure differences that may occur for TPO uprate. Normal, Upset, Emergency and Faulted conditions are evaluated. Because no increase in maximum core flow is being applied generically to TPO uprate; this factor will not affect the reactor internals. The evaluations of internals described in Section 5.5.1 addresses the potential effects of slightly (< 2%) increased steam flows, pressure drops and void fractions on reactor internal components.

For BWR/4/5/6 plants, primary and secondary stresses have previously been evaluated for current licensed conditions, with a +2% overpower allowance for all conditions except Normal operation. Therefore, all Upset, Emergency, and Faulted conditions for TPO uprate remain bounded by the existing evaluations. Where applicable, this includes annulus pressurization loads during postulated LOCA events. Pre-BWR/4 plants may include equivalent bounding evaluations, but confirmation of that basis will be included for TPO operation in the TSAR.

The slightly changed pressure drops of internal components during Normal TPO operation have been compared to the changes [ ]. This comparison is shown in Table I-1. In all cases, the expected change in pressure drop loading on reactor internal components is a very small fraction of the operating conditions. This change in loading is concluded to be negligible based on the acceptable evaluations [ ] shown in Table I-1.

In specific cases, known degraded conditions (e.g., crack indications) in structural components will be reevaluated in the TSAR to be declared acceptable. The TSAR evaluation will include any known degraded conditions that were not repaired, as well as those that were repaired, and will reflect the post-uprate configuration of the plant.

**Table I-1**

**REACTOR INTERNAL COMPONENT PRESSURE DROPS**

[

| | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

]

# APPENDIX J

# METHODS AND ASSUMPTIONS FOR SYSTEM EQUIPMENT EVALUATION FOR TPO UPRATE

## J.1 SCOPE

This appendix defines the generic methods and assumptions used for system equipment evaluation. There are potentially three categories of system equipment. The first set contains those systems that are not affected by TPO uprate (Table J-1). The second set contains those systems that are not significantly dependent upon the power level (Table J-2). The third set of equipment includes those systems that may be affected by a TPO uprate (Table J-3). In general, all items in Table J-3 need to be addressed in the TSAR. Many items in Table J-2 are resolved generically in this document. However, some items in Table J-2, while expected to have insignificant effects, require plant-specific confirmation of that expectation in the TSAR (especially items associated with balance-of-plant systems). Such items are identified by a footnote in the table.

## J.2 GUIDELINES FOR SYSTEM EQUIPMENT EVALUATIONS

### J.2.1 Systems Not Dependent Upon Power Level

The systems and associated equipment given in Table J-1 are not dependent upon reactor power level. Those systems and associated equipment will not be part of any TPO uprate and will be considered to be exempt from any license submittal pertinent to power uprate.

***Justification***

(1) These systems are basically a part of normal plant functions that are separate from and, in general, are required whether the plant is at full power or partial power.

(2) Most of these basic systems are required for operation of any type of power plant facility.

(3) Systems in Table J-1 that are somewhat unique to nuclear power plants include Decontamination and New Fuel Handling and Storage. Even those systems are unaffected by the absolute reactor power level, because new fuel is not yet exposed to uprated conditions.

### J.2.2 Systems Not Significantly Dependent Upon Power Level

The systems and associated equipment given in Table J-2 are not significantly dependent upon power level. A change in power level of only 1.5% will have negligible effect on the operating conditions, performance requirements, and environment of the respective equipment of these systems. Some items are generically dispositioned in this TLTR as discussed below and in the appendices. Others are expected to be insignificantly affected by TPO uprate, but require some plant-specific confirmation of that expectation. These systems are identified by footnote in Table J-2. Consequently, it is expected that these systems will not require extensive analysis in the plant-specific uprate submittals.

***Justification***

(1) Although many of these systems are primarily associated with the nuclear process, the increase in power level does not significantly change or alter the performance requirements of these systems.

(2) The proposed change in power level may cause a small change in process radiation monitoring or area radiation monitoring (Appendix H), but the only effect on these two systems would be a slight change of the normal radiation activity reading. The actual measurements after TPO uprate may lead to optimized shielding in some areas, similar to current efforts to minimize exposure of personnel during normal plant operation. The change in conditions will be similar to the very small change currently experienced when increasing power from 98.5% to 100% of the pre-TPO uprate power level.

(3) No significant effect upon the post accident hydrogen control systems is expected. No significant increases are postulated for the hydrogen-generation consequences of an accident, because the metal available for reaction is unchanged. The increase in hydrogen production due to radiolytic decomposition is unchanged because the system had previously been evaluated for accident conditions from 102% of CLTP. With TPO uprate, the accident analysis basis power level will not increase and the current evaluation remains valid.

(4) Offgas System performance will be controlled as in current operation. TPO uprate operation is not expected to exceed the system capability of any plant (J.2.3.13).

(5) The Main Control Room and Emergency Response Facility are only potentially affected from the viewpoint of continued assurance of habitability following a postulated accident from TPO uprate conditions. However, compliance in this area is unchanged because the systems had been previously evaluated for accident conditions from 102% of CLTP. With TPO uprate, the accident analysis basis power level will not increase and the current evaluation remains valid (Appendix H).

Additional discussion of some of the systems included in Table J-2 follows. They were included in Section J.2.3 [ ]. Systems in which the effect of TPO uprate was concluded to be insignificant (through generic evaluation or expected plant-specific confirmation) are also listed in Table J-2.

### J.2.3 Systems That May Be Dependent Upon Power Level

The systems and associated equipment that may be dependent upon the reactor power level (based on previous BWR power uprate programs, References 20 and 21) are discussed in this section. The small operating condition changes due to TPO uprate are:

- Increased power (≤ 1.5%) (i.e., heat flux, stored heat, decay heat, fission products, neutron fluences).
- Increased reactor coolant temperature (≤ 1°F) in recirculation loops and lower, subcooled portion of the vessel. (No change in pressure or temperature in the upper, saturated portion of the vessel.)

- Increased steam and FW flow rates (< 2%), and increased FW pressure (< 5 psi downstream of main pump discharge or FW control valve and < 2 psi at the vessel FW nozzles), and FW temperature (< 2°F after high pressure heaters).

These changes are relatively small and are expected to be negligible for each affected system. Where decay heat is a factor, ANS 5.1 (1979) may be used (Reference 18). The overall combined effect of these changes will be discussed in the TSAR.

### J.2.3.1 Low Pressure ECCS Systems

Hardware for the low-pressure portions of Residual Heat Removal (RHR) and Low Pressure Core Spray/Core Spray (LPCS/CS) Systems is not affected by TPO uprate. Current system performance of the RHR System Low Pressure Coolant Injection (LPCI) mode (where applicable), RHR System Suppression Pool Cooling mode, and the LPCS System are adequate because the current LOCA ECCS and containment analyses, which are the primary basis for these functions, are performed at 102% of CLTP; they already bound the requirements for TPO operation (Appendix D). All safe shutdown requirements are met for TPO operation with current system components and performance requirements. Confirmation of the above will be included in the TSAR.

***Justification***

- The upper limit of the low pressure ECCS (i.e., LPCS and RHR-LPCI) injection setpoints will not be changed. Therefore, the systems will not experience any higher pressures.
- The low-pressure ECCS (i.e., LPCS and LPCI) licensing and design flow rates will not be increased. Current safety analyses adequately bound the TPO conditions.
- Previous safety analyses (for CLTP) bound the safety analysis requirements for TPO uprate because of the allowance for at least 2% power uncertainty. The basis for the TPO uprate is to raise the operating condition within the constraint that the previous safety analyses continue to be the bounding cases.

### J.2.3.2 Recirculation System

The Recirculation System performance is concluded to be satisfactory for TPO uprate. No significant changes will be introduced by the small increase in power (≤ 1.5%) with no change in the maximum core flow or drive loop flow (Current Technical Specification limit). This conclusion includes jet pump component performance from the viewpoint of potential flow-induced vibrations at the slightly different operating core pressure drop conditions.

***Justification***

The maximum core recirculation flow rates are not being increased to achieve TPO uprate and the potential change in core pressure drop (< 0.3 psid from Appendix I) is negligible. Therefore, the Recirculation System will only experience a small operational change during normal operation due to uprate. Maximum system pumped flow will not be increased. Operation will remain within the Technical Specification drive loop flow limit, which was previously tested for vibration performance on the specific unit or a similar unit of the same design.

### J.2.3.3 Control Rod Drive System

The Control Rod Drive System is not affected by TPO uprate. Current system operational and safety evaluations bound TPO operation.

***Justification***

TPO uprate introduces no change in reactor pressure or any other condition that could affect the performance of the CRDs. There is no increase in the required performance of the drives. Therefore, it is concluded that the present CRD designs remain acceptable for TPO uprate; confirmation of this conclusion will be provided in the TSAR.

### J.2.3.4 RWCU System

The performance requirements of the Reactor Water Cleanup (RWCU) System are negligibly affected by TPO uprate. There will be no significant change in operating temperature (< 1°F) and pressure (< 1 psi) conditions in the high-pressure portion of the system. There will be no identifiable change in the level of impurities in the reactor water with respect to any effect upon regeneration frequency. The capacity of the RWCU System will be sufficient, possibly with small operational adjustments, to accommodate the small effect that TPO uprate is expected to have on RWCU duty.

***Justification***

Steady power level changes even for much larger power uprates has been shown to have nearly no effect on reactor water chemistry and the performance of the RWCU System. Power transients, independent of uprate, are the primary source of challenge to the system. It is assumed that FW System iron input is not increased significantly by TPO operation. The requirements for water chemistry will remain unchanged for the very small power increase (≤ 1.5%) introduced by TPO uprate, so safety and operational aspects of water chemistry performance are not affected. Confirmation of this conclusion will be provided in the TSAR.

### J.2.3.5 Reactor Vessel and Internals

As discussed in Appendix I, Section I.2, vessel and internals Emergency and Faulted design bases for all post-BWR/3 plants are known to include allowance for 102% of CLTP and therefore bound TPO uprate conditions. Additional plant-specific evaluation is only needed for pre-BWR/4 plants for Emergency and Faulted loads.

Normal and Upset conditions are nearly unchanged because there is no increase in reactor system pressure or temperature, except for a small increase (< 2°F) in the FW temperature and vessel subcooled region temperature (< 1°F). Plant-specific confirmation of the acceptability of these small changes will be included in the TSAR.

***Justification***

Emergency and Faulted loads have been calculated for 102% of CLTP conditions (or partial power conditions if more limiting) for all post-BWR/3 plants. Therefore, TPO conditions are bounded for these plants by the current analyses because the required analysis conditions are the same. Confirmation of acceptable margin is required in pre-BWR/4 plants in the TSAR (also shown in Tables B-1 and B-2).

The very small changes in TPO uprate operating conditions listed above are expected to be acceptable for all TPO plants. Table I-1 shows [ ] in reactor internal component pressure drops for Normal operation. Plant-specific confirmation of the expectation that these changes are acceptable is to be provided in the TSAR.

### J.2.3.6 Reactor Coolant Piping

The performance requirements for reactor coolant piping are negligibly affected by TPO uprate. There will be no significant change in operating temperature (< 1°F) and pressure (< 1 psi) conditions. There is no change in any of the accident-related loads because the current loads continue to bound the requirements of analysis for TPO operation. There is no increase in the range of reactor coolant flow. TPO uprate has negligible effect on the current evaluation of reactor coolant piping; however, confirmation of the acceptability of recirculation piping vibration will be included in the TSAR as discussed in Section 5.6.2. No other aspects of reactor coolant piping evaluation is needed in the TSAR.

***Justification***

The requirements for reactor coolant piping remain unchanged for the very small power increase (≤ 1.5%), small temperature increase (< 1°F for recirculation piping, < 2°F for FW piping, no change for steam piping). No change in coolant flow rate and no vessel operating pressure change are introduced by TPO uprate except for the very small change (< 1 psi) in pressure drop required to supply recirculation flow to the core. Safety and operational aspects of the reactor coolant piping performance are not affected; however, vibration aspects of the system design are to be confirmed in the TSAR.

### J.2.3.7 MSIVs and Main Steam Line Flow Restrictors

The performance requirements for the MSIVs and the Main Steam Line Flow Restrictors are negligibly affected by TPO uprate. There will be no change in operating temperature and pressure conditions (pressure decreased slightly along the steam line due to higher flow rate pressure drop). The small change in normal steam flow (< 2%) does no affect any of the accident-related loads because the current loads continue to bound the requirements of analysis for TPO operation. There is no increase in the steam flow calculated for a main steam line break accident. Therefore, TPO power uprate has negligible effect on the current evaluation of the MSIVs. Confirmation of this conclusion will be provided in the TSAR.

***Justification***

The requirements for the MSIVs and the Main Steam Line Flow Restrictors remain unchanged for the very small power increase (≤ 1.5%), no temperature or pressure increase, and small steam flow increase (< 2%). No change in steam line break flow rate occurs because the flow restrictor and the operating pressure are both unchanged. All safety and operational aspects of MSIV and Main Steam Line Flow Restrictor performance are within previous evaluations.

### J.2.3.8 Main Control Room Atmospheric Control System

The Main Control Room and Emergency Response Facility are not affected by TPO uprate. They were considered from the viewpoint of continued assurance of habitability following a postulated accident from TPO uprate conditions. However, compliance in this area is unchanged because the systems had previously been evaluated for accident conditions from 102% of CLTP. Confirmation of this conclusion will be provided in the TSAR.

***Justification***

With TPO uprate, the accident analysis basis power level will not increase and the current evaluation remains valid (Appendix H).

### J.2.3.9 Standby Gas Treatment System

The Standby Gas Treatment System (SGTS) is designed to minimize offside and control room dose rates during venting and purging of the primary and secondary containment atmosphere under accident or abnormal conditions, while containing airborne particulates and halogens that might be present. The current capacity of the SGTS was selected to maintain the secondary containment at a slightly negative pressure during such conditions. This capability is not changed by TPO uprate conditions.

The capability of the SGTS charcoal beds is currently evaluated to accommodate potential accident conditions from 102% of CLTP. Therefore, the system remains capable of performing its function adequately for TPO uprate. Confirmation of this conclusion will be provided in the TSAR.

***Justification***

The functions of the SGTS are currently evaluated to accommodate 102% of CLTP, therefore the current evaluation bounds TPO uprate conditions.

### J.2.3.10 Post-LOCA Combustible Gas Control System

No significant effect upon the post accident hydrogen control systems is caused by TPO uprate. No significant increases are postulated for the hydrogen-generation consequences of an accident, because the metal available for reaction is unchanged. The increase in hydrogen production due to radiolytic decomposition is unchanged because the system had previously been evaluated for accident conditions from 102% of CLTP. With TPO uprate, the accident analysis basis power level will not increase and the current evaluation remains valid.

***Justification***

No increases are postulated for the hydrogen-generation consequences of an accident, because the metal available for reaction is unchanged. The increase in hydrogen production due to radiolytic decomposition is unchanged because the system had previously been evaluated for accident conditions from 102% of CLTP.

### J.2.3.11 Radwaste System

There is no significant effect of TPO uprate on the Radwaste System. Confirmation of this conclusion will be provided in the TSAR.

***Justification***

No significant increase in total treated material is expected for a TPO uprate of ≤ 1.5% of reactor power, and it will be within the controlled capability of the system.

### J.2.3.12 Offgas System

There is no significant effect of TPO uprate on the Offgas System. Core radiolysis (formation of $H_2$ and $O_2$) will increase linearly with power (≤ 1.5%), but this change is within the capability of the system. Confirmation of this conclusion will be provided in the TSAR.

***Justification***

The system will be able to maintain acceptable operation for this small change within the controlled capability of the system.

### J.2.3.13 RHR System – Shutdown Cooling Mode

There is no significant effect of TPO uprate on the shutdown cooling mode of the RHR System. The system will be able to maintain acceptable operation for this small change within the controlled capability of the system.

***Justification***

The RHR heat exchangers are sized for the shutdown cooling mode for BWR/3 (where applicable), and all BWR/4 and 5 plants. In normal use of the shutdown cooling mode, the RHR shutdown cooling subsystem is activated after a normal blowdown to the main condenser. Some BWRs include emergency shutdown cooling as a defined scenario in which one train of the RHR shutdown cooling mode is used after rapid initial vessel depressurization. It continues heat removal and cooldown to cold shutdown conditions. The emergency shutdown scenario is more limiting. Current analysis of this case has assumed 102% of CLTP, therefore, the TPO uprate will not increase the analysis core thermal power and decay heat, which are theprimary parameters for this case. The current time to achieve emergency cooldown will remain unchanged for plants designed for this basis. The time for cooldown in the normal sequence will increase, but this change has no significant effect on plant safety. If included in the plant's licensing basis, confirmation of the initial power level for the emergency shutdown cooling scenario will be provided in the TSAR.

No hardware or operational effect on the RHR shutdown cooling subsystem resulting from operation at the TPO RTP level is anticipated, because there is no change to the operating conditions for the system in either the standby or active mode.

The sizing basis of the RHR heat exchanger is different for the various BWR product lines. For example, for BWR/6 plants, the RHR heat exchanger is sized on the basis of post-LOCA containment cooling requirements and is oversized for the shutdown cooling mode functions. For BWR/6 plants, the basis of the heat exchangers already includes 102% of CLTP and bounds the effect of a TPO uprate.

The system will be able to maintain acceptable operation for this small change within the controlled capability of the system.

**Table J-1**

**SYSTEMS NOT DEPENDENT UPON POWER LEVEL**

| | |
|---|---|
| Chlorination System | Floor and Equipment Drains |
| Plant Heating Systems | Normal Lighting |
| Miscellaneous Building HVAC | Telephone System |
| Decontamination | Public Address |
| New Fuel Handling and Storage | Grounding |
| Cranes, Hoists and Elevators | Cathodic Protection |
| Bulk Chemical Storage | Freeze Protection |
| Sanitary Drainage | Meteorological Instrumentation |
| Roof and Yard Drains | Seismic Instrumentation |
| Oil Waste | Plant Security |
| Fire Protection Systems | Auxiliary Steam |
| Service Air | |

## Table J-2

## SYSTEMS NOT SIGNIFICANTLY AFFECTED BY TPO POWER INCREASE

## (Other report sections related to each system evaluation)

| | |
|---|---|
| Offgas (5.10.11)[3] | Process Radiation Monitoring[3] |
| Standby Gas Treatment[2] | Area Radiation Monitoring[3] |
| Combustible Gas Control Systems: Containment Atmospheric Control System, Hydrogen Recombiner, Igniters (Containment)[2] | Control Rods and Control Rod Drive Hydraulic Systems (5.6.3)[1] |
| Emergency Response Facility (Appendix H)[2] | Main Control Room (Appendix H)[2] |
| Drywell Coolers[1] | Nuclear System Pressure Relief (5.6.8, Appendix E)[2] |
| Turbine/Building HVAC (FW heater area)[4] | Reactor Recirculation System (5.6.2)[1] |
| Reactor Core Isolation Cooling System (5.6.7, Appendix E)[2] | Main Steam Line Flow Restrictors (F.4)[1] |
| Main Steam Isolation Valves (MSIV)[1] | Reactor Water Cleanup System (5.6.6)[1] |
| Reactor Coolant Piping (5.6.2, Appendix K)[1,4] | Containment (5.3.2, 5.10.2, Appendix G)[1] |
| Containment Isolation and MSIV leakage control (5.6.9)[1] | RHR System (Low Pressure Coolant Injection, and Suppression Pool Cooling) (5.6.4, Appendices D and L)[1,2] |
| High Pressure Coolant Injection/Core Spray (5.6.7, Appendices D and E)[2] | (Low Pressure) Core Spray System (5.6.10, Appendix D)[2] |
| Automatic Depressurization System (5.6.8, Appendix D)[2] | Reactor Protection System[1] |
| Nuclear Fuel (5.7, Appendix E)[1] | Liquid Waste Management (5.10.9)[1] |
| Gaseous Waste Management (5.10.9)[1] | AC Power/Diesel Generators and Associated Supporting Systems (5.10.7)[1,4] |
| D.C. Power/Batteries (5.10.7)[1] | Fuel Pool Cooling (5.10.8)[1,4] |
| Hydrogen Water Chemistry (if applicable)[1] | Standby Liquid Control System (5.6.5, Appendix L)[1] |
| Reactor Building Closed Cooling Water System[1] | Turbine Building Closed Cooling Water System (5.10.4)[4] |
| Ultimate Heat Sink[2] | Power-Dependent HVAC[1] |
| Turbine Steam Bypass[1] | Service Water System (5.10.4)[1] |
| Zinc Injection (if applicable) | Neutron Monitoring System[1] |
| RHR System (SDC, CSC, and fuel pool cooling assist modes) (5.6.4)[1] | Instrument Air |

(1) Systems concluded to be acceptable for TPO uprate with no reactor pressure increase because there are negligible changes, if any, on the requirements and/or operating conditions of the systems.

(2) Safety systems that are acceptable because the current licensing analysis basis (≥ 102% of CLTP) bounds the required conditions for TPO operation and safety evaluation.

(3) Insignificant operational change expected.

(4) Systems that are expected to have negligible effect, but that expectation will be confirmed in the TSAR.

**Table J-3**

**SYSTEMS POTENTIALLY AFFECTED BY TPO POWER INCREASE**

**(Other report sections related to each system evaluation)**

| | |
|---|---|
| Pre-BWR/4 plants - Reactor Vessel and Internals (5.5.1) | FW and Condensate Systems (5.10.3) |
| Pressure Control System, including testing (Appendices C and L) | Main Steam Piping, and FW Piping and connected lines (5.10.10, Appendix K) |
| Balance-of-Plant (BOP ) - Power Conversion and Auxiliary Systems (5.10)<br>- Turbine-Generator and its controls<br>- Condenser and Steam Jet Air Ejectors<br>- Isolated Phase Bus Ducts<br>- Main Transformer | Main Condenser/Circulating Water/Cooling Tower (5.10.4) |

# APPENDIX K

# METHODS AND ASSUMPTIONS FOR PIPING EVALUATION OF TPO UPRATE

## K.1 SCOPE

The piping evaluations for BWR/4, 5 and 6 product lines are performed using the approach described below. For pre-BWR/4 plants, an analogous approach will be applied which considers the current design and licensing bases of the specific plant being evaluated. These evaluations address all plant piping, identifying that portion which is not affected and that portion that may be affected by TPO uprate.

## K.2 EVALUATION METHOD

The evaluation method described below has previously been reviewed and accepted by the NRC for power uprate, initially by a presentation to the NRC and subsequently through the application of the method described to plants applying for TPO uprate power approvals through the licensing staff (Reference 21).

GE evaluates process piping potentially affected by TPO uprate to establish the design adequacy of the piping for the limited number and amount of operating parameters changed for a small (≤ 1.5%) TPO uprate. There are no increases in vessel pressure and core flow, and a negligible increase in coolant temperature (< 1°F). The changes in core pressure drop (< 0.3 psi from Appendix I) and recirculation temperature (< 1°F) have negligible effect on the recirculation piping performance. The only piping evaluation remaining to be performed is for the small increases in main steam and FW flow (< 2%) and FW temperature (< 2°F). The process for those evaluations is depicted on the attached flow chart (Figure K-1). This is the same process previously applied to BWR power uprates (References 20 and 21).

This process begins with the generation of the heat balance, which provides the pressures, temperatures and flows at the TPO uprate conditions. These values are compared to the existing analysis basis. For all except the main steam, FW, and portions of piping of other systems connected to the main steam lines, these conditions are acceptably close to the current operating basis so that they are considered to be acceptable without further evaluation. The evaluation process need only be continued for the affected piping noted above. For these systems, the percent increases above the analysis basis are determined from this process. Note that the approved method has been applied to uprates of 5% and larger, bounding the application of the same method to the smaller change being introduced by TPO uprate.

Any increases above the analysis basis for the effected piping are next used in conjunction with a series of parametric studies which determine the percent increases in the ASME Section III, Subsection NB Code equations (i.e., 9, 10, 12, 13 and 14), Subsections NC & ND or B31.1 Power Piping Code equations for pressure, temperature and flow.

For the affected piping systems, the locations with the highest calculated stress to allowable ratio are determined. The calculated stress is then increased according to the appropriate equation percent increase and then compared to the Code allowable stress. Cumulative fatigue usage factors are evaluated in a similar manner.

These comparisons of “TPO uprate stresses and fatigue usage factors” provide the basis for determining the design adequacy of the affected piping systems for TPO uprate.

In addition to the evaluation of the ASME Code equation increases, any effect of TPO uprate on thermal displacements (only the FW system piping have any temperature change), for system components such as guides, penetrations, valves, pumps, flow elements, pipe supports, pipe whip restraints, valve flanges, and nozzles are also conducted. For plants whose licensing basis includes the results of main steam line and/or FW line vibration measurements taken during startup testing, the effects of power uprate on vibratory displacements will also be included.

The methods used and the results achieved are summarized in the TSAR.

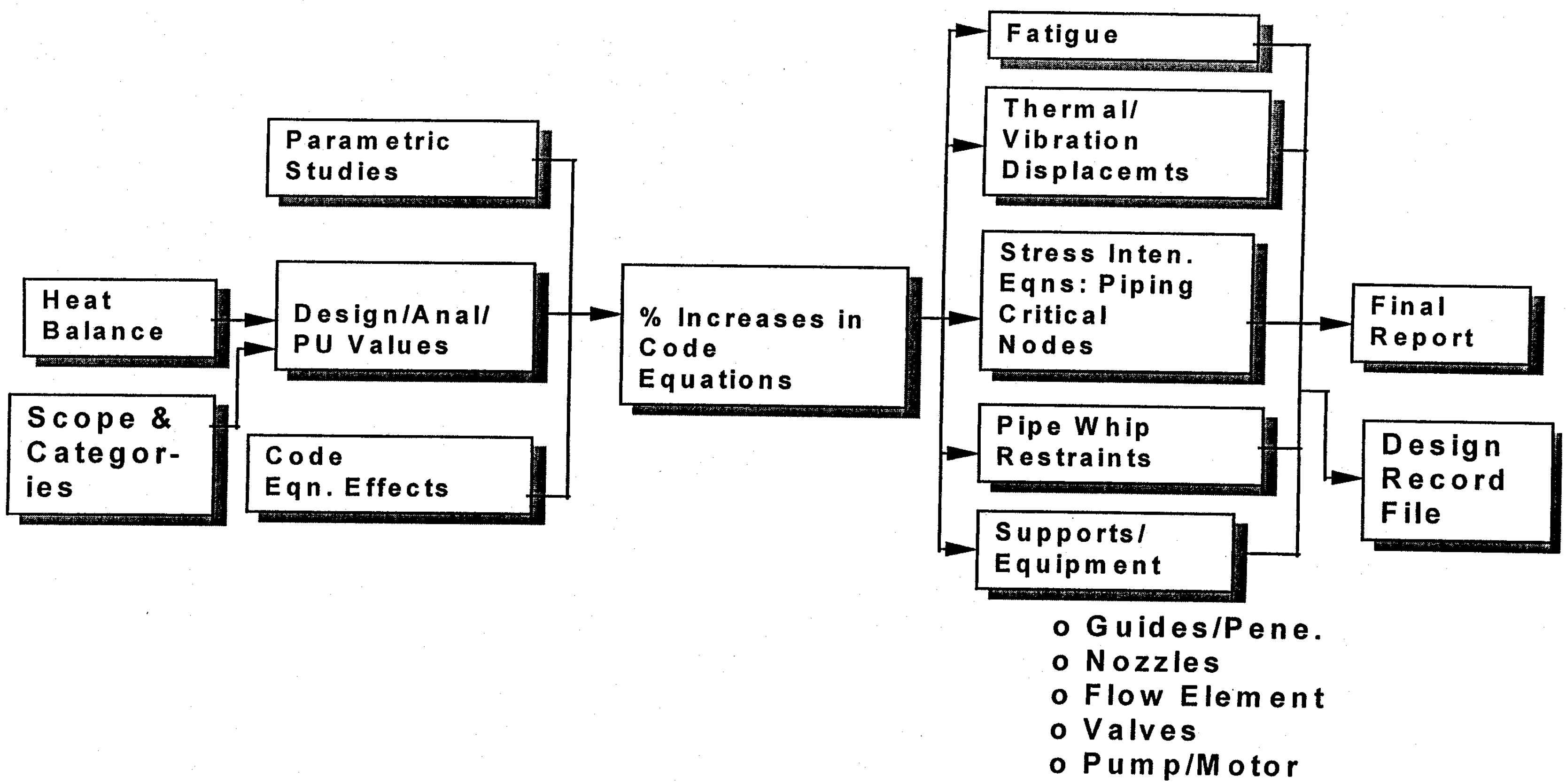


**Figure K-1. TPO Uprate Piping Evaluation Process**

# APPENDIX L

# SPECIFIC ASSUMPTIONS AND BASES FOR EVALUATIONS OF OTHER ASPECTS OF TPO UPRATE

## L.1 SCOPE

This appendix presents evaluations of some additional specific issues related to TPO uprate. In addition, it defines guidelines that will be used generically for other aspects of power uprate not included in this TLTR, including documentation of the bases and assumptions for each guideline. Plants that make selections that differ from these bases must provide separate explanations and justifications in the plant-unique TPO licensing submittal.

## L.2 GUIDELINES FOR UPRATE TESTING

The generic guidelines to be applied during the approach to and demonstration of TPO uprate operating conditions are listed with the pertinent bases, methods, and assumptions that apply. Each power uprate submittal will include a test plan that covers the following items.

### L.2.1 Approach to TPO Uprate Core Thermal Power

Measurements of core thermal power level (MWt) will be performed using the more accurate plant-specific methods proposed in the TSAR to monitor reactor power.

In preparation for initial operation at TPO uprate conditions, routine measurements of reactor and system pressures, flows, and vibration taken near 95% and 100% of CLTP, and at 100% of TPO RTP (≤ 101.5% of CLTP if applying this TLTR). The measurements will be taken along the same constant rod pattern line used for the increase to TPO RTP. Indicated core power (from the APRMs) is expected to be re-scaled in terms of new rated power before exceeding the current rating. If necessary, corresponding adjustments will be made to the APRM alarm and trip settings.

In order for the testing to be most meaningful for evaluation of turbine steam flow margin at TPO conditions, the turbine pressure controller setpoint will be readjusted at ≤ 95% of CLTP and then held constant. The setpoint will be selected so as to reach the desired reactor operating pressure at TPO uprate conditions. The generic approach is to reduce the setpoint so that the reactor dome pressure will be the same at TPO operation as CLTP conditions.

As noted above, the increase from 100% CLTP to TPO RTP conditions will be made along a constant rod pattern line, and steady-state core power measurement will be made at the new licensed power condition (≤ 101.5% of CLTP). Routine measurements of reactor and system pressures, flows, and vibration at TPO RTP conditions will be made, and then evaluated by comparison to the 95% and 100% (of CLTP) measurements recorded prior to the increase to TPO RTP.

***Justification***

(1) This guideline ensures that a careful, monitored approach to increase power is achieved. Measurements at 95% and 100% of CLTP provide information by which the conditions at TPO RTP can be compared with measurements taken after TPO operation is established.

(2) Re-scaling of the APRMs and adjustments of the flow-referenced alarm and trip lines is expected to be performed to ensure trip avoidance, and establish the setpoints as described in Appendix F.

(3) Readjustment of the operating pressure setpoint before beginning to take the baseline power ascension data similarly establishes a consistent basis for measuring the performance of the reactor and especially the turbine control valves (TCVs) as they open to accommodate TPO operating conditions. Selecting a setpoint that will produce the same vessel dome pressure as current rated operation is consistent with the generic plan for TPO uprates and is the basis for the evaluations performed for TPO uprate operation and safety. Note that setpoints associated with operating pressure (e.g., high-pressure scram and SRV setpoints) will not be changed for TPO uprate.

(4) Measurements at 95% and 100% of previous rated power and at TPO uprate conditions (generically $\leq$ 101.5% of previous rated power) ensure that a gradual, monitored approach to TPO RTP will take place. No check point in between CLTP and the TPO RTP point is required because the power change is no greater than 1.5%.

(5) Use of the new FW measurement method in the heat balances for all of the power points leading to TPO operation provides continuity of data for the power ascension to TPO conditions. Review and acceptance of the TPO submittal establishes the basis for use of the revised, more accurate methods.

### L.2.2 Fuel Thermal Margin

Demonstration of acceptable fuel thermal margin will be performed prior to and during power ascension to the TPO RTP level. It will be done at least at each steady-state heat balance point defined in Section L.2.1.

Fuel thermal margin will be projected to the TPO test point after the measurements taken at 95% and 100% of previous rated power to show expected acceptable margin. The projected thermal margin will be satisfactorily confirmed by the measurements taken at full TPO uprate conditions.

This demonstration and on-going monitoring of core and fuel conditions will be performed with the methods currently used at the plant.

***Justification***

This guideline ensures that adequate fuel thermal margins exist during the initial ascension to (and subsequent operation at) TPO uprate conditions. Use of the proposed methods ensures maintenance of acceptable licensing and operational practice.

### L.2.3 Testing of Reactor Control Systems

Acceptable performance of the pressure and FW/level control systems will be recorded at 95% and 100% of CLTP and confirmed at TPO RTP during the power ascension steps defined in Section L.2.1. These operational checks will show acceptable adjustment and operational capability, and will utilize the methods and criteria described in the original startup testing of these systems. Water level changes of ±3 inches, and pressure setpoint step changes of 3 psi will be sufficient. If necessary, adjustments will be made to the controllers and actuator elements. In particular, the pressure setpoint changes will provide data for evaluation of the performance of the linearity settings of the controls as the turbine TCVs operate further open.

***Justification***

(1) The testing of these primary control systems will ensure that acceptable operational characteristics are maintained as power is increased. Comparison to behavior near current rated conditions will provide a meaningful guide in addition to the absolute criteria contained in the original startup test instructions.

(2) Use of the original startup testing procedures and criteria will provide a consistent, previously approved method for performing these basic control tests. The tests are not in themselves safety-related transients, but will be done to assure that small operational disturbances will not introduce a significant increase in unit trips.

### L.2.4 Testing of Large Transient Disturbances

Large transient tests (e.g., isolation) will not generically be required for TPO uprates because the power change is less than or equal to only 1.5% of CLTP. Initial plant testing and experience during plant operation is considered to be sufficient.

***Justification***

(1) The testing performed during initial unit startup includes significant high power testing to demonstrate adequacy of protection for such large transient trips. Operational occurrences have continued to show that unit response is clearly bounded by the safety analyses for these events. Analyses [ ] have shown that the incremental change in unit performance will be very small for TPO power uprates of ≤ 1.5% (Appendix E, Table E-2).

(2) All units monitor such events whenever they inadvertently occur and confirm that actual response and protection actions are within required characteristics. This accepted practice would continue after power uprate.

## L.3 EVALUATION OF ATWS

The generic evaluation of a potential Anticipated Transient Without Scram (ATWS) is [

] have been performed according to the pertinent bases, methods, and assumptions listed below. This evaluation is for confirmation of continued compliance to 10 CFR 50.62 (Reference 23).

Specifically, the following criteria are to be met:

- Peak vessel bottom pressure less than the ASME service level C limit of 1500 psig.
- Maximum containment pressure and temperature lower than the design pressure and temperature of the containment structure.
- Peak cladding temperature below the 2200°F requirement of 10 CFR 50.46.
- Clad oxidation below the requirements of 10 CFR 50.46.

The previous power uprate analyses have taken into account the ATWS mitigating features dictated by the ATWS rule of 10 CFR 50.62 (Reference 23). These features constitute the recirculation pump trip (RPT) and alternate rod insertion (ARI), which are initiated on high reactor pressure or low water level, and the 86 gpm equivalent Standby Liquid Control System (SLCS) initiated manually for most units. The REDY or ODYN transient analysis models (References 3 and 27) have been applied in the previous power uprate ATWS evaluations.

For BWR TPO uprate, ATWS is primarily treated in a generic manner, similar to the evaluations that have supported BWR licensing in the past. The approach used for other TPO areas (e.g., [ ] to TPO uprate in Appendix E) is used to show that the small change of power (≤ 1.5%), coupled with no increase in the maximum control rod line (Appendix C), produces a relatively small change in the results of the mitigation of a postulated ATWS event. In addition, the PCT response [ ] indicates that the increased power level results in a relatively small change in the PCT compared to the margin to the 2200ºF limit. The margin to the PCT limit for the ATWS event is at least 700ºF. [ ] Therefore, the PCT response is of no concern for a TPO uprate.

The generic results for the limiting ATWS events show that the effect of TPO uprate is relatively small (shown in Table L-1 and Figures L-1a through L-1d). If the TPO plant shows that it currently has sufficient margin for the projected changes of the peak parameters [ ]

This section describes how these results are to be applied to each TPO uprate plant.

### L.3.1 Power Conditions for ATWS Evaluations

The generic review of results for the ATWS event shows that the effect of TPO uprate is relatively small. If the plant shows that it currently has sufficient margin for the projected changes of the peak parameters, no plant-specific ATWS analysis need be performed. If the previous ATWS analysis does not show sufficient margin, a plant-specific analysis will be performed with a discussion provided in the TSAR. The term "sufficient margin" was defined in Section L.3.

***Justification***

Evaluation of licensed power conditions is the accepted basis for the previous ATWS evaluations for all units (Reference 24). The effect of a TPO uprate can be determined from existing sensitivity analyses. Plants that have previously licensed uprated power have also reanalyzed postulated ATWS events for the increased power operating conditions. [

] this effect are shown in Table L-1 and Figures L-1a through L-1d [
]. In all cases, the changes are relatively small and plant-specific evaluation of the available margin is expected to show continued compliance to the criteria applied to ATWS analyses.

### L.3.2 Operator Actions

Operator actions (where applicable) have been assumed to be consistent with the BWR Emergency Procedure Guidelines and with the procedures that apply to each of the plant results included in the example cases in Table L-1. Typical operator actions, which occur in ATWS analyses, are as follows:

- Trip the FW pumps on high suppression pool temperature or other confirmed ATWS symptoms.
- Start the SLCS on confirmed ATWS symptoms.
- Maintain RPV water level near the top of active fuel until sufficient liquid poison is injected into the vessel during the postulated ATWS event.
- Start the RHR in the pool cooling mode on high suppression pool temperature.

***Justification***

In some areas, manual actions consistent with plant emergency operating procedures are involved in ATWS evaluation. It is most consistent for the plants to assume that these actions are performed in response to symptoms as they may occur during the postulated event. Typical plant-unique operator procedures are included in Reference 24 and in previous power uprate licensing submittals used as the basis for Table L-1. In all cases, these are currently accepted procedures for each plant and ATWS analysis. For the small power uprate involved in TPO uprate, there is no significant change in the time available for the operator to perform these assumed actions.

### L.3.3 Most Limiting Event(s)

The evaluations have included consideration of the most limiting case(s) from the viewpoints of overpressure and suppression pool cooling. Four selected representative events (guided by previous power uprate ATWS results studies of Reference 21) have been considered:

- Main Steam Isolation Valve Closure (MSIVC)
- Pressure Regulator Failure - Open (PRFO) (with subsequent MSIV closure)
- Loss of Offsite Power (LOOP)

- Inadvertent Opening of a Relief Valve (IORV)

***Justification***

These are the ATWS criteria challenged most by the TPO uprate due to increased average stored energy and increased total decay heat. Local fuel conditions are not significantly changed by a TPO uprate because the hot bundle is still limited to the same initial thermal conditions.

### L.3.4 Input Parameters

Inputs have been selected consistent with those used in previous ATWS evaluations (e.g., Reference 24). In general, nominal operating and equipment parameters are utilized for the evaluation of this special situation. Safety/relief valve and recirculation pump trip pressure setpoints will be unchanged for TPO uprate operation. For overpressure evaluation, current allowances for setpoint drift and uncertainty have already been included. The current allowable number of relief valves out of service will be unchanged for TPO operation. Decay heat inputs are greater than or equal to the 1979 ANS 5.1 results (Reference 18).

***Justification***

The approach previously applied for the ATWS evaluations shown in Table L-1 and Figures L-1a through L-1d is consistent with the accepted basis for ATWS evaluation. They also have incorporated current values of the key parameters most related to power uprate – parameters that are not changed for TPO uprate.

### L.3.5 TPO Uprate ATWS Evaluation Summary

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## L.4 EVALUATION OF FIRE MITIGATION – APPENDIX R

This generic evaluation of a potential fire event is provided [ ] evaluations have been performed according to the pertinent bases, methods, and assumptions listed below. This evaluation is for confirmation of continued compliance to 10 CFR 50.48 and 10 CFR 50, Appendix R (Reference 25).

The generic results for the limiting Appendix R events show that the effect of TPO uprate is relatively small (shown in Table L-2). If the TPO plant shows that it currently has sufficient margin for the projected changes of the peak parameters [

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Table L-2 shows such an example for plant “A” that has previously selected a very severe basis for its Appendix R analysis – significantly more conservative than the examples found for the other uprated plants. For this reason, its existing analysis has little margin for additional uprating. The bases would need reexamined in the TSAR and a more typical set of conservatisms proposed for achieving acceptable results for TPO approval.

Specifically, the following criteria are to be met:

- Peak vessel bottom pressure less than the ASME service level B limit of 1375 psig.
- Maximum containment pressure and temperature lower than the design pressure and temperature of the containment structure.
- Peak cladding temperature below the 1500°F.

[ ] have taken into account the various Appendix R mitigating features available at each plant. Wherever applicable, manual operator actions defined by the plant emergency procedures are included in the evaluations. The SAFER/GESTR-LOCA (References 2 and 31) and SHEX (Reference 17) analysis models have generally been applied for all power uprate Appendix R evaluations. Both methodologies have received NRC review and acceptance.

For BWR TPO uprate, Appendix R evaluation is primarily treated in a generic manner, similar to the other evaluations included in this TLTR. The approach used for other TPO areas (e.g., [ ] to TPO uprate in Appendix E) is used to show that the small change of power (≤ 1.5%) coupled with no increase in the maximum control rod line (Appendix C) produces a relatively small change in the results of the mitigation of a postulated fire event.

### L.4.1 Power Conditions for Appendix R Evaluations

Reactor initial operating conditions equal to the TPO uprate conditions have been evaluated. Operation remains constrained to the same control rod line as before TPO uprate (Appendix C).

***Justification***

Evaluation of licensed power conditions is the accepted basis for the previous Appendix R evaluations for all units. Analysis was done consistent with OLTP levels for all plants. Plants that have previously licensed uprated power have also reanalyzed postulated fire events for the increased power operating conditions. [

] this effect are shown in

Table L-2 [ ]. In all cases, the changes are small and adequate margin remains for the criteria applied to the Appendix R results.

### L.4.2 Operator Actions

Operator actions (where applicable) have been assumed to be consistent with the BWR Emergency Procedure Guidelines and with the procedures that apply to each of the plant results included in the example cases in Table L-2. Typical operator actions, which occur in Appendix R analyses, are as follows:

- Assure that reactor scram has occurred.
- To the extent possible, defeat any undesired spurious system/component actuations.
- Initiate RHR System suppression pool cooling mode or the Alternate Shutdown Cooling System.
- Initiate reactor repressurization, if needed, according to the suppression pool heat capacity temperature limits for the plant and the associated emergency procedures.

***Justification***

In some areas, manual actions are involved in Appendix R evaluation. It is most consistent for the plants to assume that these actions are performed in response to symptoms as they may occur during the postulated event. Typical plant-unique operator procedures are included in previous power uprate licensing submittals used as the basis for Table L-2. In all cases, these are currently accepted procedures for each plant and Appendix R analysis. For the small power uprate involved in TPO uprate, there is no significant change in the time available for the operator to perform these assumed actions.

### L.4.3 Most Limiting Event(s)

The evaluations have included consideration of the most limiting case(s) from the viewpoints of potential fuel cladding heatup and suppression pool/containment heatup. The events chosen for each plant have been based [ ]:

- Main Steam Isolation Valve Closure (MSIVC) at the start of the event.
- Loss of Off-site Power assumed at the start of the event.
- Spurious opening of one SRV (for appropriate event sequences).
- Plant-unique trains of equipment are deactivated depending upon the location of the postulated fire.
- Manual action is assumed no earlier than 10 minutes into the postulated event.

***Justification***

These are the reactor safety criteria challenged most by the power uprate due to increased average stored energy and increased total decay heat. Local fuel conditions are not significantly changed by a TPO uprate because the hot bundle is still limited to the same initial thermal conditions.

### L.4.4 Input Parameters

Inputs have been selected consistent with those used in previous Appendix R evaluations. In general, nominal operating and equipment parameters are utilized for the evaluation of this special situation. For fuel cladding and suppression pool/containment heatup mitigation evaluation, previously assumed system actuation steps and system performance are assumed. Decay heat inputs are greater than or equal to the 1979 ANS 5.1 results (Reference 18).

***Justification***

The approach previously applied for the Appendix R evaluation is consistent with the accepted basis for previous Appendix R evaluations. The previous evaluations have incorporated current values of the key parameters most related to power uprate – parameters that are not changed for TPO uprate.

### L.4.5 TPO Uprate Appendix R Evaluation Summary

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## L.5 EVALUATION OF STATION BLACKOUT

This generic evaluation of a potential loss of all alternating current power supplies is provided based on previous plant response and coping capability analyses for typical power uprate projects. The previous BWR power uprate evaluations have been performed according to the applicable bases for the plant (e.g., the bases, methods, and assumptions of Regulatory Guide 1.155 and/or NUMARC 87-00). This evaluation is for confirmation of continued compliance to 10 CFR 50.63 Station Blackout (loss of all alternating current power, Reference 29). It is recognized that this evaluation is dependent upon many plant-specific design and equipment parameters.

Specifically, the following main considerations were evaluated:

- The adequacy of the condensate/reactor coolant inventory.
- The capacity of the Class 1E batteries.
- The SBO compressed Nitrogen requirements.
- The ability to maintain containment integrity.
- The effect of loss of ventilation on rooms that contain equipment essential for plant response to a SBO event; for example:

- Control room, battery rooms, and other auxiliary electrical equipment rooms
- RCIC and HPCI room(s) as applicable
- Primary containment (Drywell and Suppression Chamber)

The previous power uprate analyses have taken into account the various SBO mitigating features available at each plant. Wherever applicable, manual operator actions defined by the plant emergency procedures are included in the evaluations. The bases for acceptable performance of individual systems and components are not expected to be changed from the current bases for TPO uprate. The SHEX (Reference 17) analysis model has generally been applied for GE calculations of containment conditions during power uprate SBO evaluations. This method has received NRC review and acceptance.

### L.5.1 Power Conditions for SBO Evaluations

While not required by the evaluation guidelines, some BWR SBO evaluations have been performed assuming ≥ 102% of CLTP. For those plants, the postulated SBO scenarios for TPO operation are bounded by the current evaluations.

The generic review of results for the limiting SBO scenarios shows that the effect of TPO uprate is relatively small (shown in Table L-3). [ ]

***Justification***

Evaluation of licensed power conditions is the accepted basis for the previous SBO evaluations for all units. In the cases where the SBO analysis was performed at ≥ 102% of CLTP, the previous analysis bounds the required analyses for SBO because the basis of TPO uprate is the reduced uncertainty in monitoring of average power. Therefore the appropriate SBO analysis point for TPO operation is the same as for CLTP conditions in these cases.

Plants that have analyzed a SBO event at nominal CLTP level can assess the effect of TPO uprate [ ]. Plants that have previously licensed uprated power have also reanalyzed postulated SBO events for the increased power operating conditions. [ ] The calculated effect on a SBO event are shown in Table L-3 [ ]. In all cases, the changes are small and adequate margin is expected to be available to accommodate a SBO event for TPO uprate.

### L.5.2 Operator Actions

Operator actions (where applicable) have previously been assumed consistent with the plant Emergency Procedure Guidelines.

***Justification***

Manual actions according to prescribed plant-specific emergency procedures are involved in SBO evaluation. These are the currently accepted procedures for each plant and SBO analysis. For the small power uprate involved in TPO uprate, there is no significant change in the time available for the operator to perform these assumed actions.

### L.5.3 TPO Uprate SBO Evaluation Summary

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The TSAR will document one of the following three bases for dispositioning the SBO:

- The previous analyses were performed at ≥ 102% of CLTP.
- The previous analyses were performed at CLTP [ ].
- If the previous SBO analyses [ ], a plant-specific evaluation will be performed.

The TSAR will confirm condensate requirements and capability of the mitigating systems to maintain core cooling for the coping period.

# Table L-1

## EVALUATION OF ATWS TRANSIENT EVENTS

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**Table L-2**

**EVALUATION OF APPENDIX R EVENTS**

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**Table L-3**

**EVALUATION OF STATION BLACKOUT EVENTS**

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**Figure L-1a**
**TPO Peak Pressure Increase to Relief Capacity for Large Size BWR**

**Figure L-1b**
**TPO Peak Pressure Increase to Peak Pressure for Large Size BWR**

**Figure L-1c**
**TPO Peak Pressure Increase to Relief Capacity for Medium Size BWR**

**Figure L-1d**
**TPO Peak Pressure Increase to Peak Pressure for Medium Size BWR**