NRC FORM 8C
(7-94)
NRCMD 3.57

# COVER SHEET FOR CORRESPONDENCE

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# NRC Request for Additional Information Set 9, Numbers 10 – 14 RXSB

## NRC RAI Set 9 Number 10 RXSB

The pressure regulator downscale failure (PRDS) is no longer an AOO for some BWR classes. However, the pressure regulator failure open (PRFO) is limiting for some ATWS scenarios. How are pressure regulator failure events evaluated for EPU to ensure that all acceptance criteria are met?

## GE Response

PRDS

There are two types of PRDS events that have been defined. One is a single regulator failure (Single PRDS) and the other is a complete downscale failure of the pressure regulator (BWR/6 only). The second event is no longer an AOO. The first event is an AOO for all BWRs. The Single PRDS results in a very mild pressure change where the backup regulator takes control without a scram.

More information on the complete regulator failure is provided in the response to RAI 14.

A PRDS ATWS scenario is bounded by other events that result in MSIV isolations and the ATWS acceptance criteria are met by analyses of the more limiting events like the MSIV closure or the PRFO.

PRFO

The failure of the pressure regulator to the upper limit of the output limiter (PRFO) causes it to further open the Turbine Control Valves (TCV) and to open the Bypass valves. The increasing steam flow and dropping turbine inlet pressure cause vessel dome pressure to drop, increasing bulk fluid void volume (which causes the level to swell), and increasing the core void volume, which decreases reactor power. This event can proceed in two ways: (1) a Main Steam Isolation Valve (MSIV) closure is initiated on low steamline pressure or (2) the swell in water level can reach a Level 8 trip of the turbine and feedwater (FW) systems, which would likely avoid MSIV closure. In either case, there is a large power reduction and an increase in the MCPR prior to a turbine trip or MSIV closure occurs. The immediate scram generated from the turbine trip or MSIV position switch would prevent a decrease in MCPR below its initial value.

The PRFO may be a limiting ATWS scenario because the assumed MSIV isolation will cause a large pressure change without the availability of the steam bypass system to relieve the pressure. The large pressure increase and reduction in core voids results in a large power increase without a scram and increased stored energy.

## NRC RAI Set 9 Number 11 RXSB

Please discuss how the limited scope CPPU LOCA analyses builds upon the full scope SAFER analyses.

## GE Response

The LOCA analysis for CPPU builds on the existing SAFER/GESTR-LOCA for the plant. There are two limiting points on the break spectrum; the full sized recirculation line break, and the worst small recirculation line break with failure of the high pressure ECCS.

In addition to the large break LOCA analysis, the small recirculation line break LOCA response will be reviewed . There is a higher steam generation rate due to the increased decay heat associated with power uprate. The higher steam generation rate may result in a longer ADS blowdown and a higher PCT for the small break LOCA.

## NRC RAI Set 9 Number 12 RXSB

ELTR1 and ELTR2 include a requirement to perform evaluation of the stability option trip setpoints for an equilibrium core.

## GE Response

The OPRM setpoint depends upon cycle-specific parameters. It must be calculated on a cycle-specific basis per the NRC approved licensing basis methodology for reload analysis, in NEDO-32465-A.

**NRC RAI Set 9 Number 13 RXSB**

ELTR1, Appendix E, requires the following transients to be analyzed for EPU conditions:

PRDS MSIVC MSIVF TTNBP

Please provide the justification for not analyzing in CPPU approach.

**GE Response**

See response to Number 14.

**NRC RAI Set 9 Number 14 RXSB**

The staff SER for ELTR1 states that "only limiting transients need to be included in the uprate amendment request, but a list of all transients analyzed in support of power uprate should be included, with an explanation of how the limiting transients were selected." ELTR2 states "--- Operating limit MCPR will be documented in each plant specific power uprate sulbmittal —." Please provide a list of the transients considered with an explanation of how the limiting transient was selected.

**GE Response**

**Background**

The plant original Final Safety Analysis Report (FSAR) documented a wide range of postulated Anticipated Operational Occurrences (AOOs) and incident events for a variety of plant conditions analyzed for the plant initial core. These AOOs establish the licensing basis for the plant and the Updated Final Safety Analysis Report documents the most recent analyses. A subset of these AOOs (limiting transients) is analyzed each reload cycle. The AOO analyses is performed to assure fuel integrity is maintained. This is accomplished by assuring the Operating Limit Minimum Critical Power Ratio (OLMCPR) is set such that there would be no Safety Limit MCPR (SLMCPR) violation. Based on the broad range of analysis results across the BWR fleet, GE has reduced the amount of analyses required for subsequent reload analyses to a limiting set of events that is sufficient to confirm or reestablish the OLMCPR. These limiting events are documented in GESTAR (Reference 1).

## NRC Request for Additional Information Set 10, Large Transient Testing

### NRC RAI Set 10 Number 1

1. Provide justification for large transient tests. As part of this justification address the following:
   a. Identify the plant systems and components challenged by the large transient tests under consideration (i.e., Load Rejection and Main Steam Isolation Valve Closure tests) and those systems/components parameters important for the tests (e.g., valve closure time).
   b. Identify modifications made to these systems and components as a result of uprate.
   c. Provide an evaluation of the effect of the power uprate for both steady state and transient response (e.g., increased power, steam flow, feed flow, etc.) on these systems and components.
   d. Describe the testing and data collection that is being performed on these systems and components including any that is part of the power ascension test plan.
   e. Discuss and evaluate related past experience regarding these types of transients at other uprated plants.

### GE Response

### NRC RAI Set 10 Number 2

Identify any new systems or features being installed and justify the proposal to not perform an integrated plant test for purposes of demonstrating plant response with the new system/feature.

### GE Response

## NRC Request for Additional Information Set 10, Large Transient Testing

### NRC RAI Set 10 Number 1

1. Provide justification for not performing the large transient tests. As part of this justification address the following:
    a. Identify the plant systems and components challenged by the large transient tests under consideration (i.e., Load Rejection and Main Steam Isolation Valve Closure tests) and those systems/components parameters important for the tests (e.g., valve closure time).
    b. Identify modifications made to these systems and components as a result of uprate.
    c. Provide an evaluation of the effect of the power uprate for both steady state and transient response (e.g., increased power, steam flow, feed flow, etc.) on these systems and components.
    d. Describe the testing and data collection that is being performed on these systems and components including any that is part of the power ascension test plan.
    e. Discuss and evaluate related past experience regarding these types of transients at other uprated plants.

### GE Response

The Constant Pressure Power Uprate (CPPU) Licensing Topical Report (CLTR) does not commit to any large transient testing (closure of all main steamline isolation valves (MSIVs) or generator load rejection (fast closure of the turbine control valves)). The requirement for no large transient testing represents a change from the NRC approved Extended Power Uprate (EPU) LTRs (ELTRs). The ELTRs identified large transient tests for power uprates of greater than 10% of original licensed thermal power (OLTP). More specifically, the following testing guideline was documented:

1. Large transient tests (e.g., isolation) will not be required for uprates less than or equal to 10% or the original licensed thermal power. Initial plant testing and experience during plant operation is considered to be sufficient.
2. A MSIV closure test, equivalent to that conducted in the initial startup testing, will be performed if the power uprate is more than 10% above any previously recorded MSIV closure transient data.
3. For uprates of more than 15%, a generator load rejection test, equivalent to that conducted in the initial startup testing, will be performed if the power uprate is more than 15% above any previously recorded generator load rejection transient data.

This testing change in CLTR is based on plant operating experience, power uprate analyses, other test requirements, and the constant pressure limitation on maximum normal operating pressure. Primarily, experience at uprated BWRs has shown that there is a close correlation between the plant transient data and the simulation of the events using current analysis methodology. Based on the similarity of plants, past transient testing, past analyses, and the evaluation of test and unplanned transient results, the effects of the uprated power level can be determined on a plant specific basis. Further, the imposition of a rapid pressurization transient from a high power level results in unnecessary and undesirable thermal and pressure cycles on the fuel and primary system. It is important to recognize that the key nuclear characteristics used in the transient analysis are confirmed by the steady state physics testing. Also, the capability of systems to provide the required transient mitigation is demonstrated by other tests required by the Technical Specifications, especially including extensive experience for each CPPU plant operating at current pressure and temperature conditions. In addition, the constant maximum normal operation pressure requirement minimizes the peak pressure expected during transients, because the setpoints of the relief valves are not increased for a CPPU uprate. EPU is based on an allowable 75 psi increase in maximum normal operating pressure which results in a substantially higher peak pressure during rapid pressurization events than CPPU.

Based on this information and the following responses, startup testing has been dispositioned as generic in the CLTR and a large transient test is not required.

Response 1a.

Large transient tests only challenge a limited set of systems and components. This situation results because the scram rapidly reduces power, and the long-term consequences are relatively benign and controlled by normal operator actions. For example, the system requirements for the required actions for the closure of all MSIVs and load rejection are limited to:

| | |
|---|---|
| **Closure of All MSIVs** | |
| Scram | Reactor Protection System |
| | Control Rod Drive System |
| Pressure Relief | Safety/Relief Valves or Relief Valves |
| Initial Core Cooling | Feedwater (plants with motor driven feedwater pumps) |
| | HPCI/HPCS (plants with turbine driven feedwater pumps) |
| | RCIC (plants with turbine driven feedwater pumps) |
| Long Term Core Cooling | FW or RCIC (Beyond the scope of the transient test) |
| **Load Rejection** | |
| Scram | Reactor Protection System |
| | Control Rod Drive System |
| | EOC-RPT (power reduction as rod insertion begins) |
| Pressure Relief | Turbine Bypass Valves |
| | Safety/Relief Valves or Relief Valves |
| Initial Core Cooling | Feedwater |
| Long Term Core Cooling | Feedwater (Beyond the scope of the transient test) |

The instrumentation that initiates these actions is also included in the list of required functions. The only other components that have a significant effect on these transients are closing characteristics of the MSIVs and turbine control valves.

Response 1b.

Experience with CPPU has demonstrated that a number of plant modifications are required to accommodate the increased power level. The most significant changes are made to the power generation systems (main turbine, feedwater, etc.). These changes are associated with accommodating the higher steam and feedwater flows. This experience also indicates that only relatively minor changes are required for the safety related systems. As described in the following, these changes do not significantly affect the plant response to a closure of all MSIVs or load rejection with bypass.

The modifications to the feedwater system made to accommodate the increased feedwater flow required for normal operation. Because feedwater flow is significantly greater than that required to restore water inventory and for decay heat removal following a scram, its change in performance does not require a large transient test.

CPPU does result in a significant increase in the peak pressure in the overpressure capability analysis, and some slight modifications may be required for the safety or safety/relief valves. These changes are made consistent with the ASME Code and are incorporated in the analyses performed for CPPU. It should be noted that the setpoints and capacity of the safety or safety/relief valves are modeled conservatively, consistent with the ASME Code requirements. These changes do not have a significant effect on either the closure of all MSIVs or load rejection transients because of the relatively small transient pressure increase for these events and the characteristic response calculated and observed for these events – they do not require the opening of all safety/relief valves.

Based on experience with previous CPPUs, the minor changes made to safety related systems are less significant to closure of all MSIVs and load rejection transients than the initial conditions for a startup test. This situation results because startup testing is performed at the beginning of cycle with some control rod inventory in the core and a smaller than design decay heat rate. Further, a wide range of initial conditions can occur. These initial conditions are conservatively treated in the safety analysis process. As a result, transient tests are far more benign than predicted in the safety analysis. Performance of the tests would not demonstrate the system design capability.

Therefore, a test would provide little information relative to any safety related system modifications.

Response 1c.

With the exception of feedwater, all of the required systems are the subject of Technical Specification testing requirements that demonstrate their required capability.

Feedwater is a normal operating system that is designed for normal plant operating requirements, which are far more demanding than the transient test requirements. As discussed in Response 1d, a substantial amount of startup test data is taken on the performance of the feedwater system.

The specific Technical Specifications that demonstrate the required safety system capability vary from plant to plant. Further, the specific testing to demonstrate compliance with the plant specific Technical Specifications is under the control of the licensee. However, the improved Standard Technical Specifications (STS) provide a demonstration of the scope of typical plant specific Technical Specifications. Based on the STS, the following key tests are required to demonstrate capability of those systems other than feedwater that perform the required actions.

| System | Technical Specification Requirement |
|---|---|
| Reactor Protection System | Calibrate MSIV position switches |
| | Calibrate TCV fast closure trip oil switches |
| | Verify RPS response time |
| Control Rod Drive System | Verify each control rod scram time is within limits |
| EOC-RPT | Calibrate TCV fast closure trip oil switches |
| | Verify EOC-RPT response time |
| Safety/Relief Valve or Relief Valves | Verify the safety/relief valve or relief valve setpoints |
| HPCI | Calibrate low water level initiation |
| | Verify system startup time and flow rate |
| HPCS | Calibrate low water level initiation |
| | Verify system flow rate |
| RCIC | Calibrate low water level initiation |
| | Verify system startup time and flow rate |

These Technical Specifications are sufficient to demonstrate the system or component initiation setpoint and performance characteristics. Safety/relief valve or relief valve flow testing is not required because flow is an inherent characteristic of the valve and the simulated flow is consistent with the ASME Code requirements.

The only other components that have an effect on the transient are closing characteristics of the MSIVs and turbine control valves.

The closing time of the MSIVs is controlled by the Technical Specifications. The STS specifies that the control valve closure time be within a minimum and maximum closing time. The closing time is consistent with the assumption in the safety analysis. The ability of the MSIVs to function at the increased steam flow conditions is bounded by their unchanged design basis to isolate the lines in the postulated event of a main steam line break accident.

For the turbine control valves, a conservative stroke time and closing characteristic is assumed in the analysis. The turbine control valve closure time and closing characteristics are included in the design basis of the main turbine and they are not significantly affected by CPPU.

Response 1d.

With respect to startup testing, no specific testing or data collection is proposed for the safety related systems. The current Technical Specifications cover these systems, and that testing is considered adequate.

The feedwater and feedwater control system performance characteristics are the subject of extensive startup testing. However, this data is intended to demonstrate its performance requirements for normal plant operation and minor upsets (control system changes, etc.), not performance during large transients. Because of the safety analysis assumptions, sophisticated modeling of the feedwater system performance is not required.

Therefore, no additional testing and data collection is considered necessary.

Response 1e.

It should be noted that GE's large transient testing database is extensive. All plants performed a rapid pressurization transient test at essentially the OLTP during their initial startup testing. The purpose of this test was primarily to demonstrate the installed systems mitigation capability. In addition, it provided a substantial amount of information used for transient model qualification for the specific plant systems performance.

To further support transient model qualification, special transient testing was performed at a domestic and a foreign plant. These tests were specially designed to capture the important transient effects. These test provide the primary test data used in the development of all current BWR transient analysis models used for the simulation of rapid pressurization transients.

Other testing or events of special note are that one foreign BWR/6 Mark III plant performed special power uprate testing at uprated power levels, and there have been three unplanned transients at previously uprated BWR/4 Mark I plants.

Tests were performed at the foreign plant to demonstrate modifications made to its system to enable it to survive a turbine trip or generator load rejection from full power without a scram being required. These tests involved turbine trips at 110.5% OLTP and 113.5% OLTP and a generator load rejection test at 104.2% OLTP. The turbine and generator trip testing demonstrated the performance of equipment that was modified in preparation for the higher power levels. Equipment that was not modified performed as before. The reactor vessel pressure was controlled at the same operating point for all of the uprated power conditions. No unexpected performance was observed except in the fine-tuning of the turbine bypass opening that was done as the series of tests progressed. These large transient tests at the foreign plant demonstrated the response of the equipment and the reactor response. The close matches observed with predicted response provide additional confidence that the uprate licensing analyses consistently reflected the behavior of the plant.

The three unplanned transients at the BWR/4 Mark I plants included two load rejections and a turbine trip subsequent to their power uprates. In each case, the licensee concluded that no anomalies were seen in the plant's response to these events, and the behavior of the primary mitigation systems was as expected. No new plant behaviors were observed that would indicate that the analytical models being used are not capable of modeling plant behavior at CPPU conditions.

To date, there have been a number of domestic power uprates of greater than 10% of OLTP licensed by the NRC. The current assessment of the need for these tests demonstrates that they do not provide any significant new information. The following information is provided consistent with this assessment.

1. The original startup testing provided a demonstration of the combined systems mitigation capability for large transients. Any plant modifications made since the original startup testing that change the mitigation capability were adequately tested with their implementation. Therefore, the systems mitigation capability for the current plant configuration has been adequately demonstrated.

2. CPPU analyses have demonstrated that the increase in power results in only a relatively small increase in the challenge to the event limits. Previous experience with CPPUs has demonstrated that only minor modifications (if any) to safety related systems are required to accommodate that increased power level. These changes generally take the form of small changes to setpoints, changes to normal operating conditions, or slight increases in system capability. Of these changes, the changes to normal operating conditions provides the most significant effect on the safety analysis (see Reponse 1b). The changes are well within the modeling capability of the currently approved safety analysis methodology.

Further, these changes can be demonstrated by system or component performance testing and do not require integrated plant testing.

3. The closure of all MSIVs (with normal position switch scram) and load rejection (with bypass) are not considered limiting events in the safety analysis. They do not result in a significant challenge to the fuel or primary system safety limits. As a result, the tests do not provide any significant new information relative to installed systems mitigation capability.

## NRC RAI Set 10 Number 2

Identify any new systems or features being installed and justify the proposal to not perform an integrated plant test for purposes of demonstrating plant response with the new system/feature.

## GE Response

Current experience with power uprate has demonstrated that new systems or features are not required to mitigate the consequences of rapid pressurization anticipated operational occurrences (large transients). Therefore, for the typical CPPU, there is no need to perform large transient testing for CPPU to test new systems or features. In this case, the generic disposition is applicable.

If a new system or feature is required for mitigation of rapid pressurization anticipated operational occurrences for CPPU, its need will be documented in the plant specific power uprate safety analysis report (PUSAR). Further, it will fail the generic disposition applicability criterion. As a result, it will be the subject of a plant specific disposition, which requires justification in the PUSAR. Any required testing of the new system or feature will then be the subject of the plant specific NRC review.

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