

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON D.C. 20555

July 11, 1994

NRC GENERIC LETTER 94-02: LONG-TERM SOLUTIONS AND UPGRADE OF INTERIM
OPERATING RECOMMENDATIONS FOR THERMAL-HYDRAULIC INSTABILITIES IN BOILING WATER REACTORS

Addressees

All holders of operating licenses for boiling water reactor except Big Rock Point.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this generic letter to request that each addressee (1) take the appropriate actions to augment its respective procedures and training for preventing or responding to thermal-hydraulic instabilities in its reactors and (2) submit to the NRC a plan describing the long-term stability solution option it has selected and the implementation schedule it proposes for the modification of plant protection systems to ensure compliance with General Design Criteria (GDC) 10 and 12 in Appendix A to Part 50 of Title 10 of the Code of Federal Regulations (10 CFR Part 50).

Background

The possibility of power oscillations due to thermal-hydraulic instabilities in boiling water reactors (BWRs) and the consequences of such events have been of concern for many years. The staff evaluated thermal-hydraulic stability as Generic Issue B-19 and recommended closure actions for resolution of that issue in Generic Letter 86-02, "Long-Term Solutions to Thermal-Hydraulic Instabilities in Boiling Water Reactors," which requested BWR licensees to examine each core reload and to impose operating limitations, as appropriate, to ensure compliance with GDC 10 and 12. GDC 10 requires that the reactor core be designed with appropriate margin to assure that specified acceptable fuel design limits will not be exceeded during any condition of normal operation, including the effects of anticipated operational occurrences. GDC 12 requires assurance that power oscillations which can result in conditions exceeding specified acceptable fuel design limits are either not possible or can be reliably and readily detected and suppressed.

On March 9, 1988, LaSalle Unit 2 experienced an instability event. The work by both the staff and industry organizations following the event has provided additional insight into thermal-hydraulic instabilities in BWR cores. The LaSalle event is described in NRC Information Notice 88-39, "LaSalle Unit 2 Loss of Recirculation Pumps With Power Oscillation Event," dated June 15, 1988. NRC Bulletin 88-07, also dated June 15, 1988, highlighted the generic concerns identified in light of the LaSalle event and requested all BWR

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licensees, regardless of BWR type or analytical core stability margin, to review the adequacy of procedures and instrumentation to respond to power oscillations, and requested review of operator training programs with regard to power oscillations. In response to these concerns, the BWR Owners' Group (BWROG) initiated a project to investigate actions that should be taken to resolve the BWR stability issue.

On October 28, 1988, the General Electric Company (GE) notified the NRC under 10 CFR Part 21 that thermal margins might not be sufficient to prevent violation of the minimum critical power ratio safety limit for some BWR plants if a 10-percent average power range monitor (APRM) oscillation was used as a procedural action point for manual scram of the plant. Based on this possibility, GE recommended stability "interim corrective actions" in a November 1988 letter to BWR utilities. On December 30, 1988, the NRC issued Bulletin 88-07, Supplement 1, approving the proposed BWROG/GE interim operating recommendations and stating additional conditions. One of these conditions addressed the applicability of the experience-based stability exclusion boundaries defined in the interim operating recommendations, and noted the need to reevaluate and justify these boundaries for cores that include new fuel designs. This bulletin also discussed long-term corrective actions. Such corrective actions might include hardware modifications or additions to facilitate manual or automatic protective response to avoid neutron flux oscillations or to suppress oscillations should they occur. Since it is possible for some oscillations to grow to levels exceeding NRC safety limits in the order of a minute, automatic protection action is generally indicated. The detailed design specifications for the automatic protection are being defined by an expanded post-LaSalle BWROG study to develop a generic resolution to the stability issue.

In June 1991, the BWROG issued NEDO-31960 (Ref. 1) which documented proposed long-term solutions to the stability issue as well as methodologies that have been developed to support the design of these long-term solutions. Supplement 1 to NEDO-31960 (Ref. 2) was issued in March 1992 and contained final methodology details and additional information requested by the NRC. By a July 1993 letter from A. C. Thadani (NRC) to L. A. England (BWROG), the NRC transmitted its safety evaluation report (Ref. 3) on NEDO-31960 and its Supplement 1 to the BWROG. Reference 3 describes the results of the staff review of the proposed solution concepts and their associated methodologies. This generic letter requests information about licensee plans for implementation of the approved solution concepts and actions taken in response to later BWROG guidance and stability experience until the long-term solution is implemented. This resolution assumes the protection system will function when required and does not consider the combination of instability and anticipated transients without scram (ATWS). That subject is being addressed by other NRC and BWROG activities.

Need for Enhancement of Interim Operating Recommendations

In early 1992, the BWROG, citing its continuing studies, provided its members additional guidance on implementation of the interim recommendations for stability actions attached to NRC Bulletin 88-07, Supplement 1. In the 1992

guidance, the BWROG emphasized the need for caution when operating near the exclusion regions and recommended reexamination of procedures and training to ensure that uncertainties in the definition of exclusion region boundaries were appropriately reflected. The NRC staff considered this guidance in conjunction with an Augmented Inspection Team (AIT) review of a Washington Nuclear Power Unit 2 (WNP-2) 1992 instability event. The AIT report (Ref. 4) discusses that review and the BWROG guidance.

On August 15, 1992, Washington Nuclear Power Unit 2 (WNP-2) experienced power oscillations during startup. The WNP-2 operators recognized the oscillations and responded promptly, consistent with their procedures and training, to initiate a manual scram. The NRC evaluated this event, concluding that the primary cause of the oscillations was very skewed radial and bottom peaked axial power distributions due to insufficient procedural control of control rod removal patterns during power ascension. It was concluded from discussions with other licensees that similar procedural practices were not unusual for some other BWRs. The skewed power distributions make the core tend towards the "harder to detect" out-of-phase oscillation mode. The WNP-2 power distribution was inconsistent with the more normal operating conditions that have been associated with the experience-based stability exclusion boundaries, and was also inconsistent with the power distribution assumptions employed in the methodology for development of long-term solution exclusion region boundaries based only on power and flow parameters. The WNP-2 core design, consisting of a mixture of 9x9 and 8x8 fuel types which caused unbalanced flow and pressure drop characteristics, was also a contributor to uncertainty in its stability exclusion boundary. The WNP-2 event is described in NRC Information Notice 92-74, "Power Oscillations at Washington Nuclear Power Unit 2," dated November 10, 1992.

Most of the BWROG long-term solutions proposed in NEDO-31960 (Ref. 1) involve substantial modifications to the plant protection system hardware; these modifications are not expected to be ready for implementation until 1995-1996. The staff review of analytical studies in support of these solutions, the additional guidance provided by the BWROG, and the circumstances leading to the WNP-2 event, have identified the following items which are appropriate to enhance the effectiveness of the interim procedures and training, implemented in response to Bulletin 88-07, Supplement 1, until implementation of the long-term solutions can be accomplished:

- (1) Bulletin 88-07, Supplement 1, requested licensees of BWRs to take actions including a procedural requirement for a manual scram under all circumstances in which there are no recirculation pumps operating with the reactor in the RUN mode. This action was not applicable to plants with effective automatic scram protection against out-of-phase regional oscillations. Bulletin 88-07, Supplement 1 indicated that a flow-biased APRM scram circuit without a simulated thermal power monitor (filtered APRM signals) would provide such protection. However, more recent analyses by the BWROG show that the flow-biased APRM scram does not provide sufficient protection for the out-of-phase mode of instability, which can produce very large asymmetric oscillations before exceeding the average power scram setpoint. The need for protection against

out-of-phase oscillations remains under review for a few small core plants with small inlet orifices. Likewise, NRC plant-specific reviews are incomplete for the BWR2 plants, Oyster Creek and Nine Mile Point 1, to ensure the effectiveness of the quadrant based APRM scram protection provided for these plants. Therefore, prior to completion of reviews of the long-term solutions for individual plants, all plants are assumed to have ineffective scram protection against out-of-phase oscillations and should comply with the Bulletin 88-07, Supplement 1 requested procedural requirement for manual scram.

- (2) Bulletin 88-07, Supplement 1, endorsed the experience-based power/flow boundaries of the interim corrective actions based on the assumption that other factors important to the core stability characteristics (e.g., radial and axial peaking, feedwater temperature, and thermal-hydraulic compatibility of mixed fuel types) were consistent with previous experience and the bounding values expected during normal operation. The BWROG studies and the precautions recommended in the early 1992 letter to its members indicated that uncertainties existed in the definition of these boundaries (Ref. 4). The WNP-2 instability event and subsequent NRC evaluation determined that some licensees may have given inadequate attention to the impact on core stability of the reload core design and operating procedures for changing reactor power. The WNP-2 experience also highlighted the value of using on-line stability monitors as an operational aid to avoid unstable operation; the capability for on-line stability monitoring does not exist currently for most BWRs.

Requested Actions

1. All licensees of BWRs, except for Big Rock Point which does not have the capability for operation under variable flow conditions, are requested to review their current procedures and training programs and modify them as appropriate to strengthen the administrative provisions intended to avoid power oscillations or to detect and suppress them if they occur prior to implementation of the long-term solutions. The experience gained at WNP-2 should be a primary guide in this review. In doing this, each licensee of a BWR (except for Big Rock Point) should:
 - a. Ensure that procedural requirements exist for initiation of a manual scram under all operating conditions when all recirculation pumps trip (or there are no pumps operating) with the reactor in the RUN mode, and ensure that operators are aware of the potential for very large power oscillations and the potential for exceeding core thermal safety limits before automatic protection systems function following the trip of all recirculation pumps (the procedural manual scram is not necessary after long-term solutions are approved and implemented for individual plants); and
 - b. Ensure that factors important to core stability characteristics (e.g., radial and axial peaking, feedwater temperature, and thermal hydraulic compatibility of mixed fuel types) are controlled within appropriate limits consistent with the core design, power/flow

exclusion boundaries, and core monitoring capabilities of the reactor in question, and that these factors are controlled through procedures governing changes in reactor power, including startup and shutdown, particularly at low-flow operating conditions. Each licensee should review its procedures and determine if instability can be avoided by these procedures and if the procedures can be carried out using existing instrument information. If it is concluded that a near-term upgrade of core monitoring capability is called for to ease the burden on operators, determine the need to incorporate on-line stability monitoring or monitors for stability sensitive parameters and inform the NRC of the schedule and technical evaluation for such upgrades found to be necessary. (These procedural operation controls will no longer be necessary for licensees which implement fully automatic long-term solutions, such as Options III or IIIa of Reference 2. Licensees should propose for plant-specific review the administrative controls to be retained in conjunction with other long-term solutions.)

2. All licensees of BWRs, except for Big Rock Point, are requested to develop and submit to the NRC a plan for long-term stability corrective actions, including design specifications for any hardware modifications or additions to facilitate manual or automatic protective response needed to ensure that the plant is in compliance with General Design Criteria 10 and 12. An acceptable plan could provide for implementing one of the long-term stability solution options proposed by the BWROG and approved by the NRC in Reference 3 or in subsequent documentation. The plan should include a description of the action proposed and a schedule of any submittal requiring plant-specific design review and approval by the NRC and an installation schedule (if applicable). The plan should also address the need for near-term and long-term technical specification modifications. Generic BWROG documents or planned submittal may be referenced in the plan.

Reporting Requirements

Pursuant to Section 182a of the Atomic Energy Act of 1954, as amended, and 10 CFR 50.54(f), each holder of an operating license for a BWR, except for Big Rock Point, shall:

1. Within sixty (60) days of the date of this letter:
 - a. Inform the NRC, in writing and under oath or affirmation, of the licensee's plans and status with respect to the actions requested in this letter; and
 - b. If the licensee does not plan to take an action requested in this letter, the reasons for not taking the action, a description of the nature of any substitute action, and a schedule for completing or implementing the substitute action;
2. If the licensee plans to take an action requested, or a substitute action, within thirty (30) days of the completion of the action, inform

the NRC, in writing and under oath or affirmation, of the action taken and verify its completion or implementation.

Each submittal shall be addressed to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555. A copy shall also be submitted to the appropriate Regional Administrator.

This generic letter requires submittal of information that will enable the NRC to verify that the licensee is complying with its current licensing basis regarding GDC 10 and 12. Accordingly, an evaluation justifying this information request is not necessary under 10 CFR 50.54(f).

References

1. NEDO-31960, "BWR Owners' Group Long-Term Stability Solutions Licensing Methodology," June 1991.
2. NEDO-31960, Supplement 1, "BWR Owners' Group Long-Term Stability Solutions Licensing Methodology," March 1992.
3. Letter from A. Thadani, NRC, to L. A. England, Chairman, BWR Owners' Group, Acceptance for Referencing of Topical Reports NEDO-31960 and NEDO-31960, Supplement 1, "BWR Owners' Group Long-Term Stability Solutions Licensing Methodology," dated July 1993.
4. Letter from J. B. Martin, NRC, to A. L. Oxen, Washington Public Power Supply System, "NRC Augmented Inspection of Washington Nuclear Project, Unit 2", September 29, 1992.

Paperwork Reduction Act Statement

The information collections contained in this request are covered by the Office of Management and Budget clearance number 3150-0011, which expires September 30, 1994. The public reporting burden for this collection of information is estimated to average 300 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Information and Records Management Branch, (T-6 F33), U.S. Nuclear Regulatory Commission, Washington, D.C., 20555, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0011), Office of Management and Budget, Washington D.C. 20503.

Compliance with the following request for information is voluntary. The information would assist the NRC in evaluating the cost of complying with this generic letter.

- (1) the licensee staff time and costs to perform requested procedure reviews and implementation of changes;

- (2) the licensee staff time and costs to prepare the requested reports and documentation;
- (3) the additional short-term costs incurred to address the changes, such as the costs of the corrective actions or the costs of down time; and
- (4) an estimate of the additional long-term costs that will be incurred as a result of implementation commitments.

Backfit Discussion

This generic letter defines the requested actions and reporting requirements for all holders of operating licenses for BWRs, except for Big Rock Point, in order to enhance the current interim operating recommendations and to provide a long-term solution to the issue of thermal-hydraulic instabilities in BWRs. The staff has concluded that these requested actions are a backfit that is necessary to ensure compliance with GDC 10 and 12. The basis for the determination is stated in the preceding discussion of the generic letter (Background section). Accordingly, pursuant to 10 CFR 50.109(a)(4)(i), a backfit analysis is not required.

If you have any questions about this matter, please contact the technical contact listed below or the appropriate NRR project manager.


Roy P. Zimmerman
Associate Director for Projects
Office of Nuclear Reactor Regulation

Technical contact: Larry Phillips, NRR
(301) 504-3232

Attachment:
List of Recently Issued NRC Generic Letters

Attachment
GL 94-02
July 11, 1994
Page 1 of 1

LIST OF RECENTLY ISSUED GENERIC LETTERS

<u>Generic Letter</u>	<u>Subject</u>	<u>Date of Issuance</u>	<u>Issued To</u>
94-01	REMOVAL OF ACCELERATED TESTING AND SPECIAL REPORTING REQUIREMENTS FOR EMERGENCY DIESEL GENERATORS	05/31/94	ALL HOLDERS OF OLs FOR NPRs
86-10, SUPP. 1	FIRE ENDURANCE TEST ACCEPTANCE CRITERIA FOR FIRE BARRIER SYSTEMS USED TO SEPARATE REDUNDANT SAFE SHUTDOWN TRAINS WITHIN THE SAME FIRE AREA (SUPP. 1 TO GL 86-10, "IMPLEMENTATION OF FIRE PROTECTION REQUIREMENTS")	03/25/94	ALL HOLDERS OF OLs OR CPs FOR NPRs
89-10, SUPP. 6	INFORMATION ON SCHEDULE AND GROUPING, AND STAFF RESPONSES TO ADDITIONAL PUBLIC QUESTIONS	03/08/94	ALL LICENSEES OF OPERATING NUCLEAR POWER PLANTS AND HOLDERS OF CONSTRUCTION PERMITS FOR NPRs
93-08	RELOCATION OF TECHNICAL SPECIFICATION TABLES OF INSTRUMENT RESPONSE TIME LIMITS	12/29/93	ALL HOLDERS OF OLs FOR NPRs
93-07	MODIFICATION OF THE TECHNICAL SPECIFICATION ADMINISTRATIVE CONTROL REQUIREMENTS FOR EMERGENCY AND SECURITY PLANS	12/28/93	ALL HOLDERS OF OLs OR CPs FOR NPRs
93-06	RESEARCH RESULTS ON ON GENERIC SAFETY ISSUE 106, "PIPING AND THE USE OF HIGHLY COMBUSTIBLE GASES IN VITAL AREAS"	10/25/93	ALL HOLDERS OF OLs OR CPs FOR NPRs

OL = OPERATING LICENSE
CP = CONSTRUCTION PERMIT
NPR = NUCLEAR POWER REACTORS

- (2) the licensee staff time and costs to prepare the requested reports and documentation;
- (3) the additional short-term costs incurred to address the changes, such as the costs of the corrective actions or the costs of down time; and
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Original signed by

Roy P. Zimmerman
Associate Director for Projects
Office of Nuclear Reactor Regulation

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(301) 504-3232

Attachment:
List of Recently Issued NRC Generic Letters

Also See SECY 94-171
OGCB/DORS:NRR
Pwen PCW fEP
07/7/94 7/7/94

AC/OGCB/DORS:NRR
RDennig
07/7/94

DPR/DORS:NRR
BKGrimes
07/7/94

#2 7/1
ADPR RPZ
RPZimmerman
07/8/94

The staff intends to issue this generic letter approximately 10 working days after the date of this information paper.

Original signed by

James M. Taylor

James M. Taylor
Executive Director
for Operations

Enclosure filed in Jacket

Enclosure:

Proposed Generic Letter Titled "Long-Term Solutions and Upgrade of Interim Operating Recommendations for Thermal-Hydraulic Instabilities in Boiling Water Reactors"

*SEE PREVIOUS CONCURRENCE

OFFICE	OGCB/DORS*	SRXB/DSSA*	SC:SRXB/DSSA*	PM:PDII*	TECH ED*	AC:SRXB/DSSA*
NAME	PCWen	HRichings	LPhillips	PO'Connor	RSanders	TCollins
DATE	05/16/94	05/16/94	05/16/94	05/17/94	05/17/94	05/19/94
ADD:DSSA*	AD:DSSA*	OGC*	AC:OGCB/DORS*	D:DORS*	ADT:MRR	AADPR/NRR
RJones	MVirgilio	SLewis	RJKiessel	BKCrimes	ATHadaway	LRReyes
05/20/94	05/21/94	05/25/94	05/31/94	06/02/94	06/03/94	06/07/94

D:NRR WRussell	D:EDO JTaylorpr
06/01/94	06/01/94

DOCUMENT NAME: PWINSTB.COM

DOCUMENT NAME FOR THE GENERIC LETTER : PWINSTB.GL