



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2 AND 3

DOCKET NOS. 50-259/260/296

INTERGRANULAR STRESS CORROSION CRACKING IN THE REACTOR

COOLANT PRESSURE BOUNDARY PIPING SYSTEMS

1.0 Introduction

Cracking in austenitic stainless steel piping in BWRs has been observed since 1960 and has been addressed by a continuing set of actions to reduce the intergranular stress corrosion cracking (IGSCC) in the piping of the nuclear power plants.

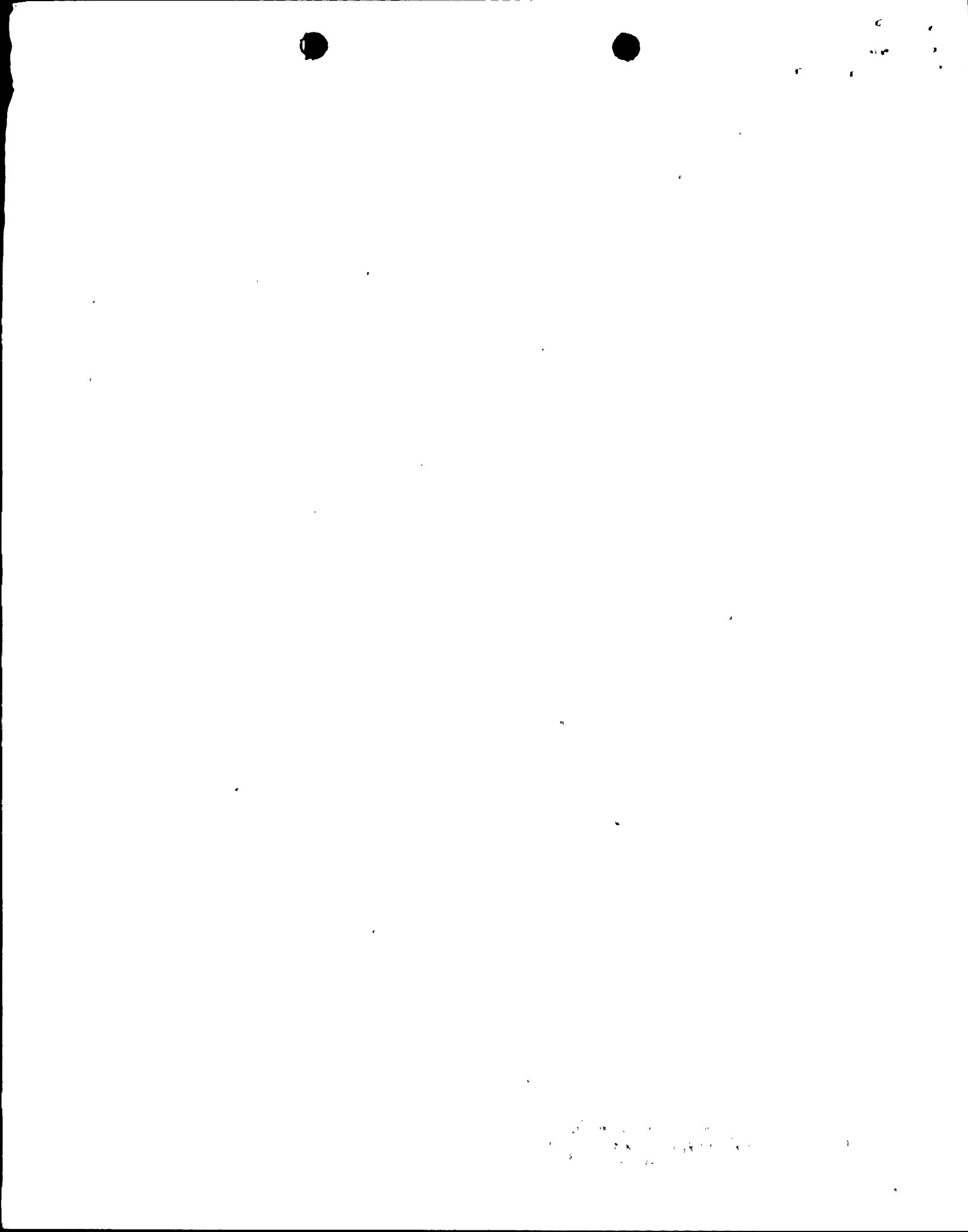
By Generic Letter 81-04 dated February 26, 1981, the NRC transmitted to all BWR licensees NUREG-0313, Revision 1, "Technical Report on Material Selection and Processing Guidelines for BWR Coolant Pressure Boundary Piping," dated July 1980. NUREG-0313, Revision 1 identifies the NRC staff's guidelines to implement the technical recommendations made in NUREG-0531, "Investigation and Evaluation of Stress Corrosion Cracking in Piping of Light Water Reactor Plants," by the NRC Pipe Crack Study Group (PCSG).

NUREG-0313, Revision 1 sets forth the NRC staff's revised acceptable methods to minimize IGSCC of BWR ASME Code Class 1, 2 and 3 pressure boundary piping and safe ends and presents material selection criteria, testing and processing guidelines, augmented inservice inspection and leakage limits and monitoring requirements for these piping systems.

The Generic Letter requested each licensee to review all ASME Code Class 1 and 2 pressure boundary piping, safe ends, and fitting materials, including the weld metal to determine the degree of compliance with the guidelines in NUREG-0313, Revision 1. The generic letter offered the option of providing a description, schedule and justification for alternative actions that would reduce the susceptibility of pressure boundary piping and safe ends to IGSCC.

The NRC staff contracted with EG&G to evaluate the licensee's (Tennessee Valley Authority) submittals in response to Generic Letter 81-04. The results of EG&G's evaluation are documented in the attached Technical Evaluation Report (TER). EG&G was instructed to determine whether or not the licensee's responses were in compliance with the guidelines in NUREG-0313, Revision 1, but EG&G was not asked to evaluate the licensee's proposed alternatives because it was anticipated that most

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of the guidelines (with the exception of leak detection requirements) would be altered in the on-going revision of NUREG-0313. EG&G concluded that the licensee's responses did not fully meet NUREG-0313, Revision 1 guidelines.

Subsequent to the issuance of the Generic Letter 81-04 for implementing NUREG-0313, Revision 1, extensive pipe cracking in the large diameter recirculation pipes was reported for the first time in Nine Mile Point, Unit 1. Prior to this time, pipe cracking was reported predominantly in the small diameter pipes. NRC issued IE Bulletin 82-03, Revision 1, dated October 1982 to nine (9) BWR plants scheduled for refueling outages in late 1982 and early 1983. Bulletin 82-03, Revision 2 requested the affected licensees to ultrasonically examine the piping welds in the recirculation system using the ultrasonic test (UT) procedures which were satisfactorily demonstrated on service-induced cracked samples. After five (5) of the seven (7) plants inspected under IE Bulletin 82-03 reported IGSCC pipe cracks in the recirculation system, NRC issued IE Bulletin 83-02 in March 1983 to the licensees of the other 14 operating BWR power plants. Bulletin 83-02 requested the affected licensees to inspect a minimum of 22 welds in the recirculation piping system with the UT capabilities to be demonstrated at EPRI NDE Center, Charlotte, North Carolina. In August 1983, confirmatory orders were issued to five (5) operating BWR plants not yet inspected for early shutdown and inspection, because there was concern that some of the plants might be operating with extensively cracked pipes. The confirmatory orders mandated that the licensees ultrasonically inspect 100% of Class 1 nonconforming welds in the recirculation, residual heat removal (RHR), core spray (CS) and reactor water clean-up (RWCU) systems. Out of the 23 operating BWR plants inspected under the IE Bulletins 82-03 and 83-02 and the confirmatory orders, IGSCC pipe cracking was reported in 19 plants.

Because of the extensive stress corrosion cracking in the recirculation and RHR piping systems in the operating BWRs, a revision of NUREG-0313, Revision 1 was initiated. A draft of NUREG-0313, Revision 2 has recently been completed and is currently being reviewed within NRC and by our consultants. The proposed NUREG-0313, Revision 2 incorporates many changes, including UT performance demonstration tests for qualifying UT examiners and procedures, upgraded augmented inservice inspection requirements and schedules, and criteria for flaw evaluation and repair. These changes are considered necessary to provide assurance of piping integrity.

2.0 Evaluation

The licensee's submittals in response to NRC's Generic Letter 81-04, dated February 28, 1981, regarding its implementation of NUREG-0313, Revision 1 were evaluated by our contractor, EG&G. The results of its evaluation were documented in the attached TER. We have reviewed EG&G's TER and concur with its evaluation that the licensee's responses did not fully meet the

guidelines set forth in NUREG-0313, Revision 1. In the TER, EG&G identified several areas of discrepancies (both minor and major) in the licensee's responses. EG&G also identified areas where a proper evaluation of the response cannot be made because adequate information was not provided. EG&G indicated that the licensee's responses have the following major discrepancies:

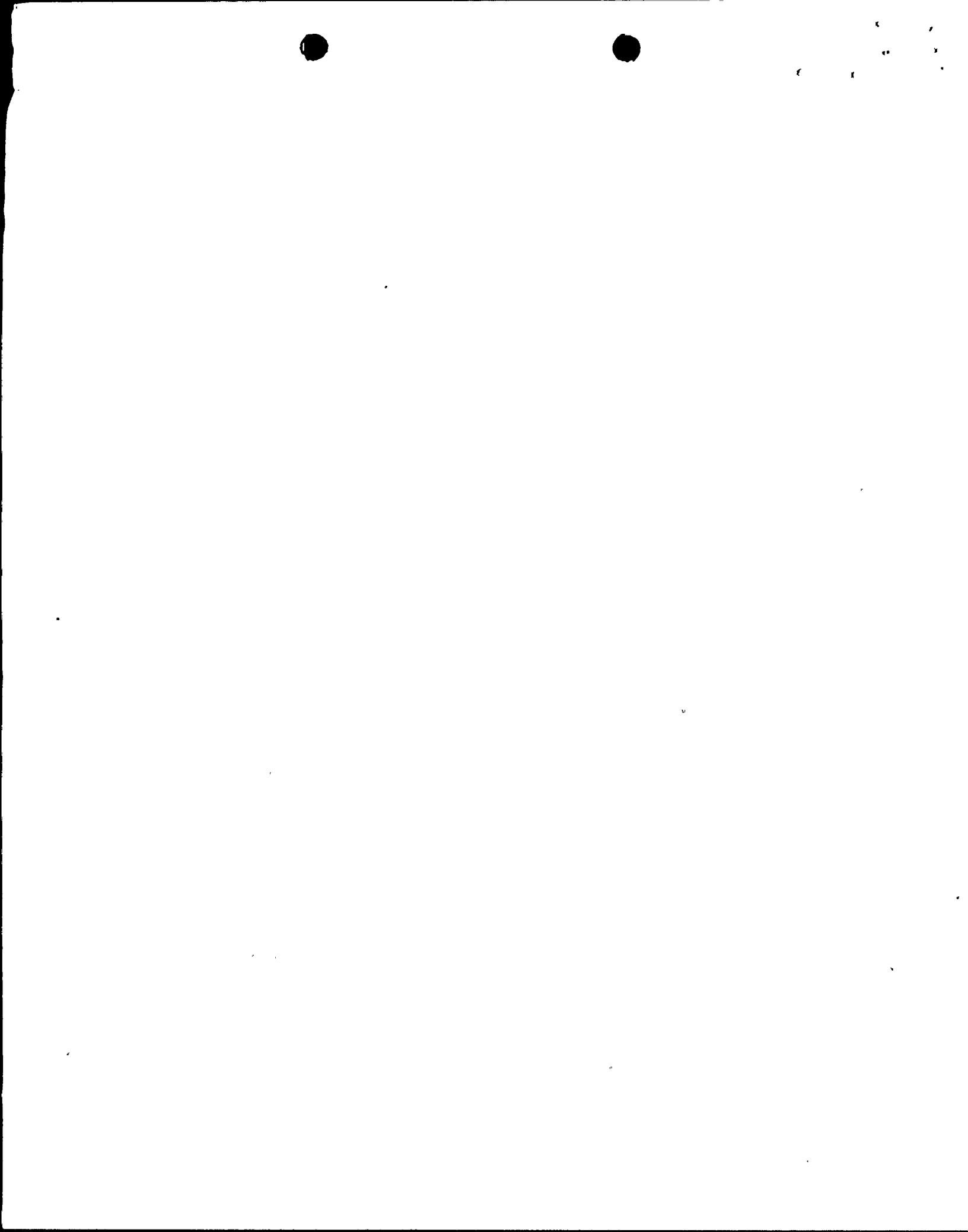
- (1) The licensee's description of leak detection methods are not detailed enough to determine whether they meet Section C of Regulatory Guide 1.45.
- (2) The licensee has not put the provisions for shutdown after a 2-gpm increase in unidentified leakage in 24 hours and for monitoring the sump level at 4-hour intervals (or less) into the Technical Specifications.

However, subsequent to issuance of the TER, the Commission issued Amendment Nos. 94, 87 and 60 to Facility Operating License Nos. DPR-33, DPR-52 and DPR-68 for the Browns Ferry Nuclear Plant, Units 1, 2 and 3. These amendments changed the Technical Specifications to add more stringent requirements on allowable primary coolant leakage into the drywell. These amendments satisfactorily resolved the discrepancies on leak detection and monitoring of unidentified leakage.

In view of the industry-wide experience in the IGSCC pipe cracking, we understand that the licensee's plans to address this issue may have been substantially revised. Furthermore, we are currently revising NUREG-0313, Revision 1 to reflect the lessons learned from recent pipe cracking experiences. Although many of the guidelines in NUREG-0313, Revision 1 will become obsolete, we do not anticipate changes in augmented leak detection and monitoring requirements.

Based on the recent pipe cracking experiences in the operating BWRs and the IGSCC related analytical and experimental work, we are reasonably certain that the growth of IGSCC cracks in the piping is slow and even if the cracks are assumed to grow through the wall, pipe leakage will occur rather than rupture. Browns Ferry units were inspected under either IE Bulletin (82-03 or 83-02) or a Confirmatory Order. Extensive cracking was found in Unit 1. Following satisfactory repairs, an Order and Amendment were issued in December 1983 authorizing return to power. Unit 2 found cracks in the manifold to sweepolet welds but no repairs were required. Unit 3, which is currently down for modifications, found no indications of cracks in the recirculation, RHR, RWCU or core spray piping.

For future operation of BWR plants with susceptible piping beyond their present fuel cycle, we proposed a short term program for reinspection of BWR piping and repair of cracked piping in the Commission Paper SECY-83-267C dated November 7, 1983. The proposed program was based on



the input from industry, NRC experts, and their consultants, and was reviewed by the Committee to Review Generic Requirements (CRGR), and the Commission. The principal elements of this Commission Paper are contained in Generic Letter 84-11 dated April 19, 1984. Therefore, in the short term, prior to the licensee's completion of the piping replacement program or of a long term fix program acceptable to NRC, the required reinspection and repair at each refuel outage should be in accordance with guidelines delineated in Generic Letter 84-11.

Should the licensee opt for undertaking a complete replacement of susceptible piping as a longer term fix, a Procedural Guidance for pipe replacement at BWRs is provided in NRC Generic Letter 84-07, dated March 14, 1984.

3.0 Conclusion

Based on a review of our contractor's evaluation, we conclude that the licensee's responses to reduce the IGSCC susceptibility of the austenitic stainless steel piping in their Browns Ferry units did not fully meet the guidelines set forth in NUREG-0313, Revision 1. However, because of the recent industry-wide experience and the other current industry-wide activities to mitigate the IGSCC (including the inspection conducted in responses to regulatory actions; e.g., Bulletins 82-03, 83-02 and the confirmatory orders) that are not reflected in the licensee's responses, we conclude that the question regarding whether or not NUREG-0313, Revision 1 guidelines are being met is moot at this time. Further staff actions will depend upon the licensee's response to Generic Letter 84-07 and 84-11.