NUREG/CR-3052

Closeout of IE Bulletin 80-07: BWR Jet Pump Assembly Failure

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PARAMETER, Inc.

Prepared for
U.S. Nuclear Regulatory
Commission

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ABSTRACT

In February 1980, disassembly of a jet pump at Dresden 3 was diagnosed from changes in operating parameters. After prompt shutdown, it was found that a broken hold-down beam had caused the failure and that six other beams had small cracks. In March 1980, one cracked beam at Quad Cities 2 and three at Pilgrim 1 were discovered, and an earlier pump failure at a foreign facility was found to be like that at Dresden 3. IE Bulletin 80-07 was issued April 4, 1980 to licensees of all General Electric BWR/3 and BWR/4 operating facilities to require daily operability surveillance of jet pumps and nondestructive examinations every refueling outage. The bulletin was issued for information to holders of construction permits for General Electric facilities; later, 13 of these facilities were selected for written responses. Extensive studies led to the conclusion that failures were caused by very slowly progressing stress corrosion cracking, and resulted in manufacture of improved beams. Bulletin status is determined by applying closeout criteria. Closeout of bulletin Item B.2 requiring operability surveillance is based on the short-term action of implementing an acceptable method and the long-term action of continuing that method until satisfactory corrective action has been completed. Followup items are suggested for all 20 operating facilities to ensure compliance with bulletin requirements and intent. The safety significance of a jet pump failure is that flow distribution would be affected during normal operation and the water level in the core region would decrease during a coincidental loss of cooling accident.

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CLOSEOUT OF IE BULLETIN 80-07: BWR JET PUMP ASSEMBLY FAILURE

INTRODUCTION

In accordance with the Statement of Work in Task Order 12 under Contract NRC-05-80-251 and Task Order 51 under Contract NRC-05-82-249, this report provides documentation for the closeout status of IE Bulletin 80-07. The following documentation is based on the records obtained from the NRC Central File, the IE File, the NRC Document Control System and the cognizant engineer's file.

IE Bulletin 80-07 was issued as a result of a BWR jet pump failure and disassembly occurrence at Dresden 3. The hold-down beams for the jet pump developed cracks due to intergranular stress corrosion which progressed through the beam until it failed. Subsequent visual and ultrasonic examinations of the other hold-down beams at Dresden 3 and several other facilities found more such cracks.

The purpose of the bulletin was to initiate visual and UT examinations of hold-down beams in all operating jet pump BWRs, and to have cracked beams replaced to avoid other similar failures. In addition, the collection of response data was to determine the extent of the problem in jet pump BWRs. The bulletin also required initiation of improved surveillance procedures to predict potential beam failures before they occur, and to ensure timely detection in case of actual failure.

The purposes of this report are to determine the closeout status of the bulletin for all facilities to which it applies, to point out remaining areas of concern, and to propose followup items.

The results of Task Order 51 are reported separately in Appendix D and are incorporated in the main body of this report. This task order was issued to reevaluate licensees' conformance with the requirements of bulletin Item B.2. In brief, this item calls for surveillance of specified jet pump parameters daily until plant technical specifications are revised or the causes of beam failures are determined and corrected.

Appendix A includes a copy of the bulletin and additional background information. Appendices B, C and E contain documentation of bulletin closeout, proposed followup items and abbreviations, respectively.

ACTIONS REQUIRED BY IE BULLETIN 80-07

The bulletin was issued to all jet pump BWR facilities with operating licenses or construction permits. Response in writing was required of all facilities with operating licenses, and of 13 selected facilities with construction permits. Actions required of facilities with operating licenses are listed in the copy of the bulletin included in Appendix A of this report.

INFORMATION REQUESTED BY DIVISION OF LICENSING
FROM PLANTS WITH CONSTRUCTION PERMITS

To aid in licensing review of BWRs, requests were sent to 13 selected construction permit holders for the following information (Reference 3, Page B-4):

1. Describe those actions being taken to preclude the occurrence of cracking such as described in IE Bulletin 80-07.

2. Provide a commitment to adopt whatever long-term solution is approved.

3. For BWRs which anticipate receiving an operating license before a long-term solution is agreed upon, describe any short-term actions to be taken to prevent or detect excessive cracking. Provide a rationale as to why these actions are sufficient to justify plant operation until a long-term solution is found.

CRITERIA FOR CLOSEOUT OF IE BULLETIN 80-07
(See Tables B.1, B.2 and D.1)

The Bulletin is CLOSED for facilities that satisfy one of the following criteria:

1. Facilities which have been cancelled, for which construction has been deferred for an indefinite time, or which have been shut down for an indefinite time.

2. Facilities for which examination as requested shows no cracked jet pump beams or unusually worn jet pump components, the surveillance program requested by the bulletin or acceptable alternate has been implemented, and all this has been confirmed by an inspection report.

NOTE: a) The GE SIL #330 Operability Surveillance Method is an acceptable alternate to the method described in bulletin Item B.2.

b) Refer to Page D-3 for details about closeout of bulletin Item B.2 on operability surveillance.

3. Facilities that provided an acceptable response that commits to a satisfactory solution to the problem, and for which there is definite indication that the progress of the solution will be tracked by some other NRC control system, such as the LER reporting system.

4. Facilities that provided an acceptable response (not required for facilities under construction) and an inspection report provides documentation that satisfactory corrective action has been completed.

NOTE: Replacement of all original hold-down beams with new BWR/4-6 beams with revised heat treatment and reduced preload is the most satisfactory corrective action.

5. Facilities under construction since the licensing review procedure will cover the subject of jet pump beam adequacy.

SUMMARY

IE Bulletin 80-07 was issued to BWR units having jet pumps. The bulletin required written response from operating units, and required no written response from units under construction. Later, the Division of Licensing requested 13 selected units with construction permits to respond in writing.

Responses were found for all of the 20 units with operating licenses. Table B.1 in Appendix B summarizes the responses for each of these units. All responses indicated compliance with the bulletin requirement for jet pump operability surveillance and operator training. In all operating units where cracked beams were found, the cracked beams but not necessarily all beams were replaced.

Of the 20 units with operating licenses, eight are BWR/3s, and 12 are BWR/4s. Cracks were found in beams in all BWR/3 reactors except Monticello and Quad Cities 1. Only one beam with UT indications was found in a BWR/4 reactor (Peach Bottom 3).

Closed or open bulletin status, as indicated in Table B.1 for units with operating licenses, is determined by applying the closeout criteria to each facility response. For the 20 facilities with operating licenses, bulletin status is closed

for 16 and remains open for four. Two facilities with open status are BWR/3s (Dresden 2 and Quad Cities 1), and two are BWR/4s (Peach Bottom 2 and 3). Refer to Appendix C for the specific reasons for the open bulletin status for each of these facilities.

The 27 BWR units with construction permits at the time that the bulletin was issued are listed in Table B.2 in Appendix B. Of these, 13 were requested to respond in writing by special letters issued by the Division of Licensing. The letters requested the information listed in a preceding section of this report. Responses were found for eight of these 13 requests. Inspection reports, and a response in answer to one of them, provided information about one other (Shoreham). The bulletin status for 15 units is closed per Criterion 5, and is closed per Criterion 1 for the remaining 12.

The closeout status of bulletin Item B.2 requiring daily operability surveillance is reported separately in Appendix D. It is shown that bulletin Item B.2 has served its intended purpose and can be closed out for all affected facilities.

As stated in Appendix D, the GE SIL #330 Alternatives A and B and the Technical Specification Type 3 are acceptable to satisfy bulletin Item B.2. The review of operability surveillance is summarized on Page D-2. The Type 3 Specification is described on Page D-11.

REMAINING AREAS OF CONCERN

Even though the bulletin can be closed out for all affected facilities, followup items for all 20 operating units to which it was issued are presented in Appendix C because of the following needs:

1. Flow monitoring surveillance on a daily basis is to be continued until improved beams have been installed or technical specifications have been revised.

2. Original BWR/3 and BWR/4-6 beams are to be scheduled for periodic ultrasonic examination, whether or not preload has been reduced.

3. All beams are to be scheduled for inservice inspection at intervals of ten years.

RECOMMENDED ACTIONS FOR LONG-TERM
RESOLUTION OF THE JET PUMP PROBLEM

The following long-term actions are recommended in order to ensure dependable performance of jet pump beam assemblies:

1. Change plant procedures and schedule NRC inspections to ensure that approved operability surveillance will be continued until (a) the plant technical specifications have been revised as necessary per bulletin Item B.2 or (b) all original hold-down beams have been replaced with improved BWR/4-6 beams with new heat treatment and 25 kips preload.

2. Continue approved visual examination (with TV camera) and ultrasonic examination of BWR/3 beams (with 25 kips preload) and original BWR/4-6 beams with 30 kips preload every refueling outage.

3. Perform approved ultrasonic examination of original BWR/4-6 beams with reduced preload of 25 kips five years after installation and subsequently at intervals of two years.

4. Schedule inservice inspection of improved BWR/4-6 beams with new heat treatment and 25 kips preload at intervals of ten years.

5. Replace cracked beams before resuming operation.

NOTE: (a) Followup is suggested to verify that these recommended long-term actions are performed satisfactorily. Followup items are suggested specifically in Appendix C for each of the 20 affected operating facilities, which are grouped by NRC region.

(b) The following methods of operability surveillance have been approved:

1. Bulletin Item B.2.b
2. Technical Specification Type 3, which is described on Page D-11
3. General Electric SIL #330, either Alternative A or B.

Referring to Appendix D, note that Technical Specifications Types 1 and 2 have been found to be unacceptable.

(c) Plant technical specifications may have to be revised to ensure performance of recommended long-term actions 2, 3 and 4.

CONCLUSION

The review made for this report of all licensee responses and of inspection reports indicates the bulletin has been successful in significantly reducing the chances of a recurrence of a jet pump failure due to cracking of hold-down beams. This success is attributable to the complete licensee compliance to ultrasonic examination of the beams and initiation of jet pump surveillance programs as requested by the bulletin. This conclusion is reinforced by the presentation of followup items for 20 operating facilities in Appendix C for further action. In addition, actions for long-term resolution of the jet pump problem are recommended to guide followup action.

APPENDIX A

Background Information

SSINS No.: 6820
Accession No.:
8002280648

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT
WASHINGTON, D.C. 20555

April 4, 1980

IE Bulletin No. 80-07

BWR JET PUMP ASSEMBLY FAILURE

Description of Circumstances:

On February 2, 1980, Commonwealth Edison Company (CECo) reported that a jet pump failed in Dresden Unit 3 while operating at about 67 percent of full power in a coastdown mode to a refueling shutdown. Observed changes in plant parameters during the event indicated an individual jet pump failure had occurred. In accordance with T.S., an orderly plant shutdown was begun to bring the unit to cold shutdown within 24 hours.

The plant parameter changes reported by the licensee were (1) generator electrical output decreased from 539 to 511 MW electrical, (2) core thermal power decreased as indicated by decreased APRM readings and steam flow to the turbine, (3) indicated total core flow increased from 97.6 to 104.7 x 10^6 lb./hr., (4) core plate differential pressure decreased from 16.1 to 13.8 psid., and (5) B recirculation loop flow increased from 49 to 54 x 10^3 gpm while A recirculation loop flow remained at 49 x 10^3 gpm. These changes were readily observed by the operator in the control room and it was postulated that a jet pump had failed. Individual jet pump readings were taken, the jet pump operability surveillance was performed, and an apparent failure of jet pump No. 13 was determined.

Following vessel head removal and defueling, TV camera and visual inspections of the jet pumps and vessel annulus revealed the hold-down beam assembly of the suspect jet pump had broken across its ligament sections at the mean diameter of the bolt thread area. Failure of the beam assembly resulted in pump decoupling at the diffuser connection. Subsequent insitu ultrasonic examination of all other jet pump hold-down beams, using a special UT technique developed by General Electric revealed ultrasonic indications of cracking at the same location in 6 of the remaining 19 beams examined. Initial estimates of crack depth ranged from 6 to 20 mils. A sketch of the typical jet pump assembly is shown in figures 1 and 2.

On March 15-16, 1980, insitu ultrasonic examination was performed on all 20 jet pump hold-down beam assemblies at Quad Cities 2 (currently shutdown for refueling). One beam was found to contain a crack indication estimated to be in excess of 100 mils depth in the same location on the beam as found at Dresden.

On March 28, 1980, Boston Edison reported that ultrasonic examination revealed crack indications in three (3) hold-down beam assemblies at Pilgrim Unit 1.

The beam assemblies having crack indications are scheduled for replacement during the current refueling outage of the above units. A metallurgical analysis has been initiated by GE to determine the probable cause(s) of the cracking.

General Electric notified utilities having operating BWR units with jet pumps of this potential problem on March 17 and 18, 1980. The NRC staff was advised on March 19, 1980 as to the actions being taken by GE in this regard. The staff was also notified of a hold-down beam failure experienced at a foreign BWR facility.

On the basis of information provided by General Electric and the recent experience at Dresden Unit 3, Quad Cities Unit 2 and Pilgrim Unit 1, concern arises that the hold-down beam assemblies and subsequent jet pump function may degrade significantly during operation. This potential for degradation could lead to jet pump disassembly and possibly reduce the margin of safety during postulated accidents.

The following actions are to be taken by licensees of GE designed BWR-3 and BWR-4 facilities with operating licenses:

A. Plants Now in Scheduled Refueling Outage Prior to Restart

1. Visual inspections assisted by TV camera shall be conducted to assess the integrity of the jet pump structures, the hold-down beam assembly, hold-downs, wedge and restrainer assembly. Particular attention should be given to areas of unusual wear, failed keeper welds or other evidence of distress that could be indicative of loss of beam assembly preload.

2. Ultrasonic examinations, utilizing GE procedure TP-508.0642 (Rev. A) or equivalent, shall be conducted to assess the integrity of the jet pump hold-down beams at the mid length ligament areas bounding the beam bolt.

3. Upon completion of the inspections required by paragraph 1 and 2 above, the appropriate NRC regional office shall be promptly notified, followed by a 14 day written report, on the results of the inspections including any deficiencies thus identified and corrective actions taken.

4. When startup for power operation begins, the surveillance described in Item B.2 shall be initiated.

B. Plants Currently Operating or Resuming Operations

1. The NRC staff has determined that the operating plants warrant inspection as required by paragraph 1 and 2 above. Therefore, licensees are requested to provide within 30 days of receipt of this

bulletin, written justification for any continued operation until these inspections are made and any defects thus identified are corrected.

2. For plants intending to justify continued operations or resume operation, the following surveillance, if not already performed, shall be initiated within 10 days after receipt of this bulletin and shall be continued until the plant technical specifications are revised or the cause of beam failure has been identified and corrected. This surveillance should improve the ability of the plant to identify an early indication of jet pump degradation or failure. Individual jet pump differential pressure readings should be recorded and used to establish a data base for expected characteristics for each jet pump. Periodic surveillance readings and individual jet pump trends when evaluated against this data base should assist in providing indication of jet pump degradation and supplement other conditions checked to determine jet pump operability.

   a. Prepare the necessary procedures and perform jet pump operability surveillance including the items specified in b. below on a daily basis, and following recirculation pump restart, and following unexpected changes observed in core flow indications, recirculation system flow indications, or established power-core flow relationships.

   b. If any of the following deviations occur during surveillance, evaluate and record the reason:

      (1) The recirculation pump flow differs by more than 10% from the established speed-flow characteristics for that pump.

      (2) The indicated total core flow is more than 10% greater than the core flow value derived from established power-core flow relationships.

      (3) The diffuser to lower plenum differential pressure reading on an individual jet pump exceeds the expected characteristics established for that pump (8.2 above).

3. If it is determined that a jet pump is inoperable or significantly degraded, the reactor shall be shutdown in accordance with technical specification requirements.

4. Review your procedures for instructing plant operators regarding identification and response to sudden individual jet pump failure. Revise procedures as required and instruct operating staff of any changes.

C. Reporting Requirements

The information in Items A.3, and B.1, is requested under the provisions of 10 CFR 50.54 (f). Accordingly, you are requested to provide within the time periods specified in these items, written statements of this information, signed under oath or affirmation.

Approved by GAO, B180225 (R0072); clearance expires 7-31-80. Approval was given under a blanket clearance specifically for identified generic problems.

Attachments:
Figures 1 and 2
Jet Pump Sketches

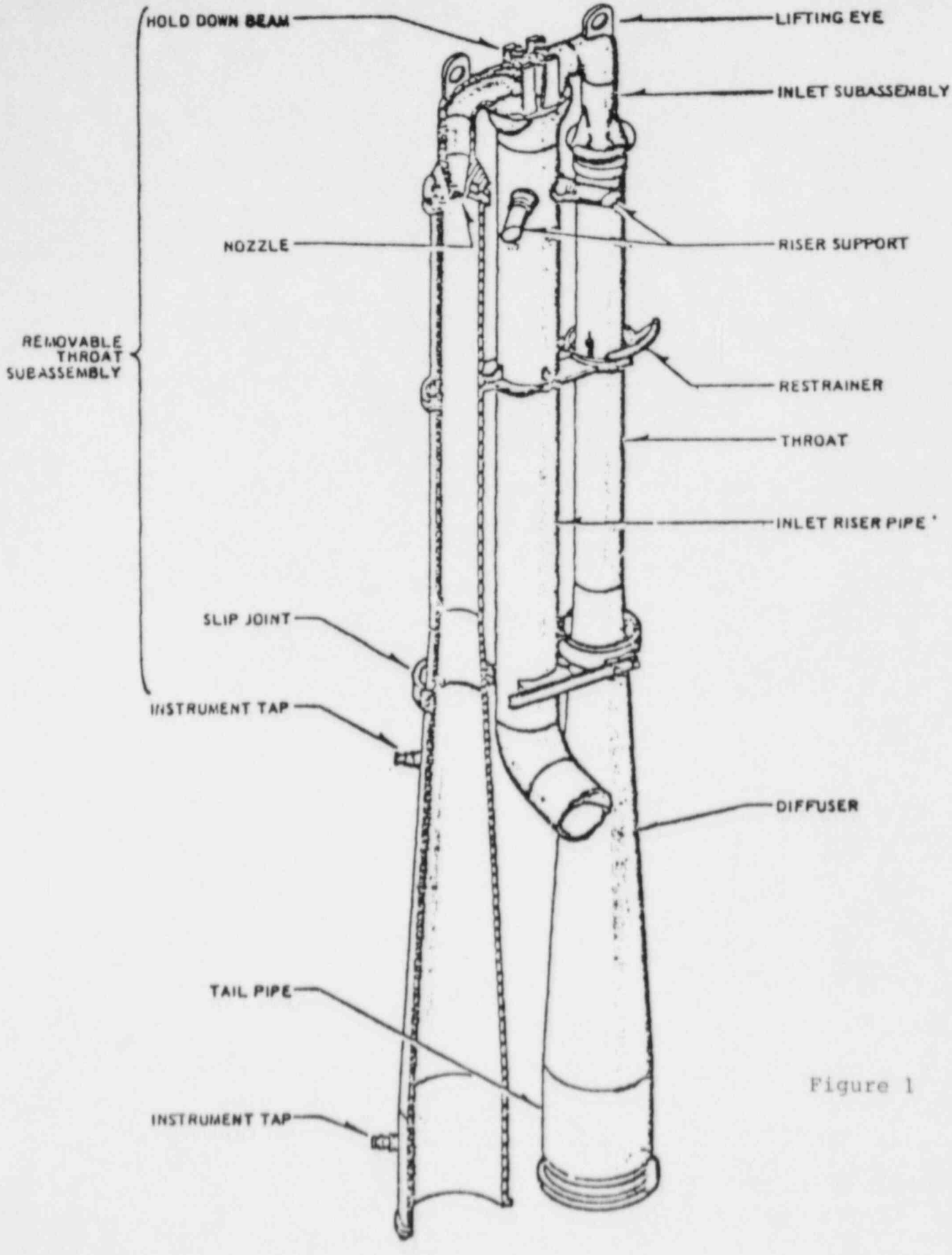
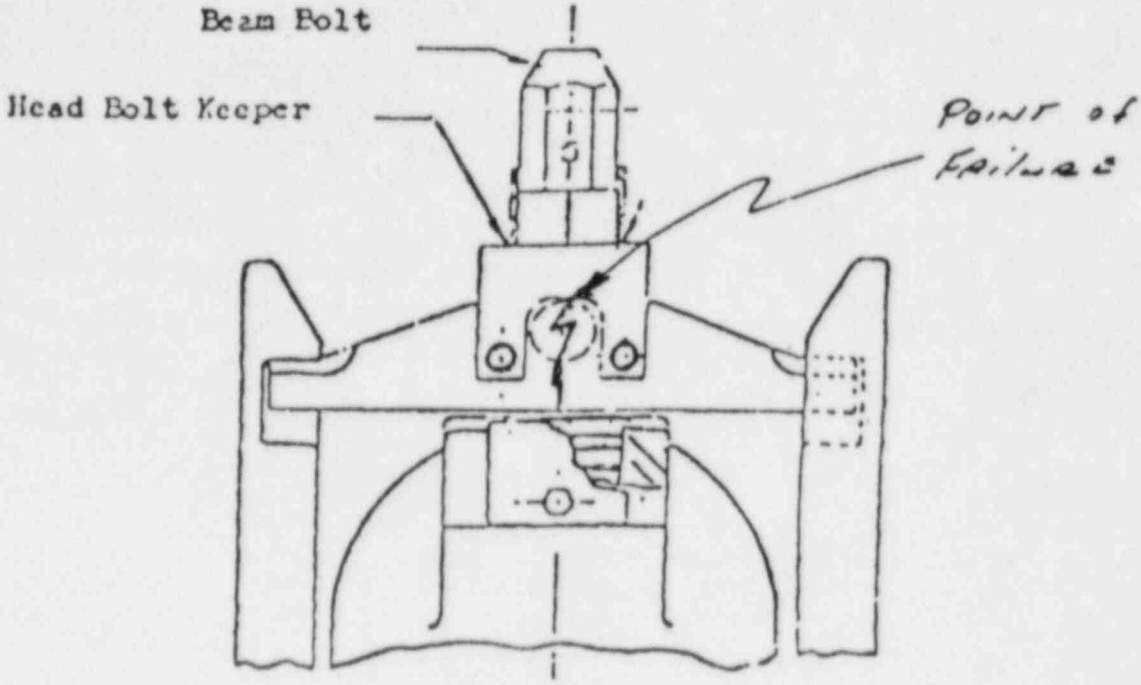

HOLD DOWN BEAM
LIFTING EYE
INLET SUBASSEMBLY
NOZZLE
RISER SUPPORT
REMOVABLE THROAT SUBASSEMBLY
RESTRAINER
THROAT
INLET RISER PIPE
SLIP JOINT
INSTRUMENT TAP
DIFFUSER
TAIL PIPE
INSTRUMENT TAP

Figure 1



Jet Pump Beam Details

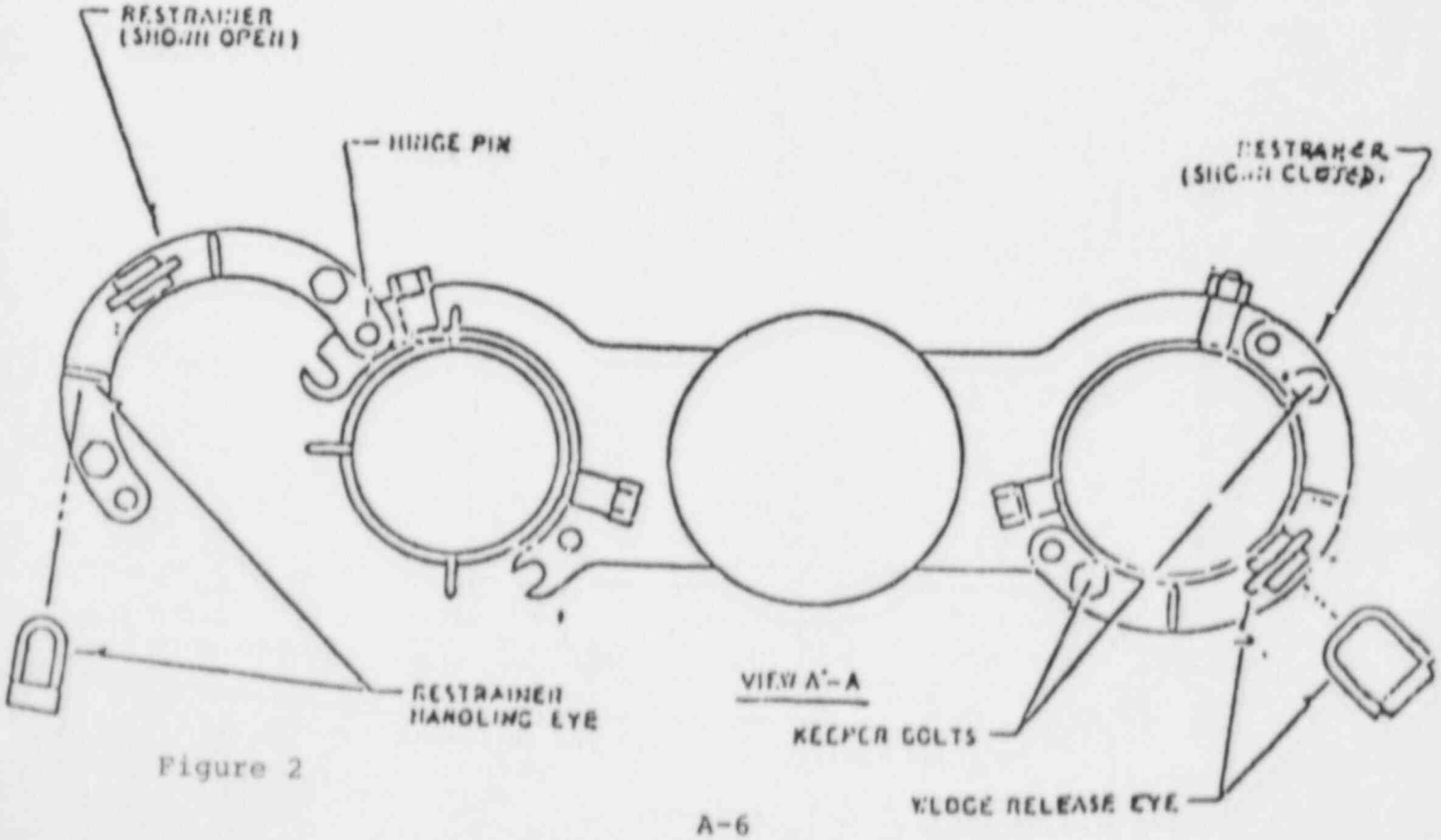


Figure 2

BACKGROUND

In February 1980 a jet pump hold-down beam failed at Dresden 3 resulting in jet pump disassembly which caused an orderly plant shutdown. Subsequent visual inspection by TV camera and ultrasonic examination, conducted at the direction of General Electric, disclosed that hold-down beams on other jet pumps at Dresden 3, Quad Cities 2 and Pilgrim contained cracks in the ligament zone at the center of the beams. Investigation determined that these cracks were caused by intergranular stress corrosion, which in the case of these jet pump beams, progressed very slowly over a period of years.

The jet pumps are essential to efficient normal operation for GE BWR/3 and later reactors, in that they increase core flow over that provided by the recirculation loop pumps by the jet pump action of adding in-vessel recirculation. This results in an increase of reactor output capacity over that produced by boiling water reactors without jet pumps.

Construction of the jet pumps is such that they can be disassembled remotely for inservice inspection. The hold-down beam and its bolting arrangement are shown in Figures 1 and 2 of the bulletin (Appendix A). The break which occurred at Dresden 3 allowed the inlet mixer section to lift off causing pump section decoupling, severly impairing the jet pump functional ability. Unbalanced jet pump loop flow and reduced core flow occur as a result of pump disassembly. Also, loss of preload and excessive deflection of the hold-down beam allow changes in indicated flow in the pump and recirculation loop which can be detected, as found by GE studies, as the beam cracks progress, and before complete failure of the beam occurs. In other words, indicated flow readings can be used to predict failure before it occurs and as in the case of Dresden 3, can be used to diagnose jet pump disassembly when it occurs.

The resultant reduction in core flow capacity which occurs with a jet pump failure could reduce the margin of safety for emergency core cooling for postulated accidents. On this basis, such an occurrence is judged safety-related, and of enough concern to warrant the issue of a bulletin.

IE Bulletin 80-07 was issued to all operating BWR/3s and BWR/4s to initiate daily surveillance of jet pump and recirculation loop flow, if not already performed. The bulletin also required visual inspection and UT examination of the jet pump hold-down assemblies in all operating plants, either during current shutdown, or at the next shutdown, with justification for continued operation for those not in a current state of shutdown. BWR facilities with construction permits received the

bulletin but were not required to respond in writing. Later, the Division of Licensing requested written responses from 13 selected facilities with construction permits.

Meanwhile, studies were being conducted under supervision of General Electric concerning the nature of the beam cracking and its relationship to design and operating life. Results of these studies are reflected in the utility responses to the bulletin regarding continued plant operation and decisions concerning action to correct the overall problem.

Initially, Task Order Number 12 was issued to provide guidance for the documentation of bulletin closeout. Later, Task Order Number 51 was issued to require special attention to bulletin Items B.2, B.3 and B.4 about continuing operability surveillance, requirements for reactor shutdown and review of plant procdures.

APPENDIX B

Documentation of Bulletin Closeout

TABLE B.1 SUMMARY OF UTILITY RESPONSES AND INSPECTION REPORTS, 20 OPERATING FACILITIES

Facility	Utility	Docket Number	NRC Reg.	BWR/3 or BWR/4	Utility Response Date	Number of Beams Cracked	Verifying Inspection Report	Bulletin Status and Criterion
Browns Ferry 1	TVA	50-259	II	4	05/07/80 05/21/81	0	81-36, 12/31/81 83-28, 08/29/83 84-16, 06/01/84	Closed 4
Browns Ferry 2	TVA	50-260	II	4	05/07/80 10/03/80	0	81-36, 12/31/81 84-16, 06/01/84	Closed 4
Browns Ferry 3	TVA	50-296	II	4	05/07/80 12/30/80	0	81-36, 12/31/81	Closed 2
Brunswick 1	CP&L	50-325	II	4	04/24/80	0	81-10, 06/22/81	Closed 2
Brunswick 2	CP&L	50-324	II	4	04/24/80 07/15/80	0	81-10, 06/22/81	Closed 2
Cooper Station	NPPD	50-298	IV	4	05/05/80 05/21/80	0	80-09, 07/09/80	Closed 2
Dresden 2	CECO	50-237	III	3	04/23/80 05/09/80 08/05/80	2	81-01, 02/12/81	Open
Dresden 3	CECO	50-249	III	3	04/23/80 05/09/80 08/05/80	6* **	81-07, 05/07/81	Closed 4
Duane Arnold	IELPCO	50-331	III	4	04/18/80	0	80-19, 11/12/80	Closed 2
FitzPatrick	PASNY	50-333	I	4	05/07/80 10/13/81 10/15/82	0	81-06, 03/23/81 81-24, 11/13/81	Closed 2
Hatch 1	GP	50-321	II	4	05/07/80 05/12/81	0	81-08, 04/13/81 81-23, 10/16/81	Closed 2
Hatch 2	GP	50-366	II	4	05/07/80 01/13/81	0	81-23, 10/16/81	Closed 2
Millstone 1	NU	50-245	I	3	04/29/80	5	80-25, 03/27/81 82-22, 12/09/82 84-05, 04/18/84	Closed 4
Monticello	NSP	50-263	III	3	04/22/80	0	80-20, 01/16/81 82-12, 12/22/84	Closed 4
Peach Bottom 2	PECO	50-277	I	4	05/02/80	0		Open
Peach Bottom 3	PECO	50-278	I	4	05/07/80 04/15/81	1		Open

TABLE B.1 (contd.)

Facility	Utility	Docket Number	NRC Reg.	BWR/3 or BWR/4	Utility Response Date	Number of Beams Cracked	Verifying Inspection Report	Bulletin Status and Criterion
Pilgrim 1	BECO	50-293	I	3	06/19/80	3	80-09, 06/12/80 80-27, 12/30/80 80-30, 02/06/81	Closed 4
Quad Cities 1	CECO	50-254	III	3	04/23/80 05/09/80 08/05/80	**		Open
Quad Cities 2	CECO	50-265	III	3	04/23/80 05/09/80 08/05/80	1**		Closed 3
Vermont Yankee 1	VYNP	50-271	I	3	05/08/80	1	81-13, 08/13/83 83-01, 05/19/83	Closed 4

* Six beams cracked and one failed at Dresden 3.
** The number of cracked beams is not given in the utility response.
The quantities for Dresden 3 and Quad Cities 2 are given in the bulletin.

TABLE B.2 SUMMARY OF UTILITY RESPONSES, 27 FACILITIES WITH CONSTRUCTION PERMITS

Facility	Utility	Docket Number	NRC Reg.	Response Request Letter	Utility Response	Bulletin Status and Criterion	Notes
Bailly 1	NIPSCO	50-367	III	08/05/80	08/27/80	Closed 1	1
Clinton 1	IP	50-461	III			Closed 5	
Clinton 2	IP	50-462	III			Closed 1	2
Grand Gulf 1	MP&L	50-416	II	08/04/80	01/14/81	Closed 5	3,4,5,11
Grand Gulf 2	MP&L	50-417	II	08/04/80	01/14/81	Closed 1	2
Hartsville A1	TVA	50-518	II			Closed 1	2
Hartsville A2	TVA	50-519	II			Closed 1	2
Hartsville B1	TVA	50-520	II			Closed 1	2
Hartsville B2	TVA	50-521	II			Closed 1	2
Hope Creek 1	PSE&G	50-354	I			Closed 5	7
Hope Creek 2	PSE&G	50-355	I			Closed 1	1
LaSalle 1	CECO	50-373	III			Closed 5	8,12
LaSalle 2	CECO	50-374	III			Closed 5	12
Limerick 1	PECO	50-352	I			Closed 5	
Limerick 2	PECO	50-353	I			Closed 5	
Nine Mile Point 2	NMP	50-410	I	06/10/80		Closed 5	
Perry 1	CEI	50-440	III	07/28/80	09/25/80	Closed 5	3,5
Perry 2	CEI	50-441	III	07/28/80	09/25/80	Closed 5	3,5
Phipps Bend 1	TVA	50-553	II			Closed 1	2
Phipps Bend 2	TVA	50-554	II			Closed 1	2
River Bend 1	GSU	50-458	IV	07/30/80		Closed 5	
River Bend 2	GSU	50-459	IV	07/30/80		Closed 1	2
Shoreham	LILCO	50-322	I	06/04/80		Closed 5	3,9
Susquehanna 1	PP&L	50-387	I	06/30/80	03/25/81	Closed 5	3,4,5,6, 10,12
Susquehanna 2	PP&L	50-388	I	06/30/80	03/25/81	Closed 5	3,4,5.6,10,11
WNP 2	WPPSS	50-397	V	08/05/80		Closed 5	12
Zimmer 1	CG&E	50-358	III	06/06/80	10/31/80	Closed 1	1

Notes:

1. Facility has been cancelled.
2. Construction has been halted indefinitely.
3. Beam preload to be reduced.
4. Plan to purchase beams of improved heat treatment, if approved.
5. Inservice inspection program planned.

TABLE B.2 (contd.)

Notes: (contd.)

6. Surveillance program planned.
7. Inspection Report 50-354/82-01 (2/11/82) holds bulletin open until GE has assessed problem completely.
8. Inspection Report 50-373/80-56 (1/19/81) states that response is to be submitted to NRC as answers to questions FSAR Q111.84 through 85. Inspection Report 50-373/81-50 (1/26/82) reports licensee has replaced beams with new revised heat treatment beams. This facility now has an operating license.
9. Inspection Report 50-322/82-02 (2/2/82) cites violation because of no correlation to get proper preload on beams, either by bolt turns or by hydraulic tensioner. Response (3/5/82) contains answers to questions posed in that inspection report.
10. Inspection Report 50-387/81-15, 50-388/81-08 (9/8/81) reports question of jet pump beam adequacy is addressed in FSAR.
11. Licensed for fuel loading and low power testing.
12. Licensed for operation.

References

1. United States Nuclear Regulatory Commission, Licensed Operating Reactors, Status Summary Report, Data as of 05/31/84, NUREG-0020, Vol. 8, No. 6, June 1984

2. United States Nuclear Regulatory Commission, Nuclear Power Plants, Construction Status Report, Data as of 06/30/82, NUREG-0030, Vol. 6, No. 2, Published October 1982,

3. United States Nuclear Regulatory Commission, Memorandum for R. L. Tedesco, Assistant Director for Licensing, DL, from J. P. Knight, Assistant Director for Components and Structures Engineering, DE, Subject, Cracking of BWR Jet Pump Holddown Beams, May 28, 1980

APPENDIX C

Proposed Followup Items

INTRODUCTION

Even though the bulletin has been closed out for all but four of the 20 facilities which were operating when it was issued, followup items for these 20 units are presented in this Appendix because of the continuing needs described as Remaining Areas of Concern on Page 4.

Region I

1. FitzPatrick

Utility personnel responded acceptably May 7, 1980, October 13, 1981 and October 15, 1982, indicating that there were no cracked beams or unusually worn components and that required surveillance had been implemented. The utility responses are verified per NRC Region I inspection reports 81-06 of March 23, 1981 and 81-24 of November 13, 1981.

Although the bulletin has been closed out for this facility per Criterion 2, followup is suggested as applicable in accordance with the notes on Page C-7. It appears that only notes 1, 3 and 5 apply at this time.

2. Millstone 1

Utility personnel responded acceptably April 29, 1980, and reported examination results in LER/RO-80.016/01T of November 6, 1980. Nine more beams with UT indications similar to those of five already replaced are identified in NRC Region I Inspection Report 80-25 of March 27, 1981. Commitment to daily operability surveillance was verified in Inspection Report 82-22 of December 9, 1982. Replacement of all 20 beams with improved beams was verified in Inspection Report 84-05 of April 28, 1984.

Although the bulletin has been closed out for this facility per Criterion 4, followup is suggested in accordance with Note 5 on Page C-7.

3. Peach Bottom 2

Utility personnel responded acceptably May 2, 1980, May 7, 1980 and April 15, 1981, indicating that there were no cracked beams or unusually worn components and that required surveillance had been implemented.

The bulletin is being held open for this facility. Followup is suggested in accordance with the notes on Page C-7. It appears that only notes 1, 3 and 5 apply at this time.

4. Peach Bottom 3

Utility personnel responded acceptably May 2, 1980, May 7, 1980 and April 15, 1981, indicating that there was one cracked beam, that there were no unusually worn components and that required surveillance had been implemented.

The bulletin is being held open for this facility. Followup is suggested in accordance with the notes on Page C-7. It appears that only notes 1, 3 and 5 apply at this time.

5. Pilgrim 1
Utility personnel responded acceptably June 19, 1980, indicating that there were three cracked beams, that there were no unusually worn components and that required surveillance had been implemented. The utility response is verified per NRC Region I inspection reports 80-09 of June 12, 1980, 80-27 of December 30, 1980 and 80-30 of February 6, 1981.

Although the bulletin has been closed out for this facility per Criterion 4, followup is suggested in accordance with Note 5 on Page C-7.

6. Vermont Yankee 1
Utility personnel responded acceptably May 8, 1980, indicating that operability surveillance per bulletin Item B.2 had been initiated and that plans were being made for UT and visual examinations during the refueling outage scheduled for September 1980. The utility response is verified in Inspection Report 81-13 of August 13, 1981. Replacement of all 20 beams with improved beams is documented in Inspection Report 83-01 of May 19, 1983.

Although the bulletin has been closed out for this facility per Criterion 4, followup is suggested in accordance with Note 5 on Page C-7.

Region II

1. Browns Ferry 1
Utility personnel responded acceptably May 7, 1980 and May 21, 1981, indicating that there were no cracked beams or unusually worn components and that required surveillance had been implemented. The utility responses are verified per NRC Region II Inspection Report 81-36 of December 31, 1981. Inprocess and final installation of all 20 improved beams are verified per inspection reports 83-28 of August 29, 1983 and 84-16 of June 1, 1984.

Although the bulletin has been closed out for this facility per Criterion 4. followup is suggested in accordance with Note 5 on Page C-7.

2. Browns Ferry 2
Utility personnel responded acceptably May 7, 1980 and October 3, 1980, indicating that there were no cracked beams or unusually worn components and that required surveillance had been implemented. The utility responses are verified per NRC Region II Inspection Report 81-36 of December 31, 1981. Final installation of all 20 improved beams is verified per Inspection Report 84-16 of June 1, 1984.

Although the bulletin has been closed out for this facility per Criterion 4, followup is suggested in accordance with Note 5 on Page C-7.

3. Browns Ferry 3

Utility personnel responded acceptably May 7, 1980 and December 30, 1980, indicating that there were no cracked beams or unusually worn components and that required surveillance had been implemented. The utility responses are verified per Region II Inspection Report 81-36 of December 31, 1981.

Although the bulletin has been closed out for this facility per Criterion 2, followup is suggested in accordance with the notes on Page C-7. It appears that only notes 1, 3 and 5 apply at this time.

4. Brunswick 1

Utility personnel responded acceptably April 24, 1980, indicating that there were no cracked beams or unusually worn components and that required surveillance had been implemented. The utility response is verified per NRC Region II Inspection Report 81-10 of June 22, 1981.

Although the bulletin has been closed out for this facility per Criterion 2, followup is suggested in accordance with the notes on Page C-7. It appears that only notes 1, 3 and 5 apply at this time.

5. Brunswick 2

Utility personnel responded acceptably April 24, 1980 and July 15, 1980, indicating that there were no cracked beams or unusually worn components and that required surveillance had been implemented. The utility responses are verified per NRC Region II Inspection Report 81-10 of June 22, 1981.

Although the bulletin has been closed out for this facility per Criterion 2, followup is suggested in accordance with the notes on Page C-7. It appears that only notes 1, 3 and 5 apply at this time.

6. Hatch 1

Utility personnel responded acceptably May 7, 1980 and May 12, 1981, indicating that there were no cracked beams or unusually worn components and that required surveillance had been implemented. The utility responses are verified per NRC Region II inspection reports 81-08 of April 13, 1981 and 81-23 of October 16, 1981.

Although the bulletin has been closed out for this facility per Criterion 2, followup is suggested in accordance with the notes on Page C-7. It appears that only notes 1, 3 and 5 apply at this time.

7. Hatch 2

Utility personnel responded acceptably May 7, 1980 and January 13, 1981, indicating that there were no cracked beams or unusually worn components and that required surveillance had been implemented. The utility responses are verified per NRC Region II Inspection Report 81-23 of October 16, 1981.

Although the bulletin has been closed out for this facility per Criterion 2, followup is suggested in accordance with the notes on Page C-7. It appears that only notes 1, 3 and 5 apply at this time.

Region III

1. Dresden 2

Utility personnel responded incompletely April 23, 1980, May 9, 1980 and August 5, 1980, indicating that there were two cracked beams, that there were no unusually worn components and that required surveillance had been implemented. The utility responses are verified per NRC Region III Inspection Report 81-01 of February 12, 1981.

The bulletin is being held open for this facility. Followup is suggested to determine whether UT examinations have been recorded and to check out corrective action per the notes on Page C-7. It appears that only notes 1, 2 and 5 apply at this time.

2. Dresden 3

Utility personnel responded acceptably April 23, 1980, May 9, 1980 and August 5, 1980, indicating that there were six cracked beams, that there were no unusually worn components and that required surveillance had been implemented. The utility responses are verified per NRC Region III Inspection Report 81-07 of May 7, 1981.

Although the bulletin has been closed out the facility per Criterion 4, followup is suggested in accordance with the notes on Page C-7. It appears that only notes 1,2, and 5 apply at this time.

3. Duane Arnold

Utility personnel responded acceptably April 18, 1980, indicating that there were no cracked beams or unusually worn components and that required surveillance had been implemented. The utility response is verified by NRC Region III Inspection Report 80-19 of November 12, 1980.

Although the bulletin has been closed out for this facility per Criterion 2, followup is suggested in accordance with the notes on Page C-7. It appears that only notes 1, 3 and 5 apply at this time.

4. Monticello

Utility personel responded acceptably April 22, 1980, indicating that there were no cracked beams or unusually worn components and that required surveillance had been implemented. The utility response is verified per NRC Region III Inspection Report 80-20 of January 16,1981. Replacement of all 20 beams with improved beams was verified in Inspection Report 82-12 of December 22, 1982.

Although the bulletin has been closed out for this facility per Criterion 4, followup is suggested in accordance with Note 5 on Page C-7.

5. Quad Cities 1

Utility personnel responded incompletely April 23, 1980, May 9, 1980 and August 5, 1980, neglecting to mention whether any cracked beams or worn components had been found and indicating that required surveillance had been implemented.

The bulletin is being held open for this facility. Followup is suggested to determine whether UT and visual examinations have been recorded and to check out corrective action per the notes on Page C-7. It appears that only notes 1, 2 and 5 apply at this time.

6. Quad Cities 2

Utility personnel responded April 23, 1980, May 9, 1980 and August 5, 1980, and reported one cracked beam in LER/RO-80 007/03L-0 of April 9, 1980.

On the basis of the licensee event report, the bulletin has been closed out for this facility. Corrective action is to be tracked as an LER Item. Followup is suggested in accordance with the notes on Page C-7. It appears that only notes 1, 2 and 5 apply at this time.

Region IV

Cooper Station

Utility personnel responded acceptably May 5, 1980 and May 21, 1980, indicating that there were no cracked beams or unusually worn components and that required surveillance had been implemented. The utility responses are verified per NRC Region IV Inspection Report 80-09 of July 9, 1980.

Although the bulletin has been closed out for this facility per Criterion 2, followup is suggested to determine whether the operability surveillance method conforms to GE SIL #330 and to check out corrective actions per the notes on Page C-7. It appears that only notes 1, 3 and 5 apply at this time.

FOLLOWUP NOTES

1. Followup is suggested to verify that the improved operability surveillance described in bulletin Item B.2 or GE SIL #330 continues to be implemented daily until either the plant technical specifications are revised to call for this surveillance or all improved BWR/4-6 beams with new heat treatment and 25 kips preload are installed.

2. Followup is suggested to verify that original BWR/3 beams are examined ultrasonically every refueling outage.

3. Followup is suggested to verify that original BWR/4-6 beams with 30 kips preload are examined ultrasonically every refueling outage.

4. Followup is suggested to verify that original BWR/4-6 beams with 25 kips preload are examined ultrasonically at five years initially and subsequently every two years.

5. Followup is suggested to verify that all beams, including BWR/4-6 beams with new heat treatment and 25 kips preload, are scheduled for inservice inspection at intervals of ten years.

6. Followup is suggested to verify that any cracked beams are replaced before operation is resumed.

APPENDIX D

Evaluation of Utility Responses, Technical Specifications, GE Service Information and NRC Documents Pertaining to Operability Surveillance of Jet Pumps.

INTRODUCTION

The purpose of Appendix D is to comply with the requirements of Task Order 51, which was issued to supplement Task Order 12.

Task Order 51 was issued because of particular concern about utility responses to bulletin action Item B.2 requiring operability surveillance. In addition to requiring special evaluation of item B.2, this task order also requires review of related items B.3 and B.4 about requirements for reactor shutdown and revision of plant procedures.

Pertinent findings, conclusions and recommendations included in Appendix D are summarized in the main body of the report. Criteria for closeout of action Item B.2 on the basis of short-term and long-term actions are presented in Appendix D and are referenced in the main body of the report as necessary conditions for application of closeout Criterion 2.

SUMMARY

Licensees were requested by IEB 80-07 Item B.2 to initiate specific jet pump operability surveillance methods for early detection of jet pump degradation or failure. Licensees were also requested to continue this surveillance until the plant technical specifications were revised or the cause of beam failure was identified and corrected.

With regard to initiation of the action requested by Item B.2, a review of licensee responses (Table D.1) shows that of the 20 units affected, 17 units initiated the surveillance requested in Item B.2, and the remaining three units initiated or were already performing an alternate method which satisfies Item B.2. The responses for eight of the 20 units indicated that GE recommendations for an alternate method would be followed. The recommendations in GE SIL #330 were reviewed and found acceptable to meet Item B.2.

With respect to resolution of Item B.2, the review shows that five units have corrected the problem of beam failure by installing improved beams. One unit, Monticello, has requested a revision to the technical specifications and has also installed improved jet pump beams. The remaining 15 units have not corrected the problem of beam failure and should continue the surveillance requested by Item B.2.

Item B.2 is closed for the five units which have installed the improved beams. Item B.2 is also closed for the remaining 15 units which have not installed improved beams but which are performing operability surveillance and UT surveillance which satisfies Item B.2. For these 15 units there are recommendations and remaining areas of concern relating to the ongoing actions which are discussed below.

IEB 80-07 Item B.2 has served its intended purpose. It has been successful in causing improved jet pump operability surveillance methods to be implemented. IEB 80-07 Item B.2 is closed for all affected facilities.

BACKGROUND

On February 2, 1980, a jet pump failed at Dresden 3 while operating at approximately 67 percent of full power. Plant operators observed changes in plant parameters, determined that a jet pump failure had occurred, and shut down the reactor in accordance with the plant Technical Specification requirements.

Prior to the Dresden 3 event, operating experience had raised concerns that some plants have technical specification requirements and related procedures for jet pump operability surveillance which would not reliably indicate jet pump failure (References 1, 2, 3, 4 and 5).

ACTIONS REQUESTED BY ITEM B.2

IE Bulletin 80-07: "BWR JET PUMP ASSEMBLY FAILURE", was issued on April 4, 1980. Item B.2 requested licensees to use a specific jet pump operability surveillance method for early detection of jet pump degradation or failure. The rationale for requesting the prescribed surveillance included the apparent increased likelihood of jet pump failure and the previous operating experience which has shown unreliable jet pump operability surveillance methods at certain plants. The surveillance method specified in Item B.2 of IEB 80-07 was chosen because it was known to accurately indicate jet pump failure in the known failure events. Licensees were requested by the bulletin to use the improved jet pump operability surveillance until the plant technical specifications were revised or the cause of jet pump hold-down beam failure was identified and corrected.

SUBSEQUENT ACTIONS

After issuance of IEB 80-07, the General Electric Company (GE) evaluated various methods for improved jet pump surveillance and recommended a method different than that specified in the bulletin. In response to IEB 80-07, some licensees stated that they planned to use the GE surveillance recommendations. On June 9, 1980, GE issued Service Information Letter (SIL) #330 which presented two methods for improving the jet pump operabililty surveillance. The GE SIL was updated in December 1980 and Supplement 1 was issued during February 1981.

GE also designed and manufactured an improved jet pump hold-down beam expected to have a significantly increased service life (Reference 6). Some plants have replaced the original beams with the new design beams, which are installed with a decreased preload as recommended by GE.

CRITERIA FOR CLOSEOUT OF ITEM B.2

This Appendix evaluates licensee actions in response to IEB 80-07 Item B.2. The GE SIL #330 surveillance method is evaluated to determine if it satisfies Item B.2. Plant technical

specifications related to jet pump surveillance methods are evaluated to determine if they are adequate or if they have been changed in response to Item B.2. The new GE design beam is evaluated to determine if it corrects the problem of beam failure as addressed in Item B.2. Based on these evaluations, Item B.2 is closed for a facility which has completed at least one of the short-term actions and at least one of the long-term actions described as follows:

Short-Term Actions (Criteria)

1. Implement the improved jet pump surveillance method as requested in Item B.2, or

2. Implement the GE SIL #330 method, which is an acceptable alternate that satisfies Item B.2.

Long-Term Actions (Criteria)

3. Revise the plant technical specifications as necessary to be in accordance with Item B.2, or

4. Replace all original hold-down beams with new hold-down beams of an improved design (BWR/4-6 beam with new heat treatment and reduced preload), or

5. Provide reasonable assurance that the improved flow monitoring surveillance will continue until either Long-Term Action 3 or 4 has been completed. This assurance is provided by a change in plant procedures and by NRC inspections.

SUMMARY OF LICENSEE RESPONSES

The summary of licensee responses and closeout of Item B.2 is provided in Table D.1. This table shows the closeout status and the closeout criteria for each operating plant affected by Item B.2. As shown in Table D.1, Item B.2 is closed for all affected operating reactors.

The following sections of this Appendix present the technical evaluations which form the basis for evaluating licensee responses, and also the findings, remaining areas of concern, and recommendations resulting from these evaluations.

TABLE D.1 SUMMARY OF UTILITY RESPONSES TO ITEM B.2

Facility	Response Date	Committed To Item B.2 (Or Alternate)?	Installed Improved Beams?	Revised Tech. Spec.?	Revised Surveillance Procedures?	Status, Criteria+
Browns Ferry 1	05/07/80	Yes	Yes	No	Changed Daily Surv. Req.	Closed 1,4
Browns Ferry 2	05/07/80	Yes	Yes	No	Changed Daily Surv. Req.	Closed 1,4
Browns Ferry 3	05/07/80	Yes	No	No	Changed Daily Surv. Req.	Closed 1,5
Brunswick 1	04/24/80	Yes	No	OK	Acceptable As Is	Closed 1,5
Brunswick 2	04/24/80	Yes	No	OK	Acceptable As Is	Closed 1,5
Cooper Station	05/21/80	Yes	No	No	Committed to GE Surv.	Closed 2,5**
Dresden 2	04/23/80 05/09/80	Yes	No	No	Changed Surv. Program Will also use GE Surv.	Closed 1,2,5
Dresden 3	04/23/80 05/09/80	Yes	No	No	Changed Surv. Program Will also use Ge Surv.	Closed 1,2,5
Duane Arnold	04/18/80	Yes	No	No	Changed Surv. Program	Closed 1,5
FitzPatrick	05/07/80	Yes	No	No	Changed Based on GE Recommendations	Closed 1,5
Hatch 1	05/07/80	Yes	No		Changed Surv. Procedures	Closed 1,5
Hatch 2	05/07/80	Yes	No		Changed Surv. Procedures	Closed 1,5
Millstone 1	04/29/80	Yes	Yes		Changed Surv. Procedures	Closed 1,4
Monticello	04/22/80	Yes	Yes	Yes*	Changed Surv. Procedures	Closed 1,4
Peach Bottom 2	05/02/80 04/30/84	Yes	No	No	Changed Surv. Procedures Will also use GE Surv.	Closed 1,5
Peach Bottom 3	05/07/80 04/15/81	Yes	No	No	Changed Surv. Program Will also use GE Surv.	Closed 1,5
Pilgrim 1	06/19/80	Yes	No	No	Changed Surv. Procedures	Closed 1,5
Quad Cities 1	04/23/80 05/09/80	Yes	No	No	Changed Surv. Program Will also use GE Surv.	Closed 1,2,5
Quad Cities 2	04/23/80 05/09/80	Yes	No	No	Changed Surv. Procedures Will also use GE Surv.	Closed 1,2,5
Vermont Yankee 1	05/08/80	Yes	Yes	No	Changed Surv. Procedures	Closed 1,4

* Monticello submitted a request for a revision of the Technical Specifications.
** See Table D.4 (Page D-20) for recommended inspection.
+ Criteria are described on Pages D-3 and D-4.

CURRENT STATUS OF LICENSEE ACTIONS

Since issuance of IE Bulletin 80-07, licensees of operating BWR facilities with jet pumps have taken action to resolve jet pump hold-down beam failure. In summary, all operating facilities are doing UT examinations of the jet pump hold-down beams each refueling outage unless they have installed new design beams, i.e. new BWR/4 beams with new heat treatment and reduced preload.

The following operating plants have replaced jet pump hold-down beams:

Plant	Replaced Beams Number	Type
Browns Ferry 1	20	BWR/4/NHT*
Browns Ferry 2	20	BWR/4/NHT
Dresden 2	2	Data Not Yet Available
Dresden 3	7	BWR/3
Millstone 1	20	BWR/4/NHT
Monticello	20	BWR/4/NHT
Peach Bottom 3	1	BWR/4/NHT
Pilgrim 1	3	BWR/3
Quad Cities 2	1	BWR/3
Vermont Yankee 1	20	BWR/4/NHT

* NHT means new heat treatment.

Additional documentation of bulletin closeout is provided in Appendix B of this report.

Five facilities have replaced all 20 original beams with 20 improved BWR/4 beams having a new heat treatment and reduced preload. Some of these facilites are no longer following IEB 80-07. There is currently no NRC requirement for any inservice inspection (ISI), not even the 10 year ISI inspection for reactor internals, for plants which have installed these new BWR/4 beams.

Fifteen facilities have not installed the improved BWR/4 beams having a new heat treatment and reduced preload. These facilities have continued operation while performing the requested jet pump operability surveillance during operation, performing UT inspections during refueling outages, and replacing any jet pump beam with a crack indication. There is currently no NRC requirement for the UT inspection each refueling outage for these plants. Since the jet pump hold-down beam failure had not been corrected for these facilities, IE Bulletin 80-07 Item B.2 still applies. The surveillance specified in Item B.2 (or an acceptable alternate) should continue for these facilities.

One original BWR/4 beam at Peach Bottom Unit 3 had a crack indication. Subsequent metallurgical evaluation has shown the failure mechanism to be IGSCC, which is the same failure mechanism experienced with the BWR/3 beams. There have been no other problems reported with BWR/4 beams having the original heat treatment. The crack indication was reported by Philadelphia Electric Company in their response of April 15, 1981 to Boyce H. Grier (RI).

EVALUATION OF JET PUMP SURVEILLANCE METHODS DESCRIBED IN GE SIL #330 AND CURRENT TECHNICAL SPECIFICATIONS

The GE SIL #330, through the December, 1980 update, presents two alternatives for jet pump performance surveillance as follows:

The jet pump flow or differential pressure (D/P) deviation from average is the most sensitive indicator of significant jet pump performance degradation. Less sensitive indicators are recirculation flow/speed ratio and jet pump loop flow/speed ratio. Consequently, the alternatives are:

A. Monitor jet pump flow or D/P deviation from loop average on a daily basis.

   The disadvantage of this alternative is that significant time is required to collect and evaluate the data.

B. Monitor less sensitive measurements but use more restrictive limits. If these are not met, then review jet pump flow or D/P deviation.

   This method reduces surveillance time since jet pump flow data is recorded to detect any obvious problems not evaluated as frequently as in Alternative A.

The SIL recommends a surveillance based on the two criteria in Alternative B. The surveillance is to be performed as follows:

Each of the required jet pumps shall be demonstrated operable prior to thermal power exceeding 25% of rated power; following any unexpected or unexplained change in core flow, jet pump loop flow, recirculation pump flow, or core plate differential pressure; and at least once per 24 hours by recording jet pump loop flows, recirculation pump speeds and individual jet pump flows (D/P) and verifying that none of the following conditions occur:

(a) The Recirculation Pump Flow/Speed Ratio deviates by more than 5% from the normal range.

(b) The Jet Pump Loop Flow/Speed Ratio deviates by more than 5% from the normal range.

If either criterion is failed, then the procedure is to record individual jet pump flows or the diffuser to lower plenum differential pressures and compare to the criteria of the limiting conditions for operation (LCO). If the LCO are not satisfied and pump speed is less than 60%, it may be necessary to increase pump speed above 60% and repeat the measurements before referring to the action statement in the technical specifications. In this case, GE recommends close monitoring and increasing recirculation pump speed only if the criteria are exceeded by a small amount.

The LCO and criteria are as follows:

All jet pumps shall be operable with the following requirements:

(a) Each individual jet pump flow percent deviation from average loop jet pump flow should not differ by more than 10% deviation from its normal* deviation, or

(b) Each individual jet pump diffuser to lower plenum differential pressure (D/P) percent deviation from average loop D/P should not differ by more than 20% deviation from its normal* deviation.

* normal expected operating range based on a data base obtained from operating experience.

The current plant technical specifications related to jet pump operability suveillance were reviewed for each affected facility currently with an operating license. These technical specifications are of the three different basic types which are identified and summarized in Table D.2. Also shown in Table D.2 is the GE SIL #330 method which was evaluated as an alternative to the method specified in IEB 80-07 Item B.2.

The adequacy of each jet pump operability surveillance method was evaluated in part by checking the validity of each method against known cases of jet pump failure. A failure in these cases involves jet pump separation at either the inlet nozzle, mixer, or diffuser sections (a plugged jet pump is outside the scope of the bulletin and was not considered). The jet pump failures evaluated are as follows:

(1) Dresden 3
Jet Pump #13 Failure
February 2, 1980

(2) Nuclenor
Jet Pump #2 Failure
May 5, 1979

(3) Quad Cities 2
Jet Pump #17 Failure
August 20, 1972

The evaluation of each surveillance method included obtaining data for each of the three jet pump failure events, performing the calculations required by the surveillance method, determining if the surveillance criteria were exceeded, and determining if the LCO required reactor shutdown when the criteria were exceeded.

Table D.3 summarizes pertinent data and results of calculations. The calculations were performed using data from references 7 through 11. Calculations were performed for several different operating states where sufficient data were available. The calculations were made using two BWR plant operating procedures. The values in Table D.3 are conservative values in cases where more than one calculation was performed. The data in Table D.3 show that the individual jet pumps are the most sensitive indicators of a failed jet pump and also show that surveillance methods of Type 1 and Type 2 are not adequate. They do not indicate the presence of a failed jet pump. Type 3 and the GE SIL #330 work in all three cases.

Based on the above calculations it is concluded that Technical Specification Types 1 and 2 are not adequate to indicate jet pump failure. Type 3 and the GE SIL #330 methods do reliably indicate jet pump failure in each case and both meet the intent of IEB 80-07 Item B.2. Types 1, 2 and 3 are described on Page D-11.

For GE SIL #330, exceeding the surveillance criteria does not necessarily mean that a jet pump has failed. When the surveillance criteria are exceeded, jet pump operability is determined by using the LCO criteria discussed above. Detailed evaluation of these criteria would require a data base for each plant. However, for the three cases examined, available data indicates that these criteria would be exceeded in each case. Specific data in one of the three cases included operating conditions at less that 60% recirculation pump speed. The LCO criteria would be clearly exceeded in this case. This highlights the need for close monitoring and evaluation of an established data base for each jet pump if the surveillance criteria are exceeded below 60% pump speed. Otherwise the reactor power may be increased unnecessarily with a failed jet pump present.

The GE SIL #330 presents data and analyses to show that advance warning of an impending failure can be detected for the BWR/3 beams. This capability was not evaluated here in detail, but appears reasonable based on operating data presented in the GE SIL #330 for the Dresden and Nuclenor failures. While advance warning is desirable, it is not necessary to satisfy the intent of Item B.2. Rapid and reliable detection of a jet pump separation is sufficient to meet the intent of Item B.2.

The GE SIL #330 Alternatives A and B and the Technical Specification Type 3 are acceptable to satisfy Item B.2 because they clearly indicate the presence of a failed jet pump. The GE SIL #330 Alternative B also would likely show early warning of jet pump separation prior to complete failure, particularly for the BWR/3 beam.

TABLE D.2 CURRENT TECHNICAL SPECIFICATIONS FOR JET PUMP SURVEILLANCE

Jet Pump Operability Surveillance Type	Plants	Description of Surveillance Method
Tech Spec Type 1	Browns Ferry 1,2,3 Duane Arnold FitzPatrick Hatch 1 Monticello Peach Bottom 2, 3 Pilgrim 1	All Three Simultaneously: (a) Loop Imbalance > 15% (b) Core Flow-Indicated vs. Derived > 10% (c) Diffuser to Lower Plenum DP- > 10% variance from mean or established value
Tech Spec Type 2	Cooper Station Hatch 2	All Three Simultaneously: (a) Recirc. Pump Flow differs by more than 15% from the established speed-flow characteristics (b) Same as Type 1 above (c) Same as Type 1 above
Tech Spec Type 3	Brunswick 1, 2* Dresden 2, 3 Millstone 1 Quad Cities 1, 2 Vermont Yankee 1	Two Simultaneously: (a) Recirc. Pump Flow differs by more than 10% from the established speed-flow characteristics (b) Indicated core flow > 10% than the core flow derived from established power-core flow relationships
GE SIL #330	Cooper Station** Dresden 2, 3 FitzPatrick** Peach Bottom 2, 3 Quad Cities 1, 2	Enter LCO if either (a) Recirc. Pump Flow/Speed Ratio deviation > 5% from normal, or (b) Jet Pump Loop Flow/Speed Ratio deviation > 5% from normal

* Brunswick 1, 2 has an additional surveillance criterion: Item (c) in Type 1 above.

** Licensees of these units stated that GE recommendations would be followed. Adherence to the method in GE SIL #330 was not specifically indicated.

TABLE D.3 EVALUATION OF JET PUMP SURVEILLANCE METHODS AGAINST ACTUAL FAILURE EVENTS

Jet Pump Operability Surveillance Type	Description of Surveillance Method	Calculated Deviations for the Event		
		Dresden 3 Jet Pump #13	Nuclenor Jet Pump #2	Quad Cities 2 Jet Pump #17
Tech Spec Type 1	All Three Simultaneously:			
	(a) Loop Imbalance > 15%	10.2%	N.A.	12.5%
	(b) Core Flow-Indicated vs. Derived > 10%	3.8%	N.A.	4.3%
	*(c) Diffuser to Lower Plenum DP- > 10% variance from mean or established value	35.9%	67%	23.6%
	Do the criteria work?	No	No	No
Tech Spec Type 2	All Three Simultaneously:			
	(a) Recirc. Pump Flow differs by more than 10% from the established speed-flow characteristics	15.0%	N.A.	14.0%
	(b) Same as TYPE 1 above	4.2%	N.A.	4.3%
	(c) Same as TYPE 1 above	35.9%	67%	23.6%
	Do the Criteria work?	No	No	No
Tech Spec Type 3	Two Simultaneously:			
	(a) Recirc. Pump Flow differs by more than 10% from the established speed-flow characteristics	15.0%	N.A.	14.0%
	(b) Indicated Core Flow > 10% than the core flow derived from established power-core flow relationships	17.5%	N.A.	24.1%
	Do the criteria work?	Yes	N.A.	Yes
GE SIL #330	Enter LCO if either			
	(a) Recirc. Pump Flow/Speed Ratio deviation > 5% from normal	10.2%	N.A.	12.3%
	(b) Jet Pump Loop Flow/Speed Ratio deviation > 5% from normal	7.3%	10%	-
	Do the criteria work?	Yes	Yes	Yes

* Values shown are % change in jet pump flow rather than DP. A 10% change in pump flow is at least ~ 20% change in DP. As change in flow is increased, the degree of conservatism is higher.

EVALUATION OF ACTIONS TO IMPROVE JET
PUMP HOLD-DOWN BEAM PERFORMANCE

1. Original Hold-Down Beams

Boiling water reactors used two different types of beam bolt assemblies prior to the Dresden 3 beam failure. These types are known as the BWR/3 beam assembly and the BWR/4-6 beam assembly. The BWR/4-6 beam assembly is directly interchangeable with the BWR/3 assembly. However, the assemblies do have design differences. One difference is that the BWR/4-6 beam is thicker than the BWR/3 beam. This design difference improves the service life of the BWR/4-6 beam compared to the BWR/3 beam.

Metallurgical studies have shown that the cause of jet pump hold-down beam failure at Dresden 3 was intergranular stress corrosion cracking (IGSSC). This hold-down beam at Dresden 3 was a BWR/3 beam fabricated from Inconel X-750. The heat treatment used on this beam and other BWR/3 beams which experienced cracking is known as Equalized and Aged. This heat treatment consisted of heating the beam to 1625 degrees Fahrenheit, and holding at this temperature for 24 hours (equalizing), followed by holding 1300 degrees Farenheit for 20 hours (aging). These BWR/3 beams were typically installed with a preload of 25 kips.

The original BWR/4-6 beams received the above heat treatment and were installed with a preload of 30 kips compared to 25 kips for the BWR/3 beams. The higher preload on the BWR/4 beam is offset by its design. The larger section properties in the BWR/4 beam result in lower maximum stress which helps make it less susceptible to cracking compared to the BWR/3 beam. This is consistent with observed operating experience. Only one crack indication (Peach Bottom 3) has been reported in a BWR/4-6 beam. The subsequent metallurgical evaluation of this cracked beam has shown that the failure mechanism (IGSCC) is the same as that experienced with the BWR/3 beams. No other indications have been reported on BWR/4-6 beams.

2. Improved Hold-Down Beams

The General Electric Company has developed two improvements to increase the service life of replacement hold-down beams. These improvements are as follows:

a) Current BWR/4-6 Beam with 25 kip Preload

The current design beam, which is used on BWR/4 through BWR/6 (BWR/4-6) plants, when installed with a 25 kip preload, is expected by GE to increase the time to crack initiation to between 19 and > 40 years. The design improvement is a reduction in preload from 30 kips to 25 kips.

b) BWR/4-6 Beam with Improved Heat Treatment and 25 kip Preload

A change in the heat treatment of the current design beam has been developed by GE to provide significantly improved resistance to IGSCC. The BWR/4-6 beam with the improved heat treatment, and a 25 kip preload, is not expected by GE to crack for more than 40 years of service.

The improved heat treatment is known as High Temperature Annealing (HTA) and Aging. The improved heat treatment consists of heating the beam above 2000 degrees Farenheit, and holding at this temperature for one hour (HTA), followed by holding at 1300 degrees Farenheit for 20 hours (aging).

GE has performed stress evaluations, experimental testing, crack initiation and propagation analyses, and service life analyses to provide a technical basis which supports the design improvements and expected increased service life.

GE has recommended schedules for inservice inspections (Reference 6 and SIL #330) as follows:

Beam Type	GE Surveillance Recommendations
Original BWR/3 Design and 25 kips Preload	UT Each Refueling Outage
Original BWR/4-6 Beam Design and 30 kips Preload	UT Each Refueling Outage
Original BWR/4-6 Beam Design and 25 kips Preload	Lead Plant-Initial UT at 5 years, subsequent UT at 2 year intervals
Improved BWR/4-6 Beam Design With Improved Heat Treatment and 25 kips Preload	None recommended

This schedule calls for a lead plant to perform inservice inspections on the BWR/4-6 beams with the original heat treatment and reduced preload. The inspection would be

ultrasonic examination for indications of cracks. The first inspection would be at five years and subsequent inspections would be within two year intervals. GE is not recommending an inservice inspection for the BWR/4-6 beams with both the improved heat treatment and reduced preload.

3. Evaluation of Improvements

Reactor operating experience for both BWRs and PWRs has now shown that Inconel X-750 is susceptible to IGSCC if not properly heat treated (Reference 12). Both domestic and foreign reactors have experienced IGSCC related failures of parts fabricated from Inconel X-750. IGSCC can be caused by an improper heat treatment or by heat from welding that causes the precipitation of certain alloy components at the grain broundary (Reference 13). The precipitation causes a depletion of corrosion-resisting elements in the areas surrounding the grain boundary.

One method of improving the resistance to IGSCC is to reheat the metal to a temperature high enough to redissolve the precipitated phase, then cool quickly enough to maintain this phase in solution. To be effective, the temperature of the Inconel X-750 must be raised to approximately 2000 degrees Farenheit. The high temperature causes formation of fresh grain boundaries which are relatively free of precipitates and impurities. This is an industry practice to improve the performance of Inconel X-750 (References 6, 13 and 14). The NRC has also previously determined that this heat treatment increases the resistance of Inconel X-750 to IGSCC initiation (Reference 14).

The GE improved heat treatment has high temperature annealing which increases resistance to IGSCC and has aging which results in high material strength. The reduced preload reduces the stress ratio and further increases resistance to IGSCC. The reduction in material yield strength due to the new heat treatment is more than offset by the improvement in resistance to IGSCC. These improvements and the supporting technical basis give reasonable asssurance that the beam service life will be significantly increased. For these reasons, facilities using the improved heat treatment and reduced preload for new BWR/4 beams are judged appropriate to satisfy IEB 80-07 Item B.2 with respect to correction of the beam problem.

The inservice inspection schedule recommended by GE has been evaluated and results determined as follows:

Beam Type	IE Surveillance Recommendation
Original BWR/3 Design and 25 kips Preload	UT Each Refueling Outage
Original BWR/4-6 Beam Design and 30 kips Preload	UT Each Refueling Outage
Original BWR/4-6 Beam Design and 25 kips Preload	All Plants-Initial UT at 5 years, subsequent UT at 2 year intervals
Improved BWR/4-6 Beam Design With Improved Heat Treatment and 25 kips Preload	Inservice Inspection (10 year schedule)

Note that two exceptions have been taken to the GE recommendations:

1. GE has estimated the increased service life to be 19- > 40 years for the original BWR/4 beam with only the reduced preload improvement. The actual beam service life may be less than the service life of the facility. Also this service life has not been verified by actual operating experience and beam degradation may occur from unexpected causes. Therefore, the inservice inspection scedule as proposed by GE appears reasonable and prudent for all facilities using this application, not just the lead plant. This inspection could be accomplished during the normally scheduled refueling outage.

   The recently reported results of the evaluation of the failure of a BWR/4 type beam at Peach Bottom 3 shows that the failure mechanism was the same as the BWR/3 type beam failures. This finding further supports the need to periodically examine plants with BWR/4 beams, even if the preload is reduced to 25 kips.

2. Likewise, for the new design BWR/4 beam with improved heat treatment and reduced preload, the > 40 year estimated service life has not been verified by operating experience. An inservice inspection schedule is prudent. A 10 year inservice schedule appears appropriate in this case. These inspections could be accomplished during the normal 10 year inservice inspection of reactor internals.

FINDINGS AND CONCLUSIONS

1. The GE SIL #330 methods, either Alternative A or B, are acceptable to satisfy Item B.2.

2. Some BWRs (8 units) have technical specifications which are adequate to reliably indicate jet pump failure.

3. Some BWRs (12 units) have technical specifications which are not adequate to reliably indicate jet pump failure.

4. IEB 80-07 requested that the specified operabilty surveillance continue until either the plant technical specifications are revised or the cause of beam failure has been corrected. The plants listed in Tables D.5, D.6 and D.7 have not corrected the hold-down beam problem (by installing 20 new design BWR/4 beams with new heat treatment and reduced preload). These plants should continue with the following until new beams are installed:

   a) UT the hold-down beams each refueling outage, and

   b) replace any beam with a crack indication, and

   c) continue the jet pump surveillance specified in Item B.2 or GE SIL #330.

   These actions provide reasonable assurance that jet pump failure will not occur or if a jet pump does fail during reactor operation, it will be detected and the reactor shut down promptly.

5. Plants which have installed 20 new BWR/4-6 beams with new heat treatment and reduced preload have satisfied IEB 80-07. These plants have no current requirement for inservice inspection. Based on the above evaluation for these plants, it appears prudent to add the jet pump beams to the 10 year ISI.

6. NRC evaluation of Generic Issue 12, BWR Jet Pump Integrity, highlights the benefits of UT inspections each refueling outage. The NRC has no requirement for the UT inspections but licensees who have not installed all improved beams are currently performing these inspections. See Reference 15, Page D-23.

7. NRC evaluation of Generic Issue 12 gives credit for the improved jet pump surveillance specified in Item B.2. There is no NRC requirement other than IEB 80-07 for this surveillance method.

8. It appears that there would be a safety benefit if facilities with BWR/3 beams installed the new BWR/4 beams, based on the number of BWR/3 beams found with crack indications. However, a cost/benefit analysis has not been performed.

9. IEB 80-07 Item B.2 has accomplished its intended purpose and is closed. Any ongoing or new concerns can be followed by other NRC mechanisms such as LERs, operating events analysis, Generic Issue 12, NRC inspections, or another (more current) bulletin if needed.

RECOMMENDATIONS

IEB 80-07 is closed for all facilities with respect to Item B.2. While the following recommendations are not required for Item B.2 closeout, these NRC actions would help ensure that ongoing licensee actions are continued until complete resolution of Generic Issue 12. Actions 1 and 2 apply to IE and Action 3 applies to NRR.

1. Followup is suggested to verify that licensees of the plants listed in Table D.4 continue the improved jet pump surveillance in accordance with Item B.2 on the GE SIL #330 until the plant technical specifications (Types 1 and 2, Page D-11) are revised.

2. Perform inspections of the plants listed in Tables D.5 and D.6 to verify that the UT inspections are performed each refueling outage until BWR/4 beams with reduced preload or improved BWR/4 beams with new heat treatment are installed.

3. Evaluate the need to modify the ISI program and/or plant technical specifications to include UT examination of jet pump beams as follows:

Beam Type	ISI Surveillance
Original BWR/3 Design and 25 kips Preload	UT Each Refueling Outage
Original BWR/4-6 Beam Design and 30 kips Preload	UT Each Refueling Outage
Original BWR/4-6 Beam Design and 25 kips Preload	All Plants-Initial UT at 5 years, subsequent UT at 2 year intervals
Improved BWR/4-6 Beam Design With Improved Heat Treatment and 25 kips Preload	Inservice Inspection (10 year schedule)

4. Evaluate the need to modify the plant technical specifications with improved jet pump operability surveillance. The methods in Item B.2, GE SIL # 330, or Type 3 Technical Specifications (Page D-11) are superior to what now exists for the plants listed in Table D.4.

The costs/benefits of these recommendations have not been evaluated. It is expected that these recommendations will be considered in light of ongoing related actions, resolution of Generic Issue 12, and available resources.

TABLE D.4 RECOMMENDED ACTION FOR ITEM B.2

Followup is suggested to verify that the following plants continue to perform the improved jet pump surveillance requested in Item B.2 or the GE SIL #330 until the plant technical specifications are revised.

Region I

FitzPatrick
Peach Bottom 2,3
Pilgrim 1

Region II

Browns Ferry 3
Hatch 1, 2

Region III

Duane Arnold

Region IV

Cooper Station*

* It is recommended that the Cooper Station surveillance method be reviewed for conformance to the GE SIL #330. The previous response from Cooper Station and the previous IE inspection report stated that GE recommendations would be followed. The content of the recommendations was not provided.

TABLE D.5 RECOMMENDED ACTION FOR UT EXAMINATION OF BWR/4 BEAMS EACH REFUELING OUTAGE

Followup is suggested to verify that the following plants continue to perform the UT inspections each refueling outage until preload is reduced or improved BWR/4 beams (20) with new heat treatment and reduced preload are installed.

Region I

FitzPatrick
Peach Bottom 2, 3

Region II

Browns Ferry 3
Brunswick 1, 2
Hatch 1, 2

Region III

Duane Arnold

Region IV

Cooper Station

TABLE D.6 RECOMMENDED ACTION FOR UT EXAMINATION OF BWR/3 BEAMS EACH REFUELING OUTAGE

Followup is suggested to verify that the following plants continue to perform the UT inspections each refueling outage until BWR/4 beams with reduced preload or improved BWR/4 beams (20) with new heat treatment are installed.

Facility	Region
Pilgrim 1	1
Dresden 2, 3	III
Quad Cities 1, 2	III

Note: The proposed followup items in Appendix C call for verification of continuing UT examination as expressed above.

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APPENDIX E

Abbreviations

AEOD	Analysis and Evaluation of Operational Data, Office for (NRC)
APCO	Alabama Power Company
AP&L	Arkansas Power & Light Company
APRM	Average Power Rate Monitor
APSCO	Arizona Public Service Company
BECO	Boston Edison Company
BG&E	Baltimore Gas and Electric Company
BWR	Boiling Water Reactor
CECO	Commonwealth Edison Company
CEI	Cleveland Electric Illuminating Company
CG&E	Cincinnati Gas and Electric Company
ConEd	Consolidated Edison Company of New York, Inc.
CP	Construction Permit
CPC	Consumers Power Company
CP&L	Carolina Power & Light Company
CYAPCO	Connecticut Yankee Atomic Power Company
DE	Division of Engineering (NRC)
DECO	Detroit Edison Company
DL	Duquesne Light Company, Division of Licensing (NRC)
DOR	Division of Operating Reactors (NRC)
DP	Differential Pressure
DPC	Dairyland Power Cooperative
DROI	Division of Reactor Operation Inspection (NRC)
DST	Division of Safety Technology (NRC)
DUPCO	Duke Power Company
ECCS	Emergency Core Cooling System
FP	Florida Power Corporation
FPL	Florida Power & Light Company
FSAR	Final Safety Analysis Report
GE	General Electric Company
GP	Georgia Power Company
GPM	Gallons per minute
GSU	Gulf States Utilities Company
HL&P	Houston Lighting & Power Company
HTA	High Temperature Annealing
IE	Inspection and Enforcement, Office of (NRC)
IEB	Inspection and Enforcement Bulletin (NRC)
IELPCO	Iowa Electric Light and Power Company
IGSCC	Intergranular Stress Corrosion Cracking
IMECO	Indiana & Michigan Electric Company

IP	Illinois Power Company
ISI	Inservice Inspection
JCP&L	Jersey Central Power & Light Company
KG&E	Kansas Gas and Electric Company
kip	1000 pounds
LCO	Limiting Conditions for Operation
LER	Licensee Event Report
LILCO	Long Island Lighting Company
LOCA	Loss of Cooling Accident
LP&L	Louisiana Power and Light Company
Met-Ed	Metropolitan Edison Company
MP&L	Mississippi Power & Light Company
MW	Megawatt
MYAPCO	Maine Yankee Atomic Power Company
NIPSCO	Northern Indiana Public Service Company
NMP	Niagara Mohawk Power Corporation
NNECO	Northeast Nuclear Energy Company
NPPD	Nebraska Public Power District
NRC	United States Nuclear Regulatory Commission
NRR	Nuclear Reactor Regulation, Office of (NRC)
NSP	Northern States Power Company
NU	Northeast Utilities
OPPD	Omaha Public Power District
PASNY	Power Authority of the State of New York
PECO	Philadelphia Electric Company
PGE	Portland General Electric Company
PG&E	Pacific Gas and Electric Company
PP&L	Pennsylvania Power and Light Company
PSCC	Public Service Company of Colorado
PSCO	Public Service Company of Oklahoma
PSE&G	Public Service Electric and Gas Company
PSI	Public Service Indiana
PSID	Pounds per square inch differential
PSNH	Public Service Company of New Hampshire
R	Region (NRC)
RG&E	Rochester Gas and Electric Corporation
SCE	Southern California Edison Company
SCE&G	South Carolina Electric & Gas Company
SIL	Service Information Letter
SMUD	Sacramento Municipal Utility District
TECO	Toledo Edison Company
TS	Technical Specification
TUGCO	Texas Utilities Generating Company
TVA	Tennessee Valley Authority
UE	Union Electric Company
UT	Ultrasonic Test (nondestructive examination using ultrasonics)
VEPCO	Virginia Electric and Power Company
VYNP	Vermont Yankee Nuclear Power Corporation
WEPCO	Wisconsin Electric Power Company
WPPSS	Washington Public Power Supply System
WPS	Wisconsin Public Service Corporation
YAECO	Yankee Atomic Electric Company

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16. ABSTRACT (200 words or less)

In February 1980, disassembly of a jet pump at Dresden 3 was diagnosed from changes in operating parameters. After prompt shutdown, it was found that a broken hold-down beam had caused the failure and that six other beams had small cracks. In March 1980, one cracked beam at Quad Cities 2 and three at Pilgrim 1 were discovered, and an earlier pump failure at a foreign facility was found to be like that at Dresden 3. IE Bulletin 80-07 was issued April 4, 1980 to licensees of all General Electric BWR/3 and BWR/4 operating facilities to require daily operability surveillance of jet pumps and non-destructive examinations every refueling outage. The bulletin was issued for information to holders of construction permits for General Electric facilities; later, 13 of these facilities were selected for written responses. Extensive studies led to the conclusion that failures were caused by very slowly progressing stress corrosion cracking, and resulted in manufacture of improved beams. Bulletin status is determined by applying closeout criteria. Closeout of bulletin Item B.2 requiring operability surveillance is based on the short-term action of implementing an acceptable method and the long-term action of continuing that method until satisfactory corrective action has been completed. Followup items are suggested for all 20 operating facilities to ensure compliance with bulletin requirements and intent. The safety significance of a jet pump failure is that flow distribution would be affected during normal operation and the water level in the core region would decrease during a coincidental loss of cooling accident.

17. KEY WORDS AND DOCUMENT ANALYSIS

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