

BALTIMORE GAS AND ELECTRIC COMPANY

P.O. BOX 1475

BALTIMORE, MARYLAND 21203

NUCLEAR POWER DEPARTMENT
CALVERT CLIFFS NUCLEAR POWER PLANT
LUSBY, MARYLAND 20657

July 20, 1984

U. S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Division of Licensing
Washington, DC 20555

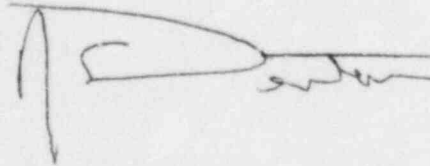
ATTENTION: Mr. D. H. Jaffe, Project Manager
Operating Reactors Branch #3

SUBJECT: Calvert Cliffs Nuclear Power Plant
Unit No. 2; Docket No. 50-318
Additional Information Regarding Steam Generator Water Hammer
Event

Gentlemen:

In response to your recent request for additional information, Enclosures (1), (2), and (3) are being forwarded for your information and use. Should you require additional information regarding the above event, please contact us.

Sincerely yours,



General Supervisor -
Training and Technical Services

RED/LES/gla

Enclosures

cc: D. A. Brune, Esquire
G. F. Trowbridge, Esquire
T. Foley, NRC

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Mr. D. H. Jaffe
July 20, 1984
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bcc: J. A. Tiernan
L. B. Russell
S. E. Jones
D. W. Latham
L. E. Salyards

ENCLOSURE (1)

REQUESTED INFORMATION REGARDING WATER HAMMER EVENT ON CALVERT CLIFFS UNIT 2 - APRIL 21, 1984

(1) OCCURRENCE DESCRIPTION

Calvert Cliffs Unit 2 was in **MODE 3** (1400 psia, 405°F) cooling down in preparation for its fifth refueling outage. An Auxiliary Feedwater (AFW) System test was completed just prior to the event, with #21 Steam Generator water level at -65". In preparation for increasing Steam Generator level from -65" to -40", the Operator opened the Main Feedwater Isolation Valves. The water hammer occurred immediately. The affected system was main feedwater, with the damaged components being the #21 Main Feedwater Isolation Valve (2-MOV-4516) motor operator and casing, a broken casting where air enters #21 Main Feedwater Regulating Valve (2-CV-1111), and a cracked yoke on the worm gear drive of the manual isolation valve to #21 Main Feedwater Regulating Bypass Valve (2-FW-132).

(2) DESCRIPTION OF DAMAGE AND POST-EVENT EXAMINATIONS

The damage resulting from the water hammer event is described in Item (1) above. The means of detecting the event was a loud, audible noise. The damage was initially assessed by visual examination of accessible piping.

The post-event examination efforts were extensive. The actual examinations conducted are summarized in Enclosure (2). The overall results of the examinations are summarized as follows:

There were no indications of damage to the feedwater piping or supports which were examined. The pressure test described in Enclosure (2) revealed no leakage from the feedwater piping subjected to the pressure test.

(3) DETERMINATION OF UNDERLYING CAUSE(S):

The root cause of the event was failure to observe the General Precaution of the Unit 2 Main Feedwater System Operating Instruction-12A, which states in part that the AFW System should be used to feed the Steam Generator any time Steam Generator water level is below -26". The event was induced by plant operations, as described above. No new systems, procedures, design or control features were involved in the event.

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REQUESTED INFORMATION REGARDING WATER HAMMER EVENT ON CALVERT CLIFFS UNIT 2 - APRIL 21, 1984

(4) PLANT DESIGN FEATURES AND OPERATIONAL PRECAUTIONS
(To minimize water hammer):

In late 1978 for Unit 2 and mid-1979 for Unit 1, we modified the Steam Generators by providing non-reducing J-Tubes to the top of the Feed Rings and covering the bottom exit nozzles. This reduced the possibility of a feedwater hammer event by extending the period of time required for the feed ring to drain once it was uncovered. These modifications were recommended by our NSSS Supplier (Combustion Engineering), and were previously installed at St. Lucie-1 and Millstone-2, which have Steam Generators similar to those at Calvert Cliffs.

Prior to installing the J-Tubes, our Unit 2 Operating License, DPR-69, contained a License Condition specifying the following feedwater addition rate limitation:

"Steam Generator Water Level Rise Rate

Except for the purpose of performing Steam Generator feedwater flow stability tests, the licensee shall whenever the secondary side water level in a Steam Generator is below the level of the feedwater sparger, limit the secondary side water level rise rate in the Steam Generator to less than 1.2 inches per minute, and shall reduce the rise rate to within this limit within two (2) minutes if this limit is exceeded. This condition shall be removed only by amendment of this license after the licensee has demonstrated to the satisfaction of the Commission that secondary side flow instability (water hammer) either will not occur, or does not result in unacceptable consequences."

This license condition was removed by License Amendment 25, dated March 10, 1980. Additional procedural guidance was incorporated in June 1980. This guidance specified that if main feedwater was lost and Steam Generator levels dropped below -26" (conservative value for top of feed ring), the AFW system should be used to restore Steam Generator levels. The AFW system should be used until Steam Generator level was greater than -26".

A review of procedural guidance provided by Combustion Engineering revealed a brief review was performed in 1979 of Steam Generator drainage paths which determined that following a reactor trip, if 5% of full main feedwater flow is maintained, the feed ring should be expected to remain filled with water.

Following this event, an engineering review of the water hammer event and existing stress calculations was conducted by the Architectural Engineer, Bechtel Power Corporation. Based upon recommendations from this review, we developed the examination schedule described in item (2) above.

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Although ASB BTP 10-2 was not specifically referenced in the Main Feedwater System testing performed following installation of the J-Tubes in the Calvert Cliffs Steam Generator feed rings, we have reviewed the BTP and can address each of the positions, as follows:

POSITION 1:

Prevent or delay water draining from the feed ring following a drop in Steam Generator water level by means such as J-Tubes.

RESPONSE:

This modification was performed on Calvert Cliffs Units 2 and 1 in late 1978 and mid 1979, respectively, as described above.

POSITION 2:

Minimize the volume of feedwater piping external to the Steam Generator which could pocket steam using the shortest possible (less than 7 feet), horizontal run of inlet piping to the Steam Generator feed ring.

RESPONSE:

The Main Feedwater feed ring inlet piping to the Steam Generator at Calvert Cliffs contains horizontal piping approximately 9' 7" maximum length between the inlet reducer and the first elbow external to the Steam Generator. The AFW piping external to the Steam Generator contains approximately 6" of piping between the first elbow external to the Steam Generator and the inlet to the Steam Generator. This information was provided to the NRC by BG&E in a letter dated March 15, 1979. This design was reviewed by the NRC and determined acceptable by a safety evaluation issued on March 10, 1980, from Mr. R. W. Reid, NRC, to Mr. A. E. Lundvall, Jr., BG&E.

POSITION 3:

Perform tests acceptable to the NRC to verify that unacceptable feedwater hammer will not occur using the plant operating procedures for normal and emergency restoration of Steam Generator water level following loss of normal feedwater and possible draining of the feed ring. Provide the procedures for these tests for approval before conducting the tests.

response:

We provided a summary of the test procedures used for the feedwater testing performed following the J-Tube modifications in a letter to the NRC dated March 15, 1979. These tests were reviewed by the NRC and described in the safety evaluation dated March 10, 1980.

ENCLOSURE (1)

REQUESTED INFORMATION REGARDING WATER HAMMER EVENT
ON CALVERT CLIFFS UNIT 2 - APRIL 21, 1984

(5) CORRECTIVE ACTION TAKEN

Following the event, we conducted an extensive investigation to identify the root cause of the event and to recommend corrective and preventive measures to minimize the possibility of recurrence.

The damaged feed water system components were repaired. The engineering evaluations performed, post event inspections and tests are described in items (2) and (4) above. Procedural precautions already in place for water hammer concerns were strengthened. Licensed personnel were informed of the event, including root cause and consequences, via a memorandum from the General Supervisor-Operations. This memorandum also reinforced the need for procedural compliance in this area.

Steam Generator water hammer events are covered in initial license training during feed water control panel lectures. The training includes events which have occurred at Calvert Cliffs. Procedures for Steam Generator refill are also covered, stressing the significance of notes and precautions concerning this condition. These items are also discussed during initial license training on heat transfer and fluid flow.

Several concerns relating to water hammer events will be reemphasized in the licensed operator requalification training program. These concerns are presently scheduled to be covered during the October and November 1984 requalification training sessions.

ENCLOSURE (2)

FEEDWATER SYSTEM INSPECTION SUMMARY

<u>DATA POINT</u>	<u>DESCRIPTION</u>	<u>FIGURE NUMBER</u>	<u>EXAM TYPE</u>	<u>ITEM NUMBER</u>
6	Pipe to Nozzle Weld at #21 Steam Generator	1	UT	1
10	Both Welds on first piping elbow external to #21 Steam Generator inside Containment	1	UT	2
20	Structural Steel of vertical snubber at data point 20	1	Visual	A
60	Structural Steel of the support at data point 60	2	Visual	A
45	Structural Steel of the support at data point 45	2	Visual	B
80	Structural Steel of the support at data point 80	2	Visual	C
45	90° Elbow at data point 45	1	UT	3
35	90° Elbow at data point 35	1	UT	4
3,4	Valve to Pipe Welds on 2-FW-1111CV	3	UT	3,4
2	Elbow Welds on 1st elbow upstream of 2-FW-131	3	UT	5
NA	Bolts in 2-FP-4156	3	Visual	1,2
75	Valve Yoke on 2-FW-4516-MOV	2	PT (Liquid Penetrant)	1
NA	Valve Yoke on 2-FW-1111CV	3	PT (Liquid Penetrant)	6
NA	Piping between 2-FW-131 and 2-FW-4516 MOV	NA	Pressure Test (900 psi for 20 min.)	NA

In addition, visual examinations were conducted on the main feedwater ring inside #21 Steam Generator and the Structural Steel of all piping supports from #21 Steam Generator to #26 A&B High Pressure Feedwater Heaters.

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