475

GPU 4.15

G PU-475

Babcock & Wilcox

Power Generation Group

P.O. Box 1260, Lynchburg, Va. 24505

Telephone: (804) 384-5111

January 23, 1979

Letter No. D-3132
File Ref: N4M-2/12B14
Ref Ltr: K-5020/4-27-78

MEB'79 01 25 565

Tennessee Valley Authority
400 Commerce Avenue
Knoxville, TN 37902

Attention: Mr. D. R. Patterson
Chief Mechanical Engineer

Bellefonte Nuclear Plant Units 1 & 2
Contract No. 71C62-54114-2
B&W Reference: NSS-15 & -16
Subject: Small Break LOCA Analysis

Gentlemen:

The attached report is in response to your reference letter. Please let us know if further discussion is required.

Very truly yours,

James McFarland
Senior Project Manager

Robert E. Lightle

By
Robert E. Lightle
Associate Project Manager

REL:dc
Attachment

cc: W. Brent Wade
J. L. Atchison
E. L. Logan

JAN 30 1979

JAN 25 1979

	DRAFT REPLY	COPY
CC:		
EEB, W8C126C-K		
CEB, W9C126C-K		
RMH		
EGS (C.M)		
CAC		
GFD (LHC)		

RLSimmons
X4192

MASTER FILE

X040181

MEDS, E4B37 C-K

N4M-2-14

Have you got CM's reply

Response to TVA Letter K-5020, Emergency Core Cooling System — Small Break LOCA Analysis N4M-2-14(AR), April 27, 1978

Via TVA Letter K-5020, TVA transmitted to B&W a report entitled, "Decay Heat Removal During a Very Small LOCA for a B&W 205-Fuel-Assembly PWR," by C. Michelson, dated January, 1978. This report presents a simplified, hand calculation review of the small break transient and potential consequences for very small breaks not explicitly examined within the small break topical for the 205 FA plant, BAW-10074A, Rev. 1. Within this paper, the following concerns were expressed for the very small breaks:

1. How is decay heat removed?
2. Will system repressurization occur? If so, could a smaller case be a worst break?
3. If the operator isolates the break, will system repressurization occur? If so, will the pressure relief valves be subjected to slug or two-phase flow?

Responses to these concerns are developed in the subsequent paragraphs.

Before discussing these concerns, a general overview of the small break transient in a B&W 205 plant needs to be briefly discussed. Small LOCAs can be viewed as a slow transient during which the RCS can be described as a sealed manometer. Because of the internals vent valves, no extensive steam bubble will form within the reactor vessel while any significant liquid inventory remains in the loop. Many experiments have been run which show that so long as a fluid, with qualities less than 70% or so, covers the core, no adverse core temperature excursion will occur at decay heat power levels. Thus, any problems with small breaks will only occur after the RCS loops have depleted their inventory.

Decay heat removal from the core region is no problem as stated above. However, decay heat removal from the system as a whole needs to be examined further. There are two ways of removing decay heat from the system; via the break and/or via the steam generator. Both of these items are discussed in detail in the TVA letter. For the very small LOCAs of interest in this discussion, it was shown that the break alone is not capable of removing all the decay heat and heat removal via the steam generator is necessary. While the TVA-predicted break size that this occurs at was not checked quantatively, the actual break size that it occurs at is inconsequential. Such a break size does exist where the steam generators are necessary.

The role of the steam generator as a heat removal source is basically as described in the letter. Initially, natural circulation will be maintained in the system and the necessary heat removal is easily accomplished. Once a steam bubble of sufficient size necessary to fill the U-bend at the top of the hot legs is formed, natural circulation will cease. The intermittant natural circulation discussed in the letter will not occur due to the slow nature of the small break transient. Once natural circulation ceases, the system will repressurize somewhat until the SG primary side liquid level drops

X040182

1 19

below the SG secondary side level and condensation heat transfer is established. During this period between the natural circulation and condensation heat removal modes, the letter expresses concerns that the liquid inventory within the system will be depleted at a rate in excess of the rates for the breaks analyzed by B&W because of the partial repressurization of the system. TVA is concerned that this ultimately will result in more core uncovery than that shown in the small break topical report BAW-10074A. This is not the case.

During the natural circulation phase, it is obvious that the smaller the break, the slower the loss of system inventory and the longer the period of natural circulation. After natural circulation ceases, system pressure will be controlled by a "volume balance." That is, the system pressure will balance at a point where the volume of fluid discharged through the break equals the volume of steam being created in the core. Since the cold leg fluid enthalpy remains unchanged during a small break transient, the volume relief out the break increases with increasing system pressure and break size. The volume of steam being generated in the core decreases with increasing pressure. As the break decreases in size, the RC system will repressurize to a higher value; thus the volume relief out the break necessary to match the volume of steam being created decreases. Therefore, the system inventory will be lost at a slower rate as break size decreases. Once the SG becomes available for condensation heat removal, the primary system pressure will depressurize to approximately the SG secondary side pressure. Since the secondary side of the SG will respond in a similar manner to that of the 0.05 ft^2 break analyzed in the topical, the primary side pressure response, following the advent of condensation heat removal, will be similar to that of the 0.05 ft^2 break. Thus, for the smaller breaks, the system inventory will always be greater than that for the 0.05 ft^2 break and the core will always remain covered and will not undergo a temperature excursion.

In the paper concerns are raised relative to isolation of the break after natural circulation is lost. The scenario presented in the letter is reasonable. Should the break be isolated at that time, system repressurization to the pressurizer safety valve setpoint is probable. Two-phase or liquid flow through the safety valves will also probably occur. Once the system depletes sufficient inventory to establish condensation heat transfer across the SG, the system will depressurize and no further loss of inventory will occur. The core will remain covered for this secenario and no temperature excursion occurs. Should the pressurizer safety valves become damaged because of the two-phase flow out the valves, the response of the system would then be similar to that presented in the FSAR for the pressurizer safety valve stuck open accident and no core uncovery occurs.

As far as the appropriateness of the operator using pressurizer level indication to trip the HPI pumps, B&W agrees that the level indication is not a reliable indication of the state of the RCS. However, use of the pressurizer level indication, along with system temperature and pressure measurements to ensure that the system is still in a substantially subcooled state, will provide sufficient guidance for operator action.

In summary, while the TVA paper raises valid concerns and gives a detailed examination of the small break transient, the small break topical report provides sufficient analyses to ensure the ability of the B&W 205 plant ECCS system to control small break in the RCS.

XC4C183 1 18

Babcock&Wilcox

Power Generation Group
P.O. Box 1260, Lynchburg, Va. 24505
Telephone: (804) 384-5111

January 23, 1979

GPU EXHIBIT 475 for ident.
3/18/82 M. A. RUDOLPH

Letter No. D-3132
File Ref: N4M-2/12B14
Ref Ltr: K-5020/4-27-78

MED '79 01 25 565

Tennessee Valley Authority
400 Commerce Avenue
Knoxville, TN 37902

Attention: Mr. D. R. Patterson
Chief Mechanical Engineer

Bellefonte Nuclear Plant Units 1 & 2
Contract No. 71C62-54114-2
B&W Reference: NSS-15 & -16
Subject: Small Break LOCA Analysis

Gentlemen:

The attached report is in response to your reference letter. Please let us know if further discussion is required.

Very truly yours,

James McFarland
Senior Project Manager

Robert E. Lightle

By
Robert E. Lightle
Associate Project Manager

REL:dc
Attachment

cc: W. Brent Wade
J. L. Atchison
E. L. Logan

JAN 30 1979

JAN 25 1979

	DRAFT REPLY	COPY
DISTRIBUTION CC:		
EEB, W8C126C-K		
CEB, W9C126C-K		
RMH		
EGB (CM)		
CAC		
GFD (LHG)		

RLSimmons
X4192

MASTER FILE

Have you got CM's reply

X040181

MEDS, E4352 2-5

1 1

Babcock & Wilcox

Power Generation Group
P.O. Box 1260, Lynchburg, Va. 24505
Telephone: (804) 384-5111

January 23, 1979

GPU EXHIBIT 475 FOR IDENT.
3/18/82 H. A. RUDOLPH

Letter No. D-3132
File Ref: N44-2/12B14
Ref Ltr: K-5020/4-27-78

MEB'79 01 25 565

Tennessee Valley Authority
400 Commerce Avenue
Knoxville, TN 37902

Attention: Mr. D. R. Patterson
Chief Mechanical Engineer

Bellefonte Nuclear Plant Units 1 & 2
Contract No. 71C62-54114-2
B&W Reference: NSS-15 & -16
Subject: Small Break LOCA Analysis

Gentlemen:

The attached report is in response to your reference letter. Please let us know if further discussion is required.

Very truly yours,

James McFarland
Senior Project Manager

Robert E. Lightle
By
Robert E. Lightle
Associate Project Manager

REL:dc
Attachment

cc: W. Brent Wade
J. L. Atchison
E. L. Logan

JAN 30 1979

JAN 25 1979

DISTRAH CC:	DRAFT REPLY	COPY
EEB, W8C125C-K		
CEB, W9C126C-K		
RAH		
EGB (CM)		
CAC		
GFD (LHC)		

RLSimmons
X4192

MASTER FILE

Have you got CM's reply

X04C181

MEDS, E4B57

Response to TVA Letter K-5020, Emergency Core Cooling System — Small Break LOCA Analysis N4M-2-14(AR), April 27, 1978

Via TVA Letter K-5020, TVA transmitted to B&W a report entitled, "Decay Heat Removal During a Very Small LOCA for a B&W 205-Fuel-Assembly PWR," by C. Michelson, dated January, 1978. This report presents a simplified, hand calculation review of the small break transient and potential consequences for very small breaks not explicitly examined within the small break topical for the 205 FA plant, BAW-10074A, Rev. 1. Within this paper, the following concerns were expressed for the very small breaks:

1. How is decay heat removed?
2. Will system repressurization occur? If so, could a smaller case be a worst break?
3. If the operator isolates the break, will system repressurization occur? If so, will the pressure relief valves be subjected to slug or two-phase flow?

Responses to these concerns are developed in the subsequent paragraphs.

Before discussing these concerns, a general overview of the small break transient in a B&W 205 plant needs to be briefly discussed. Small LOCAs can be viewed as a slow transient during which the RCS can be described as a sealed manometer. Because of the internals vent valves, no extensive steam bubble will form within the reactor vessel while any significant liquid inventory remains in the loop. Many experiments have been run which show that so long as a fluid, with qualities less than 70% or so, covers the core, no adverse core temperature excursion will occur at decay heat power levels. Thus, any problems with small breaks will only occur after the RCS loops have depleted their inventory.

Decay heat removal from the core region is no problem as stated above. However, decay heat removal from the system as a whole needs to be examined further. There are two ways of removing decay heat from the system; via the break and/or via the steam generator. Both of these items are discussed in detail in the TVA letter. For the very small LOCAs of interest in this discussion, it was shown that the break alone is not capable of removing all the decay heat and heat removal via the steam generator is necessary. While the TVA-predicted break size that this occurs at was not checked quantatively, the actual break size that it occurs at is inconsequential. Such a break size does exist where the steam generators are necessary.

The role of the steam generator as a heat removal source is basically as described in the letter. Initially, natural circulation will be maintained in the system and the necessary heat removal is easily accomplished. Once a steam bubble of sufficient size necessary to fill the U-bend at the top of the hot legs is formed, natural circulation will cease. The intermittant natural circulation discussed in the letter will not occur due to the slow nature of the small break transient. Once natural circulation ceases, the system will repressurize somewhat until the SG primary side liquid level drops

X040182

below the SG secondary side level and condensation heat transfer is established. During this period between the natural circulation and condensation heat removal modes, the letter expresses concerns that the liquid inventory within the system will be depleted at a rate in excess of the rates for the breaks analyzed by B&W because of the partial repressurization of the system. TVA is concerned that this ultimately will result in more core uncovery than that shown in the small break topical report BAW-10074A. This is not the case.

During the natural circulation phase, it is obvious that the smaller the break, the slower the loss of system inventory and the longer the period of natural circulation. After natural circulation ceases, system pressure will be controlled by a "volume balance." That is, the system pressure will balance at a point where the volume of fluid discharged through the break equals the volume of steam being created in the core. Since the cold leg fluid enthalpy remains unchanged during a small break transient, the volume relief out the break increases with increasing system pressure and break size. The volume of steam being generated in the core decreases with increasing pressure. As the break decreases in size, the RC system will repressurize to a higher value; thus the volume relief out the break necessary to match the volume of steam being created decreases. Therefore, the system inventory will be lost at a slower rate as break size decreases. Once the SG becomes available for condensation heat removal, the primary system pressure will depressurize to approximately the SG secondary side pressure. Since the secondary side of the SG will respond in a similar manner to that of the 0.05 ft^2 break analyzed in the topical, the primary side pressure response, following the advent of condensation heat removal, will be similar to that of the 0.05 ft^2 break. Thus, for the smaller breaks, the system inventory will always be greater than that for the 0.05 ft^2 break and the core will always remain covered and will not undergo a temperature excursion.

In the paper concerns are raised relative to isolation of the break after natural circulation is lost. The scenario presented in the letter is reasonable. Should the break be isolated at that time, system repressurization to the pressurizer safety valve setpoint is probable. Two-phase or liquid flow through the safety valves will also probably occur. Once the system depletes sufficient inventory to establish condensation heat transfer across the SG, the system will depressurize and no further loss of inventory will occur. The core will remain covered for this secenario and no temperature excursion occurs. Should the pressurizer safety valves become damaged because of the two-phase flow out the valves, the response of the system would then be similar to that presented in the FSAR for the pressurizer safety valve stuck open accident and no core uncovery occurs.

As far as the appropriateness of the operator using pressurizer level indication to trip the HPI pumps, B&W agrees that the level indication is not a reliable indication of the state of the RCS. However, use of the pressurizer level indication, along with system temperature and pressure measurements to ensure that the system is still in a substantially subcooled state, will provide sufficient guidance for operator action.

In summary, while the TVA paper raises valid concerns and gives a detailed examination of the small break transient, the small break topical report provides sufficient analyses to ensure the ability of the B&W 205 plant ECCS system to control small break in the RCS.