04/06/78

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TN VALLEY AUTH

DOCDATE: 03/30/78
DATE RCVD: 04/06/78

DOCTYPE: LETTER NOTARIZED: NO

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SUBJECT:
LICENSEE EVENT REPT #77-012 CONCERNING TEMPERATURE TRANSIENTS EXPERIENCED WITH THE SIX CHARCOALADSORBER BEDS IN THE OFFGAS SYSTEM.

PLANT NAME: BROWNS FERRY - UNIT 3

REVIEWER INITIAL: XRS
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********** DISTRIBUTION OF THIS MATERIAL IS AS FOLLOWS **********

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(DISTRIBUTION CODE A002)

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A004

STATES NUCLEAR REGULATORY COMMISSION
DDC DAILY ACCESSION LIST

03/31/78 PAGE 43

FILE LOCATION

#1
BR: 78083-0218 TASK NBR:
PE: LETTER FICHE NBR :
ZE: 2P+4P NOTARIZED: NO
: LPDR: YES CLASS:

ER D C RECP AFFILIATION: NE NUC ENERGY
NN D L ORG AFFILIATION: NRC

TICE OF PROPOSED ISSUANCE OF AMEND. TO OPERATING LIC. CONCERNING REEVALUATION
THE EMERGENCY CORE COOLING SYSTEM COOLING PERFORMANCE IN ACCORDANCE W/NRC
DER FOR MODIFICATION OF LIC. DTD. 03/11/77.

BR: 78086-0174 TASK NBR:
PE: LETTER FICHE NBR :
ZE: 1P+1P+15P NOTARIZED: NO
: LPDR: YES CLASS:

ER D C RECP AFFILIATION: NE NUC ENERGY
B H ORG AFFILIATION: NRC

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TA AS REQUESTED...W/ATT REPT: IODINE PATHWAY STUDY

BR: 78082-0082 TASK NBR:
PE: LETTER FICHE NBR :
ZE: 2P+1P+2P NOTARIZED: YES
: LPDR: YES CLASS:

NN D L RECP AFFILIATION: NRC
ER D C ORG AFFILIATION: NE NUC ENERGY

OPOSED TECH SPEC CHANGE AMENDING OPERATING LICENSE NO. DPR-21 DEALING WITH
LTER EFFICIENCY TESTS OF THE STANDBY GAS TREATMENT SYSTEM.

TENNESSEE VALLEY AUTHORITY

CHATTANOOGA, TENNESSEE 37401

MAR 30 1978

REGULATORY DOCKET FILE COPY

1978 APR 6 PM 2 00

US NRC DISTRIBUTION SERVICES BRANCH

DISTRIBUTION SERVICES UNIT

Mr. James P. O'Reilly, Director
U.S. Nuclear Regulatory Commission
Office of Inspection and Enforcement
Region II
230 Peachtree Street, NW., Suite 1217
Atlanta, Georgia 30303

Dear Mr. O'Reilly:

TENNESSEE VALLEY AUTHORITY - BROWNS FERRY NUCLEAR PLANT UNIT 3 - DOCKET NO. 50-296 - FACILITY OPERATING LICENSE DPR-68 - REPORTABLE OCCURRENCE REPORT BFRO-50-296/7712

The enclosed report is a supplement to my letter dated July 29, 1977, concerning temperature transients which were experienced with the six charcoal adsorber beds in the offgas system during normal operation. This report is submitted in accordance with Browns Ferry unit 3 Technical Specifications, Section 6.7.2.A.(9).

Very truly yours,

TENNESSEE VALLEY AUTHORITY

H. S. Fox
Director of Power Production

Enclosure (3)
cc (Enclosure):
Director (3)
Office of Management Information and Program Control
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Director (40)
Office of Inspection and Enforcement
U.S. Nuclear Regulatory Commission
Washington, DC 20555

A002
S
1/1

JAN 3 0 1980

Mr. James P. O'Reilly, Director
U.S. Nuclear Regulatory Commission
Office of Inspection and Enforcement
Region II
101 Marietta Street, N.W., Suite 1217
Atlanta, Georgia 30303

Dear Mr. O'Reilly:

[illegible]
[illegible]
[illegible] -296/7712

The enclosed report is a supplement to my letter dated July 20, 1977, concerning [illegible] which occurred [illegible] during normal operation. This report is submitted in accordance with Browns Ferry unit 3 Technical Specifications, Section 6.7.2.A.(9).

Very truly yours,

TENNESSEE VALLEY AUTHORITY

[illegible] Fox
Director of Power Production

Enclosure (3)
cc (Enclosure):
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Office of Management Information and Program Control
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Director (40)
Office of Inspection and Enforcement
U.S. Nuclear Regulatory Commission
Washington, DC 20555

NRC FORM 366
(7-77)

U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT

EXHIBIT A

CONTROL BLOCK: (1) (PLEASE PRINT OR TYPE ALL REQUIRED INFORMATION)

01 | A L B R F 3 (2) | 0 0 - 0 0 0 0 0 - 0 0 (3) | 4 1 1 1 1 (4) | (5)
LICENSEE CODE | LICENSE NUMBER | LICENSE TYPE | CAT

CON'T 01 | REPORT SOURCE L (6) | 0 5 0 0 0 2 9 6 (7) | 0 7 1 7 7 7 (8) | 0 3 2 8 7 8 (9)
DOCKET NUMBER | EVENT DATE | REPORT DATE

EVENT DESCRIPTION AND PROBABLE CONSEQUENCES (10)

02 During normal operation, temperature transients were experienced with
03 the six charcoal adsorber beds in the offgas system. The stack radiation
04 monitor showed no increases during this period. There were no effects
05 upon public health and safety; redundancy was not applicable; and there
06 were no previous occurrences.
07
08

09	SYSTEM CODE	CAUSE CODE	CAUSE SUBCODE	COMPONENT CODE	COMP. SUBCODE	VALVE SUBCODE
	M B (11)	X (12)	X (13)	F I L T E R (14)	Z (15)	Z (16)

(17) LER/RO REPORT NUMBER	EVENT YEAR		SEQUENTIAL REPORT NO.		OCCURRENCE CODE	REPORT TYPE		REVISION NO.
	7 7	—	0 1 2	/	0 1	T	—	1

ACTION TAKEN	FUTURE ACTION	EFFECT ON PLANT	SHUTDOWN METHOD	HOURS (22)	ATTACHMENT SUBMITTED	NPRD-4 FORM SUB.	PRIME COMP. SUPPLIER	COMPONENT MANUFACTURER
X (18)	F (19)	A (20)	Z (21)	0 0 0 0	Y (23)	N (24)	N (25)	G 0 8 0 (26)

CAUSE DESCRIPTION AND CORRECTIVE ACTIONS (27)

10 A drainline on the offgas preheater was found plugged. Without adequate
11 preheating, dilution steam condensed on the catalyst preventing the recom-
12 bination of hydrogen and oxygen. Ignition of the hydrogen and oxygen in
13 the offgas system downstream of the recombiner apparently ignited the char-
14 coal. The drainline was unplugged and the charcoal beds were returned to
(See attached sheet)

15	FACILITY STATUS	% POWER	OTHER STATUS (30)	METHOD OF DISCOVERY	DISCOVERY DESCRIPTION (32)
	E (28)	0 4 7 (29)	N/A	A (31)	Increased heat in adsorber beds

16	ACTIVITY RELEASED	CONTENT OF RELEASE	AMOUNT OF ACTIVITY (35)	LOCATION OF RELEASE (36)
	Z (33)	Z (34)	N/A	N/A

PERSONNEL EXPOSURES

17	NUMBER	TYPE	DESCRIPTION (39)
	0 0 0 (37)	Z (38)	N/A

PERSONNEL INJURIES

18	NUMBER	DESCRIPTION (41)
	0 0 0 (40)	N/A

LOSS OF OR DAMAGE TO FACILITY (43)

19	TYPE	DESCRIPTION
	Z (42)	N/A

PUBLICITY

20	ISSUED	DESCRIPTION (45)	NRC USE ONLY
	(44)	TVA Press Release dated July 18, 1977.	

NAME OF PREPARER ________ PHONE: ________

*Revision 9/5/78

Cause Description and Corrective Actions (Continued)

service and satisfactorily passed operational testing.

JGD:SGS
3/27/78

EVENT DESCRIPTION

At 2215 hours on 7/15/77 the unit was returned to service after being shutdown since 7/7/77. During startup, problems were encountered with high offgas flow rates, low recombiner preheat temperatures, and low recombiner temperatures.

At 0900 hours on 7/17/77 operations was notified by a chemical laboratory analyst that the concentration of hydrogen in the offgas system was greater than 4%. One of the redundant hydrogen analyzers was in service during this period, but did not indicate an abnormal concentration of hydrogen in the offgas system. Subsequent analysis at 1345 indicated hydrogen concentration was less than 4%. About 1200 hours on 7/17/77, an attempt was made to place the standby steam jet air ejector (SJAE) "B" in service. Problems were encountered with the pressure controller regulating dilution steam to the third stage of SJAE. During the 1-3/4 hour period associated with the unsuccessful attempt to transfer SJAE's, several significant but brief transients were noticed in system pressure, apparently due to excessive dilution steam. Increases were noticed in system flow rate, dew point, and reheater inlet temperature. Efforts to transfer the SJAE were terminated at 1400 hours on 7/17/77, and system operation using the original "A" SJAE resumed. The stack radiation monitor showed no increase during this period. The charcoal adsorber beds were in service with parallel flow through two trains of three vessels each.

An effort to switch to the standby recombiner was unsuccessful because acceptable preheater temperatures could not be obtained.

DESCRIPTION OF THE OCCURRENCE

At about 1200 hours on 7/17/77, the temperature of adsorber beds "B," "C," "D," and "F" began to increase from their steady state average temperature of 67° F. The temperature of "C" bed peaked at 146° F at 1645 hours, and "D" bed temperature peaked at 146° F at 1720 hours. The indicator temperature of "B" bed went offscale (150° F) at 1610, and "F" bed temperature peaked at 138° F at 1815 hours. The temperature of the vault housing the charcoal vessels increased steadily beginning after 1200 hours on 7/17/77, from its normal 75° F to 100° F over a 7-hour period.

The charcoal vessels were isolated at 2000 hours and the offgas flow was routed through the bypass line. On 7/18/77 at 0420 hours a nitrogen purge was began through "B" and "C" vessels.

On 7/18/77, at 1200 hours the adsorber vault room was entered. The bottom of "D" vessel was found to be hot with its blue-gray paint discolored but not blistered or cracked. A slight discoloration of the paint covering the center portion of "B" vessel was evident. Thermocouples were attached to the exterior surfaces of vessels "B" and "D" for supplemental monitoring during the nitrogen purge. The maximum skin temperature recorded was 142° F at midpoint of "B" vessel.

All vessel temperatures were within the normal range on 7/20/77.

CORRECTIVE ACTION

A task force composed of TVA operating and design employees and GE employees met at BFNP on 7/20/77 and 7/21/77 to investigate the occurrence. On 7/22/77 the unit was removed from service to facilitate repair work recommended by the task force. During the outage, work on the preheater drainlines revealed that two common sections of 1-1/2" line were restricted. Since external means were used to dislodge the blockage, the cause for the blockage is not known. It was these blocked drainlines which prevented normal steam flow through either of the recombiner's preheaters. Without adequate preheat, condensation formed in the preheater. This condensate carried over to the recombiner vessel, covered the catalyst, and prevented recombination. When the recombiner drain was opened, moisture drained off the catalyst reinitiating recombination.

The existing bottom drains on the charcoal beds were found to be inadequate to drain the entire system. A Design Change Request to install a low point drain on the inlet to each vessel has been initiated.

Restricted sample lines preventing the hydrogen analyzer from functioning were blown free. The sensor measuring the moisture content of the influent to the charcoal beds was coated with dirt and had to be replaced. Methods to improve the reliability of these two instruments are being pursued. On 7/23/77 the unit was returned to service after demonstrating satisfactory operation of both preheaters, both recombiners, both hydrogen analyzers, and "B" SJAE.

Plant procedures have been reviewed and revised to include explicit actions to be taken in the event vital offgas system parameters deviate from their designed range.

Samples of the charcoal in "B" vessel were taken and examined. No evidence of discoloration or degradation was seen. The moisture content of the samples was determined to be 2%. Samples of the charcoal in the other beds will be taken to ensure it is dry before the beds are placed back in service.

An extensive investigation was conducted to determine the cause of the temperature excursion. All evidence suggests a hydrogen ignition in the offgas system ignited carbon fines in adsorber beds B and D which resulted in some sustained combustion. This heat was transported by the offgas flow to other beds as evidenced by the swings in bed temperature.

The system was operated for approximately 12 hours (midnight until noon) just before the incident with no recombination taking place. Since there was no flow on the steam side of the offgas preheater because of the blocked preheater drain, the dilution steam, instead of being preheated, was at saturated temperature. This resulted in condensation on the catalyst which prevented recombination from taking place. Without recombination, the radiolytic production rate of hydrogen (about 50 cfm at that time) and the offgas flow (200 cfm at the time of the incident) gave a hydrogen concentration from the inlet of the holdup pipe to the stack of 25%.

The SJAE logic is such that one jet must be shut completely down before the other can be started. This results in about a two-minute period in changing SJAE's when there is no dilution steamflow. Quite likely, when the attempt was being made to switch from "A" to "B" set of SJAE's misting over of the catalyst ceased when "A" SJAE was shutdown, and, during the two-minute interval before "B" was started up, hydrogen diffused back into either recombiner (the valve on the standby recombiner was cracked open), contacted the now-active catalyst, and ignition took place. Velocity of a flame front of this sort is about 6,000 fps (reference 1) and accounts for the "blown apart" appearance of the pre- and after-filter elements.

The theory of spontaneous combustion by moisture adsorption does not seem possible for this type of system. Experimental data utilizing moist gas flow (references 2 and 3) gave temperature increases at least an order of magnitude below the ignition point of carbon; and, in fact after an initial temperature peak, further temperature rises were not possible due to the thermal desorption of the water. In other words, spontaneous combustion appears to be a self-limiting phenomenon given a set of airflow and humidity conditions. Experimental data with no airflow also gave a very low temperature rise ($46^{\circ}F$) for the size of carbon bed in question (reference 4).

Ignition by hydrogen flame appears the most plausible; and, in fact, an almost identical circumstance occurred in 1958 (reference 5).

The charcoal beds were returned to service on November 11, 1977. Special Test 155 was performed to closely monitor differential pressure and isotopic delay times during the first two months of service. All system parameters closely paralleled values obtained during the initial startup testing program. Thus, the July 17, 1977, temperature excursion did not affect the performance of the charcoal beds.

JGD:SGS
3/27/78

Attachment III

References

1. Carlson, Knight, Henrie, Flame and Detonation Initiation and Propagation in Various Hydrogen-Air Mixtures, With and Without Water Spray, Atomics International Division, issued May 11, 1973.

2. J. L. Kovach, The Evaluation of the Ignition Temperature of Activated Charcoals in Air, Steam, Oxygen and Oxides of Nitrogen, Nuclear Consulting Services, Inc., NUCON 024, 1968.

3. Dederick, Martin, Porter, Reactions of Hydrogen/Oxygen Mixtures with Charcoal and Thermal Effects Associated with Physical Adsorption, General Electric Company, Report No. 72CRD182, June 1972.

4. Personal correspondence between Dan L. Paul, TVA Chemical Section, and Willard Clark, President, Barnebey - Chaney, July 28, 1977.

5. Browning, Removal of Fission Product Activity from Gases, Nuclear Safety 1 (4), page 49, June 1960.

JGD:SGS
3/27/78

NRC FORM 366 (7-77)

U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT

EXHIBIT A

CONTROL BLOCK: [| | | | |] (1) (PLEASE PRINT OR TYPE ALL REQUIRED INFORMATION)

0 1	A L B R F 3 (2)	0 0 - 0 0 0 0 0 - 0 0 (3)	4 1 1 1 1 (4)	(5)
	LICENSEE CODE	LICENSE NUMBER	LICENSE TYPE	CAT

CON'T

0 1	REPORT SOURCE: L (6)	0 5 0 0 0 2 9 6 (7)	0 7 1 7 7 7 (8)	0 3 2 8 7 8 (9)
		DOCKET NUMBER	EVENT DATE	REPORT DATE

EVENT DESCRIPTION AND PROBABLE CONSEQUENCES (10)

0 2 During normal operation, temperature transients were experienced with
0 3 the six charcoal adsorber beds in the offgas system. The stack radiation
0 4 monitor showed no increases during this period. There were no effects
0 5 upon public health and safety; redundancy was not applicable; and there
0 6 were no previous occurrences.
0 7
0 8

0 9	SYSTEM CODE	CAUSE CODE	CAUSE SUBCODE	COMPONENT CODE	COMP. SUBCODE	VALVE SUBCODE
	M B (11)	X (12)	X (13)	F I L T E R (14)	Z (15)	Z (16)

(17) LER/RO REPORT NUMBER

EVENT YEAR		SEQUENTIAL REPORT NO.		OCCURRENCE CODE	REPORT TYPE		REVISION NO.
7 7	—	0 1 2	/	0 1	T	—	1

ACTION TAKEN	FUTURE ACTION	EFFECT ON PLANT	SHUTDOWN METHOD	HOURS (22)	ATTACHMENT SUBMITTED	NPRD-4 FORM SUB.	PRIME COMP. SUPPLIER	COMPONENT MANUFACTURER
X (18)	F (19)	A (20)	Z (21)	0 0 0 0	Y (23)	N (24)	N (25)	G 0 8 0 (26)

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1 0 A drainline on the offgas preheater was found plugged. Without adequate
1 1 preheating, dilution steam condensed on the catalyst preventing the recom-
1 2 bination of hydrogen and oxygen. Ignition of the hydrogen and oxygen in
1 3 the offgas system downstream of the recombiner apparently ignited the char-
1 4 coal. The drainline was unplugged and the charcoal beds were returned to
(See attached sheet)

1 5	FACILITY STATUS	% POWER	OTHER STATUS (30)	METHOD OF DISCOVERY	DISCOVERY DESCRIPTION (32)
	E (28)	0 4 7 (29)	N/A	A (31)	Increased heat in adsorber beds

1 6	ACTIVITY RELEASED	CONTENT OF RELEASE	AMOUNT OF ACTIVITY (35)	LOCATION OF RELEASE (36)
	Z (33)	Z (34)	N/A	N/A

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1 7	NUMBER	TYPE	DESCRIPTION (39)
	0 0 0 (37)	Z (38)	N/A

PERSONNEL INJURIES

1 8	NUMBER	DESCRIPTION (41)
	0 0 0 (40)	N/A

LOSS OF OR DAMAGE TO FACILITY (43)

1 9	TYPE	DESCRIPTION
	Z (42)	N/A

PUBLICITY

2 0	ISSUED	DESCRIPTION (45)	NRC USE ONLY
	(44)	TVA Press Release dated July 18, 1977.	

NAME OF PREPARER ______________________ PHONE: ______________

*Revision [signature]

Cause Description and Corrective Actions (Continued)

service and satisfactorily passed operational testing.

JGD:SGS
3/27/78

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JGD:SGS
3/27/78

Attachment III

References

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2. J. L. Kovach, The Evaluation of the Ignition Temperature of Activated Charcoals in Air, Steam, Oxygen and Oxides of Nitrogen, Nuclear Consulting Services, Inc., NUCON 024, 1968.

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5. Browning, Removal of Fission Product Activity from Gases, Nuclear Safety 1 (4), page 49, June 1960.

JGD:SGS
3/27/78

NRC FORM 366 (7-77)

U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT

EXHIBIT A

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LICENSEE CODE | LICENSE NUMBER | LICENSE TYPE | CAT

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09 M B (11)	X (12)	X (13)	F I L T E R (14)	Z (15)	Z (16)

(17) LER/RO REPORT NUMBER: EVENT YEAR 7 7 — SEQUENTIAL REPORT NO. 0 1 2 / OCCURRENCE CODE 0 1 — REPORT TYPE T — REVISION NO. 1

ACTION TAKEN	FUTURE ACTION	EFFECT ON PLANT	SHUTDOWN METHOD	HOURS (22)	ATTACHMENT SUBMITTED	NPRD-4 FORM SUB.	PRIME COMP. SUPPLIER	COMPONENT MANUFACTURER
X (18)	F (19)	A (20)	Z (21)	0 0 0 0	Y (23)	N (24)	N (25)	G 0 8 0 (26)

CAUSE DESCRIPTION AND CORRECTIVE ACTIONS (27)

10 A drainline on the offgas preheater was found plugged. Without adequate
11 preheating, dilution steam condensed on the catalyst preventing the recom-
12 bination of hydrogen and oxygen. Ignition of the hydrogen and oxygen in
13 the offgas system downstream of the recombiner apparently ignited the char-
14 coal. The drainline was unplugged and the charcoal beds were returned to
(See attached sheet)

	FACILITY STATUS	% POWER	OTHER STATUS (30)	METHOD OF DISCOVERY	DISCOVERY DESCRIPTION (32)
15	E (28)	0 4 7 (29)	N/A	A (31)	Increased heat in adsorber beds

	ACTIVITY RELEASED	CONTENT OF RELEASE	AMOUNT OF ACTIVITY (35)	LOCATION OF RELEASE (36)
16	Z (33)	Z (34)	N/A	N/A

PERSONNEL EXPOSURES

	NUMBER	TYPE	DESCRIPTION (39)
17	0 0 0 (37)	Z (38)	N/A

PERSONNEL INJURIES

	NUMBER	DESCRIPTION (41)
18	0 0 0 (40)	N/A

LOSS OF OR DAMAGE TO FACILITY (43)

	TYPE	DESCRIPTION
19	Z (42)	N/A

PUBLICITY

	ISSUED	DESCRIPTION (45)	NRC USE ONLY
20	(44)	TVA Press Release dated July 18, 1977.	

NAME OF PREPARER ______ PHONE: ______

*Revision 9/5/78

Cause Description and Corrective Actions (Continued)

service and satisfactorily passed operational testing.

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3/27/78

EVENT DESCRIPTION

At 2215 hours on 7/15/77 the unit was returned to service after being shutdown since 7/7/77. During startup, problems were encountered with high offgas flow rates, low recombiner preheat temperatures, and low recombiner temperatures.

At 0900 hours on 7/17/77 operations was notified by a chemical laboratory analyst that the concentration of hydrogen in the offgas system was greater than 4%. One of the redundant hydrogen analyzers was in service during this period, but did not indicate an abnormal concentration of hydrogen in the offgas system. Subsequent analysis at 1345 indicated hydrogen concentration was less than 4%. About 1200 hours on 7/17/77, an attempt was made to place the standby steam jet air ejector (SJAE) "B" in service. Problems were encountered with the pressure controller regulating dilution steam to the third stage of SJAE. During the 1-3/4 hour period associated with the unsuccessful attempt to transfer SJAE's, several significant but brief transients were noticed in system pressure, apparently due to excessive dilution steam. Increases were noticed in system flow rate, dew point, and reheater inlet temperature. Efforts to transfer the SJAE were terminated at 1400 hours on 7/17/77, and system operation using the original "A" SJAE resumed. The stack radiation monitor showed no increase during this period. The charcoal adsorber beds were in service with parallel flow through two trains of three vessels each.

An effort to switch to the standby recombiner was unsuccessful because acceptable preheater temperatures could not be obtained.

DESCRIPTION OF THE OCCURRENCE

At about 1200 hours on 7/17/77, the temperature of adsorber beds "B," "C," "D," and "F" began to increase from their steady state average temperature of 67° F. The temperature of "C" bed peaked at 146° F at 1645 hours, and "D" bed temperature peaked at 146° F at 1720 hours. The indicator temperature of "B" bed went offscale (150° F) at 1610, and "F" bed temperature peaked at 138° F at 1815 hours. The temperature of the vault housing the charcoal vessels increased steadily beginning after 1200 hours on 7/17/77, from its normal 75° F to 100° F over a 7-hour period.

The charcoal vessels were isolated at 2000 hours and the offgas flow was routed through the bypass line. On 7/18/77 at 0420 hours a nitrogen purge was began through "B" and "C" vessels.

On 7/18/77, at 1200 hours the adsorber vault room was entered. The bottom of "D" vessel was found to be hot with its blue-gray paint discolored but not blistered or cracked. A slight discoloration of the paint covering the center portion of "B" vessel was evident. Thermocouples were attached to the exterior surfaces of vessels "B" and "D" for supplemental monitoring during the nitrogen purge. The maximum skin temperature recorded was 142° F at midpoint of "B" vessel.

All vessel temperatures were within the normal range on 7/20/77.

CORRECTIVE ACTION

A task force composed of TVA operating and design employees and GE employees met at BFNP on 7/20/77 and 7/21/77 to investigate the occurrence. On 7/22/77 the unit was removed from service to facilitate repair work recommended by the task force. During the outage, work on the preheater drainlines revealed that two common sections of 1-1/2" line were restricted. Since external means were used to dislodge the blockage, the cause for the blockage is not known. It was these blocked drainlines which prevented normal steam flow through either of the recombiner's preheaters. Without adequate preheat, condensation formed in the preheater. This condensate carried over to the recombiner vessel, covered the catalyst, and prevented recombination. When the recombiner drain was opened, moisture drained off the catalyst reinitiating recombination.

The existing bottom drains on the charcoal beds were found to be inadequate to drain the entire system. A Design Change Request to install a low point drain on the inlet to each vessel has been initiated.

Restricted sample lines preventing the hydrogen analyzer from functioning were blown free. The sensor measuring the moisture content of the influent to the charcoal beds was coated with dirt and had to be replaced. Methods to improve the reliability of these two instruments are being pursued. On 7/23/77 the unit was returned to service after demonstrating satisfactory operation of both preheaters, both recombiners, both hydrogen analyzers, and "B" SJAE.

Plant procedures have been reviewed and revised to include explicit actions to be taken in the event vital offgas system parameters deviate from their designed range.

Samples of the charcoal in "B" vessel were taken and examined. No evidence of discoloration or degradation was seen. The moisture content of the samples was determined to be 2%. Samples of the charcoal in the other beds will be taken to ensure it is dry before the beds are placed back in service.

An extensive investigation was conducted to determine the cause of the temperature excursion. All evidence suggests a hydrogen ignition in the offgas system ignited carbon fines in adsorber beds B and D which resulted in some sustained combustion. This heat was transported by the offgas flow to other beds as evidenced by the swings in bed temperature.

The system was operated for approximately 12 hours (midnight until noon) just before the incident with no recombination taking place. Since there was no flow on the steam side of the offgas preheater because of the blocked preheater drain, the dilution steam, instead of being preheated, was at saturated temperature. This resulted in condensation on the catalyst which prevented recombination from taking place. Without recombination, the radiolytic production rate of hydrogen (about 50 cfm at that time) and the offgas flow (200 cfm at the time of the incident) gave a hydrogen concentration from the inlet of the holdup pipe to the stack of 25%.

The SJAE logic is such that one jet must be shut completely down before the other can be started. This results in about a two-minute period in changing SJAE's when there is no dilution steamflow. Quite likely, when the attempt was being made to switch from "A" to "B" set of SJAE's misting over of the catalyst ceased when "A" SJAE was shutdown, and, during the two-minute interval before "B" was started up, hydrogen diffused back into either recombiner (the valve on the standby recombiner was cracked open), contacted the now-active catalyst, and ignition took place. Velocity of a flame front of this sort is about 6,000 fps (reference 1) and accounts for the "blown apart" appearance of the pre- and after-filter elements.

The theory of spontaneous combustion by moisture adsorption does not seem possible for this type of system. Experimental data utilizing moist gas flow (references 2 and 3) gave temperature increases at least an order of magnitude below the ignition point of carbon; and, in fact after an initial temperature peak, further temperature rises were not possible due to the thermal desorption of the water. In other words, spontaneous combustion appears to be a self-limiting phenomenon given a set of airflow and humidity conditions. Experimental data with no airflow also gave a very low temperature rise (46°F) for the size of carbon bed in question (reference 4).

Ignition by hydrogen flame appears the most plausible; and, in fact, an almost identical circumstance occurred in 1958 (reference 5).

The charcoal beds were returned to service on November 11, 1977. Special Test 155 was performed to closely monitor differential pressure and isotopic delay times during the first two months of service. All system parameters closely paralleled values obtained during the initial startup testing program. Thus, the July 17, 1977, temperature excursion did not affect the performance of the charcoal beds.

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3/27/78

Attachment III

References

1. Carlson, Knight, Henrie, Flame and Detonation Initiation and Propagation in Various Hydrogen-Air Mixtures, With and Without Water Spray, Atomics International Division, issued May 11, 1973.

2. J. L. Kovach, The Evaluation of the Ignition Temperature of Activated Charcoals in Air, Steam, Oxygen and Oxides of Nitrogen, Nuclear Consulting Services, Inc., NUCON 024, 1968.

3. Dederick, Martin, Porter, Reactions of Hydrogen/Oxygen Mixtures with Charcoal and Thermal Effects Associated with Physical Adsorption, General Electric Company, Report No. 72CRD182, June 1972.

4. Personal correspondence between Dan L. Paul, TVA Chemical Section, and Willard Clark, President, Barnebey - Chaney, July 28, 1977.

5. Browning, Removal of Fission Product Activity from Gases, Nuclear Safety 1 (4), page 49, June 1960.

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3/27/78