REGULATORY INFORMATION DISTRIBUTION SYSTEM (RIDS)

ACCESSION NBR:8409250208 DOC.DATE: 84/09/19 NOTARIZED: YES DOCKET #
FACIL:STN-50-528 Palo Verde Nuclear Station, Unit 1, Arizona Publi 05000528
STN-50-529 Palo Verde Nuclear Station, Unit 2, Arizona Publi 05000529
STN-50-530 Palo Verde Nuclear Station, Unit 3, Arizona Publi 05000530
AUTH.NAME AUTHOR AFFILIATION
VAN BRUNT,E.E. Arizona Public Service Co.
RECIP.NAME RECIPIENT AFFILIATION
KNIGHTON,G. Licensing Branch 3

SUBJECT: Forwards addl info re steam generator tube rupture analysis per NRC 840427 request.

DISTRIBUTION CODE: B001D COPIES RECEIVED:LTR 1 ENCL 1 SIZE: 18
TITLE: Licensing Submittal: PSAR/FSAR Amdts & Related Correspondence

NOTES:Standardized plant. 05000528
Standardized plant. 05000529
Standardized plant. 05000530

	RECIPIENT ID CODE/NAME		COPIES LTTR	COPIES ENCL	RECIPIENT ID CODE/NAME		COPIES LTTR	COPIES ENCL
	NRR/DL/ADL		1	0	NRR LB3 BC		1	0
	NRR LB3 LA		1	0	LICITRA,E	01	1	1
INTERNAL:	ADM/LFMB		1	0	ELD/HDS3		1	0
	IE FILE		1	1	IE/DEPER/EPB	36	3	3
	IE/DEPER/IRB	35	1	1	IE/DQASIP/QAB	21	1	1
	NRR/DE/AEAB		1	0	NRR/DE/CEB	11	1	1
	NRR/DE/EHEB		1	1	NRR/DE/EQB	13	2	2
	NRR/DE/GB	28	2	2	NRR/DE/MEB	18	1	1
	NRR/DE/MTEB	17	1	1	NRR/DE/SAB	24	1	1
	NRR/DE/SGEB	25	1	1	NRR/DHFS/HFEB	40	1	1
	NRR/DHFS/LQB	32	1	1	NRR/DHFS/PSRB		1	1
	NRR/DL/SSPB		1	0	NRR/DSI/AEB	26	1	1
	NRR/DSI/ASB		1	1	NRR/DSI/CPB	10	1	1
	NRR/DSI/CSB	09	1	1	NRR/DSI/ICSB	16	1	1
	NRR/DSI/METB	12	1	1	NRR/DSI/PSB	19	1	1
	NRR/DSI/RAB	22	1	1	NRR/DSI/RSB	23	1	1
	REG FILE	04	1	1	RGN5		3	3
	RM/DDAMI/MIB		1	0				
EXTERNAL:	ACRS	41	6	6	BNL(AMDTS ONLY)		1	1
	DMB/DSS (AMDTS)		1	1	FEMA-REP DIV	39	1	1
	LPDR	03	1	1	NRC PDR	02	1	1
	NSIC	05	1	1	NTIS		1	1

TOTAL NUMBER OF COPIES REQUIRED: LTTR 54 ENCL 46

21 [illegible]

Arizona Public Service Company

ANPP-30572 EEVBJr/TFQ
September 19, 1984

Director of Nuclear Reactor Regulation
Attention: Mr. George Knighton, Chief
Licensing Branch No. 3
Division of Licensing
U.S Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Palo Verde Nuclear Generating Station (PVNGS)
Units 1, 2 and 3
Docket Nos. STN-50-528/529/530
File: 84-056-026; G.1.01.10

Reference: 1) Letter from G.W. Knighton, NRC, to E.E. Van Brunt, Jr., APS, dated April 27, 1984. Subject: Request for Additional Information - Palo Verde Steam Generator Tube Rupture Analysis.

2) Drawing No. 13-J-SGE-001 Rev. 1, Pneumatic Loop Diagram Atmospheric Dump Valves

Dear Mr. Knighton:

Please find attached the responses to your questions regarding the Steam Generator Tube Rupture Analysis as requested by the referenced letter.

If there are any questions concerning this matter, please contact me.

Very truly yours,

E E Van Brunt /

E. E. Van Brunt, Jr.
APS Vice President
Nuclear Production
ANPP Project Director

EEVB/KLM/wpc

Attachment

cc: E.A. Licitra (w/a)
A.C. Gehr (w/a)

B001
1/1

STATE OF ARIZONA)
) ss.
COUNTY OF MARICOPA)

I, A. Donald B. Karner, represent that I am Assistant Vice President of Arizona Public Service Company, that the foregoing document has been signed by me for Edwin E. Van Brunt, Jr., Vice President, Nuclear Production, on behalf of Arizona Public Service Company with full authority so to do, that I have read such document and know its contents, and that to the best of my knowledge and belief, the statements made therein are true.

Donald B. Karner

Sworn to before me this 19th day of September, 1984

Notary Public

My Commission Expires:

My Commission Expires April 6, 1987

RESPONSE TO NRC
QUESTIONS CONCERNING
SGTR ANALYSIS

QUESTION 1

In the SGTR analysis for Palo Verde Units submitted by your letter dated January 27, 1984, the acceptability of the radiological consequences is heavily dependent on the operator's action on controlling the cooldown rate. It is assumed in the analysis that the operator has to open one ADV in each steam generator at a 10.5% opening position to ensure a maximum cooldown rate of 75°F. The staff notes that the ADVs have no device to limit their opening to the assumed 10.5%, and other calculations have shown that an opening of slightly less than 12% would result in exceeding the 10 CFR Part 100 guideline values. Also, there are no specific limits in either the technical specifications or procedures to restrict opening of the ADV to less than the 10.5% assumed. There is only the maximum cooldown rate limit of 75°F/hr, a value that we believe is difficult for the operator to determine during a complicated event like the SGTR. Discuss what positive measures will be taken to ensure that the assumed ADV opening position and cooldown rate will not be exceeded.

Response

The January 27, 1984 analysis of the SGTR with the loss-of-offsite power and the failure of the stuck open ADV event assumed that, once the operator identified and pursued isolating the affected steam generator, all auxiliary feedwater flow ceased to that generator. This approach was chosen to maximize radiological consequences pursuant to direction from the Regulatory Staff. This arbitrary restriction results in the hypothetical radiological consequences being very sensitive to valve opening position because of the subsequent tube uncovery.

QUESTION 1 (Cont'd)

Response (Cont'd)

Further review of this non-design-basis accident calculation has indicated that it is unnecessarily conservative to assume tube uncovery. Accordingly, the PVNGS Emergency Operating Procedures will include direction to feed the affected steam generator in order to keep the tubes covered and maintain the iodine partition coefficient. This is not a deviation from the CE Emergency Procedure Guidelines (CEN-152). Rather, it is an additional consideration to be used to mitigate the consequences of a SGTR, and provides substantial benefits for the instances where the ruptured steam generator cannot be isolated from the atmosphere (e.g., stuck open ADV). This multiple failure event, SGTR and a fully stuck open ADV, was not contemplated by CEN-152, just as it is not considered by the NRC's Standard Review Plan.

This modification to the PVNGS Procedure will be incorporated before fuel load of PVNGS Unit 1. Training of the operators will commence soon after approval of the procedure modification, and will require approximately 3 months to train all of the Unit 1 shifts. This training should be complete by initial criticality. Training will include simulator time and will emphasize the reduction of offsite releases and the potential for overfill of the affected steam generator.

Including this additional procedure into the analysis leads to a revised 0 to 2 hour Thyroid Dose of 200 Rem including a fully (100%) open atmospheric dump valve and a pre-existing iodine spike. This is the highest dose (refer to Table 1 for the complete dose results) and is well within Part 100 criteria.

It should be noted that a stuck, fully open ADV is not considered a credible event as there is no single failure that can cause the valve to run full open and stay there. Refer also to the response provided for Question 3.

QUESTION 2

The SGTR analysis also assumes a cooldown rate of 30°F/hr at 30 minutes after the attempted closing of the affected steam generator ADV. Describe how the operator monitors the plant conditions to prevent the cooldown rate exceeding 30°F/hr during this time period.

Response

The long term cooldown rate of 30°F/hr was chosen for the January 27, 1984 analysis so that shutdown cooling conditions were reached 8 hours after the event. This maximized the 0-8 hour dose. A more rapid, or a slower, cooldown would release less steam from the ruptured steam generator.

This assumption is not used in the revised analysis presented in the Response to Question 1.

QUESTION 3

Since the ADVs at Palo Verde do not have upstream block values, there would be virtually no way of isolating a stuck open ADV. The staff believes from an overall plant safety standpoint, Palo Verde should install block valves upstream of the ADVs, per the interface requirement stated in the CESSAR System 80 FSAR. Discuss your technical justification for a lack of the block valves, especially in light of industry experience suggesting that stuck open steam system valves are not an uncommon occurrence.

Additionally, the Palo Verde SGTR analysis should either assume an ADV stuck in the full open position, or the applicant should provide positive assurance that the ADV cannot be opened beyond the assumed 10.5%.

Response

The analysis presented in the Response to Question 1 assumes an ADV stuck in the full open position. Nevertheless, this is not considered a credible single failure.

The PVNGS ADV's are air operated hydraulic valves. The valves are spring loaded to fail close on loss of air. Additionally, they may be closed by air or by an integral handwheel, if necessary. In order for the valve to open, an air supply must be provided. Two parallel sets of fail closed 3-way solenoid valves (four total) provide the air supply. In the closed position, the valves isolate the air supply and bleed air off of the ADV. The solenoid valves are powered by 2 channels of essential DC power. Each valve is controllable from the Control Room. Closure of any one valve is sufficient to terminate the air supply and close the ADV. The control schematic is provided as Figure 1.

QUESTION 3 (Cont'd)

Response (Cont'd)

Should all four solenoid valves fail by remaining energized, the operator can regulate the air supply by using the valve positioner and controller. These will also be able to close the ADV. In short, for the ADV to open and remain open, there must be six failures involving two channels of DC power. This is considered an incredible event.

Mechanical binding of the valve was also considered. In order to remain open, the valve would need to seize up so firmly that neither air pressure, spring nor manual handwheel operation would be able to close the valve. This would result in the valve sticking at the operating range. As noted in the January 27, 1984 analysis, offsite dose exposure is less than 150 Rem even with the tubes uncovered. Under the revised analysis of Question 1, with the tubes covered, the dose is 41 Rem (Table 1).

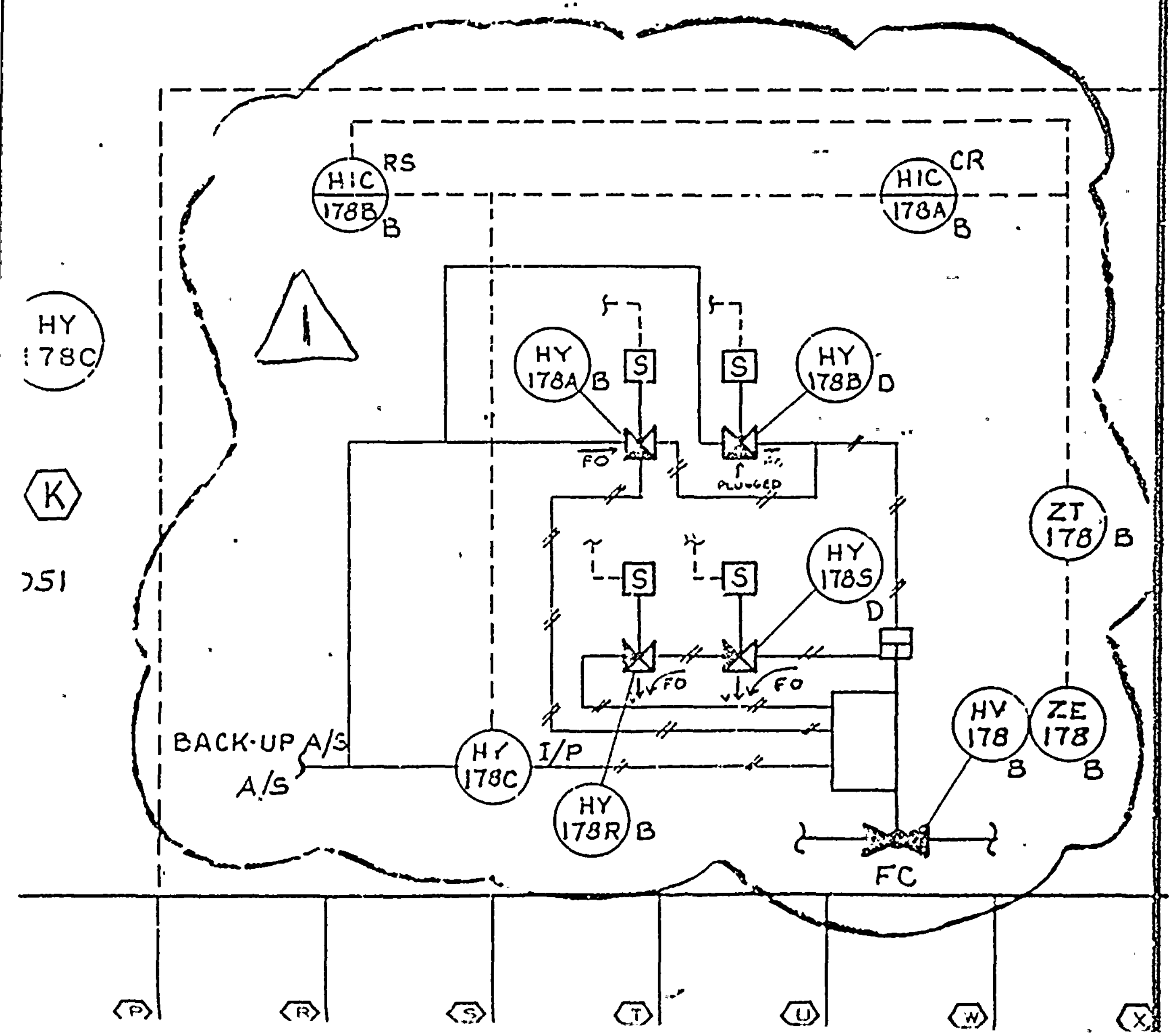
TABLE 1

RADIOLOGICAL CONSEQUENCES OF THE STEAM GENERATOR TUBE RUPTURE WITH A LOSS OF OFFSITE POWER AND FULLY STUCK OPEN ADV

Location	Offiste Doses, Rems	
	GIS	PIS
1. Exclusion Area Boundary 0-2 hr. Thyroid	40	200
2. Low Population Zone Outer Boundary 0-8 hr. Thyroid	20	41

FIELD
EF. EL. 85′ -6"

FIGURE 1



APPENDIX

Steam Generator Tube Rupture With A Loss of Offsite Power and a Fully Stuck Open Atmospheric Dump Valve (ADV)

Identification of Event and Causes

This transient is similar to that described in CESSAR Appendix 15D. It assumes that the plant is challenged by a steam generator tube rupture that includes additional events and failures beyond those postulated by the NRC Standard Review Plan 15.6.3. In addition to the conservative assumptions of the SRP (loss of offsite power, accident meteorology, iodine spiking, etc.), this analysis postulates that the operators open an ADV on the affected steam generator and that it both runs to the full open position and that it sticks full open for the duration of the transient. The ADV is presumed to remain open despite the availability of two redundant and independent safety grade valve control systems and a manual handwheel to close the ADV.

Sequence of Events and Systems Operation

Table 15A-1 presents a chronological list of events which are assumed to occur during the steam generator tube rupture event with a loss of offsite power from the time of the double-ended rupture of a steam generator U-tube to the attainment of shutdown cooling entry conditions.

The CE Emergency Procedure Guidelines, CEN-152, contain guidance to the operator for controlling a steam generator tube rupture. Recognizing that the coincident occurrence of the limiting (conservative) assumptions of the SRP is unlikely, CEN-152 proposes that, should offsite power and the steam bypass control system be unavailable, the operator opens an ADV

APPENDIX (Continued)

on each steam generator (ruptured or not) in order to preclude a challenge to the main steam safety valves (MSSVs). This action presupposes that the ADVs are reliable and can be closed after the RCS is cooled to a temperature which precludes a challenge to the MSSVs. It also presupposes that the MSSVs have not opened. However, due to the coincident conservative assumptions of the SRP, the MSSVs open early in the transient. Furthermore, Palo Verde procedures are oriented towards diagnosing the event and stabilizing the plant prior to initiating cooldown.

Because of the PVNGS emphasis on proper diagnosis prior to operator action, it is unlikely that the operator would open the ADV once the diagnosis indicated an SGTR.

Nevertheless, this scenario assumes that once an operator diagnoses a SGTR, he opens an ADV (as suggested in CEN 152). To recover from this scenario, the plant specific Palo Verde Steam Generator Tube Rupture Procedure includes direction to the operator to maintain steam generator level such that the steam generator tubes are covered.

As is evident, the multiple failure scenario being postulated is not internally consistent. However, for analytical purposes, the sequence of events described in Table A-1 serves to bound the scenario by projecting the adverse operator action (full opening of the ADV on the ruptured generator) and the non-mechanistic ADV failure to occur at the earliest possible time consistent with ANSI Standard N660. Subsequent beneficial operator actions are delayed by times that are also consistent with the ANSI Standard.

APPENDIX (Continued)

Accordingly, an analytical model was developed from the bounding assumptions. The model features include:

- secondary releases from both the MSSVs and ADVs
- early operator action to open the ADVs
- one potential series of operator actions to cover the S/G tubes
- time delays for operator recovery action
- delay in reaching shutdown cooling (chosen to maximize 8-hour steam release)

The disposition of normally operating systems for the SGTR event are the same as those presented in Table 15D-2 of CESSAR. The utilization of Safety Systems during the event is the same as that presented in Table 15D-3 of CESSAR.

The major assumptions regarding systems operation during the event are summarized below.

1) The auxiliary feedwater system (AFWS) is activated at 25% level wide range and shuts off at 30% level wide range prior to operator action.

2) Two AFW pumps are assumed to be available to supply feedwater to either steam generator. No credit is taken for the third IE powered AFW train. An AFW flow rate of 750 gpm per pump is assumed to be delivered to the steam generators at a SG pressure of 1270 psia.

3) The response times of ADVs, MSIVs, AFW control valves, and AFW flow isolation valves are assumed to be instantaneous.

APPENDIX (Continued)

4) After the loss of offsite power subsequent to reactor trip, no credit is taken for charging. One charging pump is assumed available for auxiliary spray in the pressurizer.

5) Two high pressure safety injection (HPSI) pumps are assumed to be available subsequent to the generation of a safety injection actuation signal.

RADIOLOGICAL CONSEQUENCES

The physical model is the same as that discussed in CESSAR Section 15D.3.2 except that the ADV of the affected steam generator opens fully. In order to reduce the radiological releases, the operator takes appropriate actions to recover the U-tubes of the affected steam generator. Actions assumed in this analysis included overriding the automatic isolation of AFW flow to the affected steam generator and diverting the flow of both AFW pumps of the affected steam generator.

The assumptions and conditions employed for the evaluation of radiological releases are the same as those discussed in CESSAR Section 15D.3.2.B with the exceptions of assumptions 7, 9, and 10. They are:

7. During the period when the water level in the affected steam generator is above the top of the U-tubes, that portion of the leaking primary fluid which flashes to steam upon entering the steam generator is assumed to be released to the atmosphere with a decontamination factor (DF) of 1.0. The portion of the leaked fluid that does not flash, mixes with the liquid in the steam generator and is released to the atmosphere with a DF of 100. During the period when the water level is below the top of the U-tubes, it is assumed that all the leaking primary fluid escapes to the atmosphere with a DF of 1.0. No credit is taken for the presence of steam separators and dryers which would retain a part of the escaping primary liquid in the steam generator.

APPENDIX (Continued)

9. The 0-2 hour and 2-8 hour primary-to-secondary leakage through the rupture are 285,400 lbm and 516,700 lbm, respectively.

10. The atmospheric dispersion factors employed in the analyses are: 3.1×10^{-4} sec/m^3 for the exclusion area boundary and 5.1×10^{-5} sec/m^3 for the low population zone.

The mathematical model is as described in CESSAR Section 15D.3.2.C.

The two-hour exclusion area boundary (EAB) and the eight-hour low population zone (LPZ) boundary inhalation doses for both the GIS and the PIS are presented in Table A-2. The calculated EAB and LPZ doses are well within the acceptance criteria.

CONCLUSIONS

The radiological releases calculated for the SGTR event with a loss of offsite power and a fully stuck open ADV are well within the 10CFR100 guidelines. The RCS and secondary system pressures are well below the 110% of the design pressure limits, thus, assuring the integrity of these systems. Additionally, no violation of the fuel thermal limits occurs, since the minimum DNBR remains above the 1.19 value throughout the duration of the event.

TABLE A-1

SEQUENCE OF EVENTS FOR A STEAM GENERATOR TUBE RUPTURE WITH A LOSS OF OFFSITE POWER AND FULLY STUCK OPEN ADV

Time (Sec)	Event	Setpoint or Value	Success Path or Comment
0.0	Tube Rupture Occurs	---	
40	Third Charging Pump Started, feet below program level	-0.75	Primary System Integrity
40	Letdown Control Valve Throttled Back to Minimum Flow, feet below program level	-0.75	Primary System Integrity
47	CPC Hot Leg Saturation Trip Signal	---	Reactivity Control
48	Turbine/Generator Trip: Stop Valves Start to Close	---	Secondary System Integrity
	CEAs Begin to Drop	---	Reactivity Control
51	Turbine Stop Valves Closed	---	Secondary System Integrity
	Loss of Offsite Power	---	
52	Main Steam Safety Valves open, psia	1265	Secondary System Integrity
56	Maximum Steam Generator Both Steam Generators, psia	1330	
167	Auxiliary Feedwater Actuation on Low Steam Generator Level Trip Signal, Intact Steam Generator, feet above tube sheet	19.75	Secondary System Integrity
177	Auxiliary Feedwater Actuation on Low Steam Generator Level Trip Signal, Ruptured Steam Generator, feet above tube sheet	19.75	Secondary System Integrity
460	Operator Opens One ADV on each SG	---	Reactor Heat Removal

TABLE A-1 (Continued)

SEQUENCE OF EVENTS FOR A STEAM GENERATOR TUBE RUPTURE WITH A LOSS OF OFFSITE POWER AND FULLY STUCK OPEN ADV

Time (Sec)	Event	Setpoint or Value	Success Path or Comment
460	ADV of the affected SG instantaneously opens fully		
484	Pressurizer empties		
513	MSIS Actuation, Secondary Pressure, psia	919	Secondary System Integrity
535	Automatic isolation of AFW to affected SG, ΔP SG, psi	185	Secondary System Integrity
581	Safety injection actuation signal	1578	Primary System Inventory
655	Operator overrides the AFW isolation signal and re-establishes auxiliary feedwater flow to the affected SG.		
775	Operator feeds affected SG with both AFW pumps		
895	Operator shuts the ADV of the unaffected steam generator		
1015	Operator initiates auxiliary spray to the pressurizer		
1385	Level in the affected SG above the top of U-tubes, percent wide range	71.5	
2040	Pressurizer level, percent	50	
2400	Operator controls HPSI flow, backup pressurizer heater output, and auxiliary spray flow to control RCS pressure and subcooling, °F	20	

TABLE A-1 (Continued)

SEQUENCE OF EVENTS FOR A STEAM GENERATOR TUBE RUPTURE WITH A LOSS OF OFFSITE POWER AND FULLY STUCK OPEN ADV

Time (Sec)	Event	Setpoint or Value	Success Path or Comment
28,800	Shutdown cooling entry conditions are reached RCS Pressure, psia/Temp, °F	400/350	
28,800	Operator activates shutdown cooling system		

TABLE A-2

RADIOLOGICAL CONSEQUENCES OF THE STEAM GENERATOR TUBE RUPTURE WITH A LOSS OF OFFSITE POWER AND FULLY STUCK OPEN ADV

Location	Offsite Doses, Rems	
	GIS	PIS
1. Exclusion Area Boundary 0-2 hr. Thyroid	40	200
2. Low Population Zone Outer Boundary 0-8 hr. Thyroid	20	41

[illegible]

[illegible]
[illegible]
[illegible]

[illegible] [illegible]

[illegible]