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SUBJECT: Forwards justification for continued operation potential for single failure causing opening of bypass control valves.

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WILLIAM F. CONWAY
EXECUTIVE VICE PRESIDENT
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161-03569-WFC/MEP/RAB
November 1, 1990

Docket Nos. STN 50-528/529/530

Mr. John B. Martin
Regional Administrator, Region V
U. S. Nuclear Regulatory Commission
1450 Maria Lane, Suite 210
Walnut Creek, CA 94596-5368

Reference: Letter from W. F. Conway, APS, to J. B. Martin, USNRC, (102-01875-WFC/TRB/GWS) dated October 24, 1990
Subject: Request for Information on Steam Bypass Control System

Dear Mr. Martin:

Subject: Palo Verde Nuclear Generating Station (PVNGS)
Units 1, 2 and 3
Justification For Continued Operation Potential for a Single Failure Causing the Opening of All Steam Bypass Control Valves
File: 90-056-026

The referenced letter provided APS's basis for interim operation of the Palo Verde units until a formal JCO could be provided. The attachment to this letter contains the formal justification for continued operation, including a safety analysis for the simultaneous opening all steam bypass control valves from full power. The results of the analysis demonstrate that no Specified Acceptable Fuel Design Limits would be exceeded for this event.

As stated in the attachment, an evaluation of the Chapter 15 events identified as being potentially affected by the Steam Bypass Control System will be completed by November 23, 1990. Upon completion of this evaluation APS will submit the applicable analyses for review and approval by Nuclear Regulatory Commission staff.

If you have any questions, please contact Michael E. Powell at (602) 340-4981.

Sincerely,

WFC/MEP/RAB

Attachment
cc: Document Control Desk
C. M. Trammell
S. R. Peterson
D. H. Coe
A. H. Gutterman

IE01
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Justification for Continued Operation

Potential for a Single Failure Causing the Opening of All Steam Bypass Control Valves

EXECUTIVE SUMMARY

On October 20, 1990, at 12:29, a power distribution module failure caused the opening of all in service (i.e. 7 of 8 valves) steam bypass control valves (SBCVs) in PVNGS Unit 3. The resulting power transient was terminated by the Core Protection Calculator (CPC) variable overpower trip (VOPT) which operated as designed. Spurious opening of more than one steam bypass valve was not considered credible in the design of the system and was not analyzed in the Updated Final Safety Analysis Report (UFSAR). Since this event was outside the design basis for PVNGS, preparation of a Justification for Continued Operation (JCO) was initiated.

An interim JCO was issued on October 24, 1990. This JCO included the prudent compensatory action of stationing an operator at the SBCS panel to terminate any spurious actuation, pending the completion of additional analysis. An analysis of the quick opening of all 8 SBCVs from 102% power has been completed. It demonstrates that Specified Acceptable Fuel Design Limits (SAFDLs) would not be exceeded. The completion of this analysis allows removal of the previous compensatory action since the event the operator was to prevent (spurious opening of the SBCVs while at 102% power) has now been analyzed with acceptable results.

Justification for continued operation of PVNGS until such time as the SBCS design basis is restored (no single failure can cause the opening of more than one SBCV), or APS has submitted and the Nuclear Regulatory Commission has approved an UFSAR Chapter 15 analysis for the inadvertent opening of more than one SBCV is provided by the following:

The October 20, 1990 event was reviewed and data from the Core Operating Limit Supervisory System (COLSS), which maintains the initial conditions of analyzed events, showed that 11% power margin existed from the COLSS Departure from Nucleate Boiling Ratio Limit (DNBR). Subsequent analysis of the event demonstrated that the Plant Protection System provides adequate protection for excess steam demand events of this nature.

APS has performed a licensing basis analysis using NRC approved methodology of an excess steam demand event in which all 8 SBCVs quick open and remain open from an initial power level of 102% percent. The normal operating configuration of 7 SBCVs in service is conservative with respect to the analysis. The analysis demonstrated that no SAFDL would be exceeded. The analysis was reviewed and concurred with by ABB-Combustion Engineering Inc. The results of this analysis are shown in the Safety Analysis Section of this JCO.

The excess steam demand event from 102% power described above is judged to be a bounding event, but as an additional conservatism APS has placed a 5 percent power margin penalty in the COLSS until such time as events initiating from lower power levels are evaluated. In the event COLSS is out of service this 5 percent penalty will be applied to the CPCs to provide equivalent protection. The 5

percent penalty will provide additional margin to a power operating limit and in the judgement of APS and ABB-Combustion Engineering will more than adequately mitigate the possibility that an excess steam demand event occurring from less than 102% power could have worse consequences than the 102% power condition. The analysis of events initiating from lower power levels will be completed by November 15, 1990.

APS will analyze the impact of SBCS malfunctions on the following events. These events were chosen from a review of Chapter 15 by APS and ABB-Combustion Engineering. This review utilized the single failure criteria described in the UFSAR. Additional reviews of Chapter 15 events are being conducted to determine if any other events are affected. The events determined to potentially be affected and a date for completion of the analysis of each follows:

Event	Forecast Date
Opening of all 8 SBCVs with Loss of Offsite Power	November 19, 1990
CEA Ejection	November 21, 1990

Should a problem be identified as a result of these two analyses APS will disable seven SBCVs, leaving one valve per unit in service. Operation in this mode has been analyzed in the Chapter 15 Safety Analysis with acceptable results and APS has procedures available which can be put into effect promptly to implement this mode of operation.

The root cause of the power distribution module failure was determined to be a faulty diode. The power distribution module has been replaced. The failure of the diode was a random low frequency event.

These actions provide assurance that continued operation will not result in a reduction in safety.

I. STEAM BYPASS CONTROL SYSTEM (SBCS)

A. Equipment Description

The steam bypass control system consists primarily of the steam bypass valves and Steam Bypass Control System (SBCS). The SBCS controls the positioning of the steam bypass valves, through which steam is bypassed around the turbine into the condenser or atmosphere.

The system is designed to increase plant availability by making full utilization of steam bypass capacity to remove excess Nuclear Steam Supply System (NSSS) thermal energy following turbine load rejections. This is achieved by the selective use of steam bypass valves and the controlled release of steam. This avoids unnecessary reactor trips, and prevents the opening of pressurizer or secondary safety valves.

The Reactor Power Cutback System (RPCS) is used in conjunction with the SBCS to reduce the required steam bypass valve capacity. Additionally, the SBCS is used during turbine loading to provide an even load on the reactor as the turbine is brought up to load. The system is also used during reactor heatup and cooldown to remove excess NSSS energy, and control the rate of temperature change.

The following three types of valve signals are generated for each steam bypass valve: a modulation signal which controls the flow rate through the valve; a quick opening signal which causes the valve to fully open in a short time; and a valve permissive signal which is required for the preceding two signals to operate the bypass valve.

In the modulation mode a steam flow signal is sent to a program which develops a main steam header pressure program signal. At the same time the pressurizer pressure is used to generate a pressurizer pressure bias program. The two program signals and the measured main steam header pressure are compared to provide an error signal which goes to the controller. The controller demand, or a manual signal provided by the operator, is passed to an electro-pneumatic converter on each steam bypass valve. This converts the electrical signal to an air signal which is passed through the first solenoid valve to the air actuated steam bypass valve.

In the quick opening mode the pressurizer pressure and steam flow signals are compared and the difference signal produced is sent to a change detector. The change detector output is compared to a threshold value; if a change signal exceeds the threshold a quick opening signal is produced. The quick opening signal energizes the solenoid which then blocks the modulated air signal and applies the full air system pressure, to quick open the valve.

A permissive signal is also produced by the SBCS. This signal is provided by circuitry identical to that described above except that the output of a permissive controller is converted to a binary signal and fed into an OR gate with the permissive quick opening signal. If a permissive signal is present it will open the second solenoid valve and allow either the modulated or the quick open air signal to be applied to the pneumatically operated bypass valves. When the permissive signal is removed the control air is vented to atmosphere and the valve closes. When turbine condenser pressure exceeds a preset value, the steam bypass valves which discharge into the condenser are prevented from opening.

Reactor Power Cutback demand signals are generated by the same circuitry that produces the valve quick opening signals. These redundant signals are sent to the RPCS.

B. The functions of the SBCS are as follows:

1. The system automatically dissipates excess energy in the Nuclear Steam Supply System (NSSS) by regulating the flow of steam through the steam bypass valves. This allows for the following:

a. Any load rejection including a turbine trip from 100% power without a reactor trip.

b. NSSS thermal conditions can be achieved when it is desirable to have reactor power greater than turbine power, for example, during turbine synchronization.

c. Maintaining hot zero-power conditions.

2. To prevent a single failure from opening the bypass valves when not necessary, possibly causing an excess load incident, the SBCS was intended to have complete redundancy in its design, with the valve opening demand signals being required on a two-out-of-two basis for the valves to open. In addition, to offer a certain degree of protection to the turbine/condenser, the steam bypass valves are closed and prevented from opening whenever the main condenser conditions are unsatisfactory, normally indicated by a low condenser vacuum. This interlock has no effect on the SBCVs which dump to atmosphere. This interlock also has redundancy in its design, with a one-out-of-two indication necessary to close the valves.

3. The SBCS also produces two additional functions: an Automatic Control Element Assembly (CEA) Withdrawal Prohibit (AWP) to prevent CEAs from being automatically withdrawn in response to Reactor Regulating System (RRS) demands, and an Automatic-CEA-Motion Inhibit (AMI) to prevent automatic withdrawal or insertion of the CEAs in response to RRS demands. The AWP is

produced whenever there is an excess steam demand, since this is an indication of excess NSSS energy, and a CEA withdrawal would not be warranted. The AMI function is there to keep the reactor power at a selectable level after a load rejection to house load or a turbine trip. This has the purpose of allowing a quick reloading of the turbine/generator if the loss of load is due to a temporary fault.

C. Design Criteria

1. To prevent a single failure from opening the bypass valves when not necessary, possibly causing an excess load incident, the SBCS was intended to have complete redundancy in its design, with the valve opening demand signals being required on a two-out-of-two basis for the valves to open.

2. The interface requirements for other portions of the SBCS not supplied or designed by CE are specified in PVNGS document number 13-10407-N001-13.02-2009, Section 3. The pertinent section regarding Balance of Plant Instrumentation Interface is III, E. This in part states that the two header pressure signals (P_{s1} and P_{s2}) are required to be independent signals powered from independent sources in the SBCS.

3. Load rejections of any magnitude can be accommodated without tripping the reactor or lifting the pressurizer or steam generator safety valves.

4. It provides a means of manually controlling the reactor coolant system temperature during plant heatup and cooldown.

5. It prevents the opening of safety valves after a unit trip, and effects a smooth transition to hot zero-power conditions.

6. It automatically controls steam pressure, and thus reactor coolant temperature, to the hot zero power value when in hot zero-power conditions.

7. The SBCS operates the steam bypass valves in a sequential manner to minimize valve wear and improve controllability. The steam bypass valves which discharge to atmosphere are the last to open and the first to close.

8. The use of a master control station provides the capability of bumpless balanceless transfer from manual to automatic and from automatic to manual. The individual valve control stations provide complete flexibility in the use of the steam bypass valves.

9. The SBCS produces a CEA Automatic Motion Inhibit (AMI) whenever reactor power falls below 15%; or when the turbine and reactor power fall below preselected thresholds and the SBCS can accommodate the excess reactor power.

10. An Automatic Withdrawal Prohibit (AWP) signal is generated to block CEA outward motion when a demand for steam bypass exists.

11. It facilitates operation during turbine startup, synchronization and initial loading by automatically providing a heat sink for excess reactor power.

12. Pressure is controlled during the loss of one-out-of-two feedwater pumps.

13. A condenser interlock is provided to block steam bypass when condenser pressure exceeds a preset limit. This interlock has no effect on the SBCVs which dump to atmosphere.

14. A test panel located in the cabinet assembly provides virtually complete built-in system test capabilities.

II. SAFETY FUNCTION

The steam bypass control system is not essential for the safety of the plant (Ref: CESSAR 7.7.1).

III. SBCS History at PVNGS

The Palo Verde Nuclear Generating Station has experienced other events which involved SBCS malfunctions resulting in excess steam flow. These events are described below:

1. January 9, 1986 - Unit 1 - During a 100% unit load rejection test and subsequent failure of the fast bus transfer system, power was lost to Non-Class 1E 120VAC distribution panel 1E-NNN-D11. When power was restored to NNN-D11 the SBCS opened all 8 valves in response to a manual modulation demand created by the power restoration. The cause of the valves opening was the transfer of the master controller to manual from automatic following restoration of power to the SBCS. When the controller was reenergized it transferred to the manual mode of operation with a demand signal equal to 33% (equal to the automatic control signal in effect at the time of the power loss/recovery). The reason the master controller had a demand signal present was that the manual setpoint tracks the automatic demand signal to produce a bumpless transfer from automatic to manual. Plant Change Request (PCR) 86-13-SF-011 was initiated to evaluate the problem. The PCR was later cancelled on September 22, 1986 for the following reasons:

a. Steam Bypass Control System (SBCS) troubleshooting revealed that power interruptions exceeding approximately 2 seconds results in a system transfer to "Emergency Off," a "fail safe" mode prohibiting anomalous system behavior.

b. Successful testing of Fast Bus Transfer in Unit 2 at 100% power, September 11, 1986, minimized the potential for a sustained loss of power to the non-class distribution system without a coincident power interruption to the class system as well.

2. March 3, 1986 - Unit 1 - A faulty cable on a control board chart recorder resulted in a voltage transient on NNN-D11. This transient caused erroneous signals to be sent to the SBCS. The SBCVs opened and approximately 300MWe was lost from the output of the main generator. The transient was terminated when a fuse blew. Site Modifications 13-SM-RM-002 implemented a change to the cables on the suspect recorders to eliminate pinching and potential grounding of these cables. These modifications have been completed in all three units.

3. September 11, 1986 - Unit 1 - A reactor trip resulted from the loss of all four steam flow inputs to the SBCS when a circuit board in the Emergency Response Facility Data Acquisition and Display System (ERFDADS) was grounded. This caused all 8 SBCVs to quick open. The resulting transient was terminated by a Main Steam Isolation Signal. This problem is being addressed in three ways: (1) the extender board which caused the grounding was modified to isolate the inputs from any ground source; (2) warning placards were posted in the equipment cabinets reminding personnel of the potential for a reactor trip when work was being performed in the cabinet; (3) Design Change Package (DCP) 13FJ-SD-032 was written to split up the steam flow signals among various boards thereby eliminating the potential for single failure. The DCP work is complete in Unit 1. The DCP is scheduled to be completed in Unit 2 by November 15, 1990 and Unit 3 during the next refueling outage.

4. March 3, 1989 - Unit 3 - Following a large load rejection as a result of a turbine generator trip the SBCS initiated a quick open demand, as designed, the initial quick open signal was followed by multiple quick openings of four of the eight SBCVs. This resulted in a reactor trip and safety system actuations. The quick open signals after the initial signal were caused by a failed permissive timer card in the SBCS. This problem was corrected by the replacement of the timer card.

The implementation of corrective actions for the previously identified SBCS malfunctions were not performed expeditiously because at the time it was not recognized that this event,

which was assumed to be bounded by the Main Steam Line Break analysis of the UFSAR Chapter 15, was actually an anticipated operational occurrence (AOO) and as such analyzed to different acceptance criteria than a limiting fault. Engineering will review these events and their corrective actions as part of the design review outlined in the Corrective Action section of this JCO.

IV. ENGINEERING EVALUATION

EVALUATION OF THE STEAM BYPASS CONTROL SYSTEM RESPONSE

SUMMARY

The response of the SBCS was as expected for the false rapidly increasing steam generator pressure signal received. The false pressure signal was caused by a power supply voltage transient being applied to the Main Steam Header Pressure transmitters and current to voltage converters. The voltage transient was due to the failure of blocking diode loading down the +15 volt portion of a Power Distribution Module in Nest 1 in Cabinet 3J-ZJN-CO2E. This condition resulted in the outputs of equipment in the cabinet failing low. The fuse, provided for fault isolation, then blew and isolated the Power Distribution Module containing the faulted diode. The fault condition cleared and the power supply voltage returned to normal and all outputs in the cabinet returned to their original values, except the equipment powered from Nest 1. In the case of the Main Steam Header pressure transmitter inputs to SBCS this represented a rapidly increasing steam generator pressure.

The SBCS received a false rapidly increasing pressure signal input to the SBCS Master Controller - a proportional-integral controller. As the false pressure signal approached the controller's setpoint, the controller demanded a modulation of the Steam Bypass Valves. The opening of the valves caused an excess steam demand on the reactor and the subsequent reactor trip. A short time later the SBCS was returned to service and properly controlled pressure.

ROOT CAUSES OF THIS EVENT

The root cause of the false pressure transient that led to the 10/20/90 Unit 3 reactor trip was a failed diode in a Foxboro Power Distribution Module. The failed Power Distribution Module was removed from Unit 3 on Saturday, 10/20/90. It was identified as having a failed diode (shorted) and blown fuse. An engineering evaluation of this module performed October 23, 1990 identified that these were the only component failures on this module. The failure mode was the shorting of the diode which shorted the +15 volt power to common. The subsequent fuse failure was a result of excess current due to the shorting of the diode.

The root cause of a single failure of a power distribution module affecting more than one steam bypass control valve was a failure to comply with the interface requirements for the system during installation. Balance of plant instrumentation interface requirements state that the two signals in question (i. e., Steam Header Pressure), are to be two independent signals. However, these signals, in the Palo Verde configuration are not two completely independent signals. They share a common connection at the current to voltage converters associated with the two signal loops. Therefore the interface design requirement, as stated in PVNGS document number 13-10407-N001-13.02-2009, Section 3, for independent signals powered from independent sources from the SBCS was not met.

The Nuclear Plant Reliability Data System (NPRDS) was reviewed for trends or identified failures of this type of module. No failures of this type were found in the data base. PVNGS has previously experienced fuse failures associated with this type of module, but these failures were attributed to disconnected leads being inadvertently grounded or shorted.

The vendor was contacted for any information regarding their experience with failure of these modules. They stated that no excessive failures had occurred for the modules and that the mean time between failure was roughly the same as the life of the plant. IEEE-500 "Industry Reliability Data" was also reviewed and supported the 30 year or longer mean time between failure estimate provided by Foxboro.

Based on the above, it is determined that this is a random failure.

V. SAFETY ANALYSIS

Recognizing that there was no Chapter 15 analyses explicitly covering the opening of more than one SBCVs as an anticipated operational occurrence an effort was immediately begun to perform an analysis which would provide assurance that SAFDLs would not be exceeded. APS with the assistance of ABB-Combustion Engineering reviewed Chapter 15 and determined the analyses which needed to be performed with opening of more than one SBCV being considered as an anticipated operational occurrence and single failure. The following analyses were determined to be affected by operation of the SBCS:

1. Quick opening of all 8 SBCVs from 102% power. This event is classified as an anticipated operational occurrence. An analysis has been completed and is presented in the following sections. The results demonstrated that SAFDLs would not be exceeded. Although this is judged to be the bounding event an evaluation of events initiating from less than 102% power will be performed. The completion of this evaluation is scheduled for November 15, 1990.

2. Quick opening of all 8 SBCVs from full power and loss of offsite power following turbine trip. This is classified as an infrequent event. This analysis is scheduled for completion by November 19, 1990.

3. Control Element Assembly ejection. This event is classified as an accident. This analysis is scheduled for completion by November 21, 1990.

These analyses will be performed utilizing the methodology and assumptions of UFSAR Chapter 15. Upon completion of the analyses they will be submitted to the Nuclear Regulatory Commission for approval and will be incorporated into UFSAR Chapter 15 analyses, as required.

INADVERTENT OPENING OF ALL STEAM BYPASS CONTROL SYSTEM VALVES AT FULL POWER

Identification of Event and Causes

The inadvertent opening of the steam bypass control system valves (IOSBCSV) event results in an increase in heat removal by the secondary system greater than that previously analyzed in the PVNGS UFSAR, Section 15.1, Revision 2. The IOSBCSV event is analyzed to verify that the minimum DNBR resulting from this event will not violate the SAFDL (DNBR > 1.24).

For this event, the major parameter of concern is the minimum hot channel DNBR. This parameter establishes whether a fuel design limit has been violated and thus whether fuel cladding degradation might be anticipated. Those factors which cause a decrease in local DNBR are:

a. increasing coolant temperature
b. decreasing coolant pressure
c. increasing local heat flux (including radial and axial power distribution effects)
d. decreasing coolant flow

Sequence of Events and Systems Operation

The inadvertent opening of the steam bypass control system (SBCS) valves increases the rate of heat removal by the steam generators, causing a rapid cooldown of the reactor coolant system (RCS). Opening all eight SBCS valves increases the steam flow by 88% of full power steam flow. Due to the negative moderator temperature coefficient (MTC) assumed for this event, core power increases from the initial value of 102% of rated core power to a value of 118%, at which time the reactor trips on CPC variable overpower. The CPC variable overpower trip (VOPT) is conservatively delayed by .3 seconds. The

feedwater control system, which is assumed to be in the automatic mode, supplies feedwater to the steam generators such that steam generator water levels are maintained.

Following the generation of a turbine trip on reactor trip, the feedwater control system enters the reactor trip override mode and reduces feedwater flow to 5% of nominal, full power flow. If the low steam generator (SG) level setpoint is reached due to continued steaming through the SBCS, an auxiliary feedwater actuation signal (AFAS) is generated and the auxiliary feedwater pumps will actuate to provide additional feedwater. The steam generators will continue to blowdown until the main steam isolation valves close on low secondary system pressure (820 psia). Thereafter, the RCS and steam generators will heat up and repressurize until the main steam safety valve (MSSV) opening set pressures are reached. Steaming will then resume through the MSSVs to remove heat stored in the core and RCS. If required, the RCS pressure will be limited by the primary safety valves (PSVs), such that RCS pressure will remain within 110% of design pressure.

Analysis of Effects and Consequences

A. Mathematical Model

The nuclear steam supply system (NSSS) response to the IOSBCSV event was simulated using the CESEC-III computer program described in UFSAR section 15.0.3. The time-dependent thermal margin on DNBR in the reactor core was calculated using the CETOP-D computer program which uses the CE-1 critical heat flux correlation described in Chapter 4 of the UFSAR.

B. Input Parameters and Initial Conditions

Table 1 lists the assumptions and initial conditions used for this event in addition to those discussed in UFSAR Section 15.0. Conditions were chosen such that, for an event initiated at 102% of rated core power, the overpower condition caused by the increase in steam flow results in the closest approach to the specified acceptable fuel design limits (SAFDL).

C. Results

The dynamic behavior of key NSSS parameters following the IOSBCSV is presented in Figures 1 through 5. Table 2 summarizes the major events, times and results for this transient.

The IOSBCSV increases the rate of heat removal by the steam generators, causing cooldown of the RCS. Due to the negative moderator reactivity coefficient, core power increases from 102% of rated core power to 118% at 6.41 seconds, at which time a reactor trip signal occurs on CPC variable overpower. At 7.3 seconds, the control rods

begin inserting into the core. Power increases to a maximum of 126.6% at 8.45 seconds, before dropping in response to the reactor trip, as shown in Figure 1. At 8.95 seconds the minimum DNBR of 1.27 occurs, followed by a rapid increase in DNBR as shown on Figure 2.

Conclusions

The IOSBCSV event results in a DNBR greater than 1.24 throughout the transient, such that the SAFDL is not violated and no fuel failure occurs.

TABLE 1

ASSUMPTIONS AND INITIAL CONDITIONS FOR FULL POWER INADVERTENT OPENING OF THE STEAM BYPASS CONTROL SYSTEM VALVES (8)

Parameter	Value
Initial Core Power Level, MWt[1]	3876
Initial Core Inlet Coolant Temperature, °F	570
Initial Core Mass Flow rate, 10^6 lbm/hr	147.2
Initial Pressurizer Pressure, psia	2200
Initial Pressurizer Water Volume, ft^3	918
Initial Steam Generator Pressure, psia	1070
Initial Steam Generator Inventory, lbms per SG	174,000
CEA Worth on Trip, 10^{-2} delta rho	-6.5
Core Burnup	End of Cycle
ASI	-.32
Max. Radial Peaking Factor	1.56
MTC, 10^{-4} delta rho/°F	-3.5
FTC	Beginning of Cycle (min.)
Gap Conductance, 10^6 Btu/ft^2-hr-°F	1.814

[1] The time-dependent thermal margin for calculating DNBR was initiated at the power operating limit, with a required overpower margin of 115%.

TABLE 2
SEQUENCE OF EVENTS FOR FULL POWER
INADVERTENT OPENING OF THE STEAM BYPASS CONTROL SYSTEM VALVES (8)

Time	Event	Setpoint or Value
0.0	SBCS Valves begin to open	--
0.1	SBCS valves fully open	--
6.41	Reactor trips, (VOPT)	118%
7.3	CEA's drop into core	--
8.45	Power peak occurs, % full power	126.6
8.95	Minimum DNBR occurs	1.27

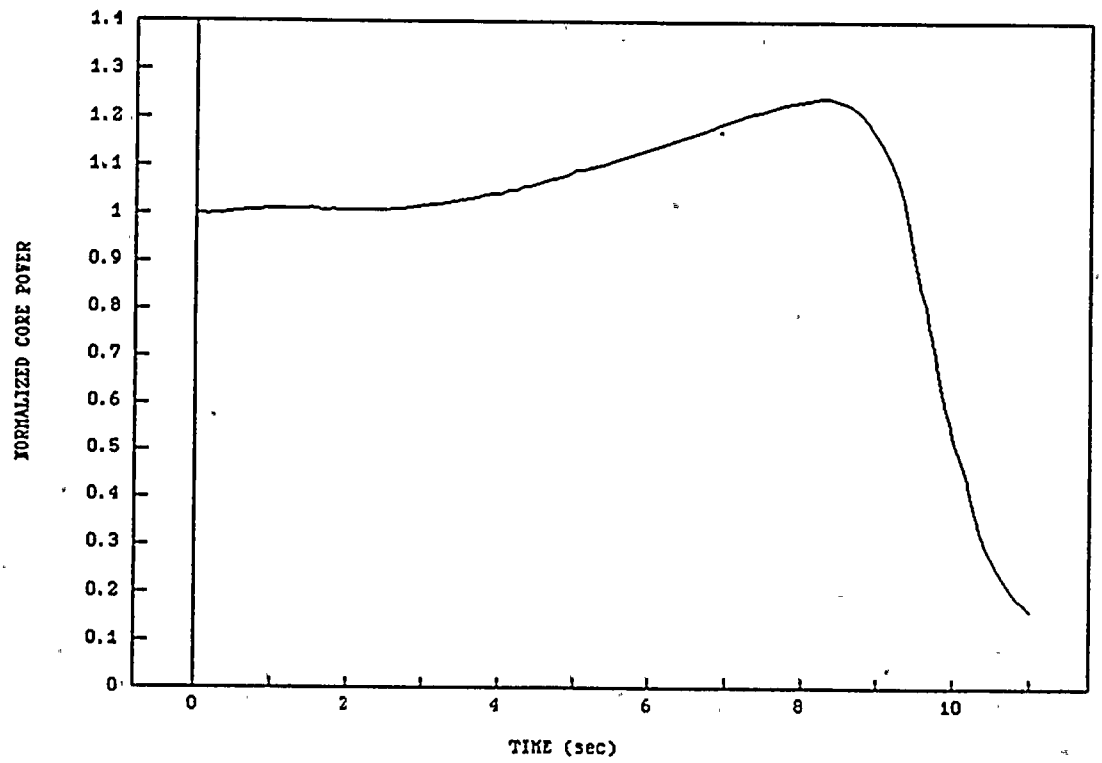

Figure 1: Normalized Core Power

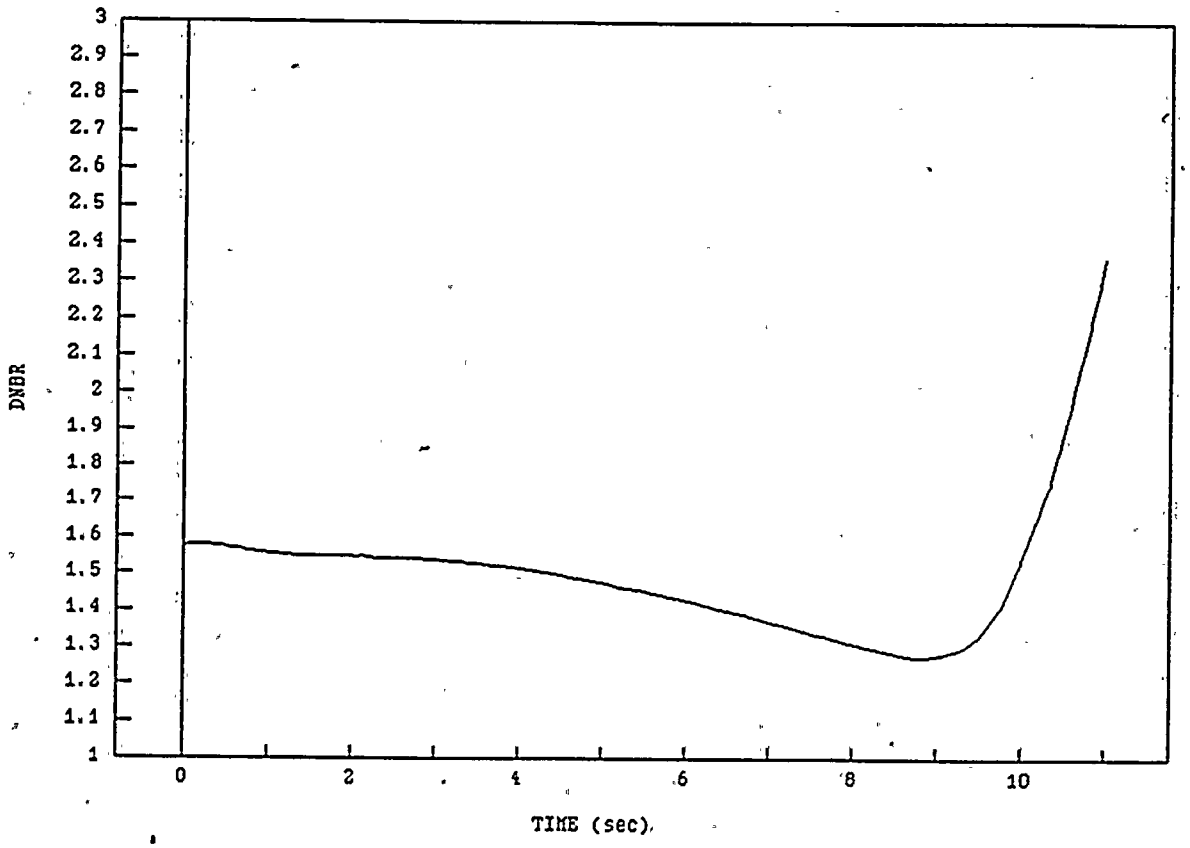

Figure 2: DNBR vs. Time

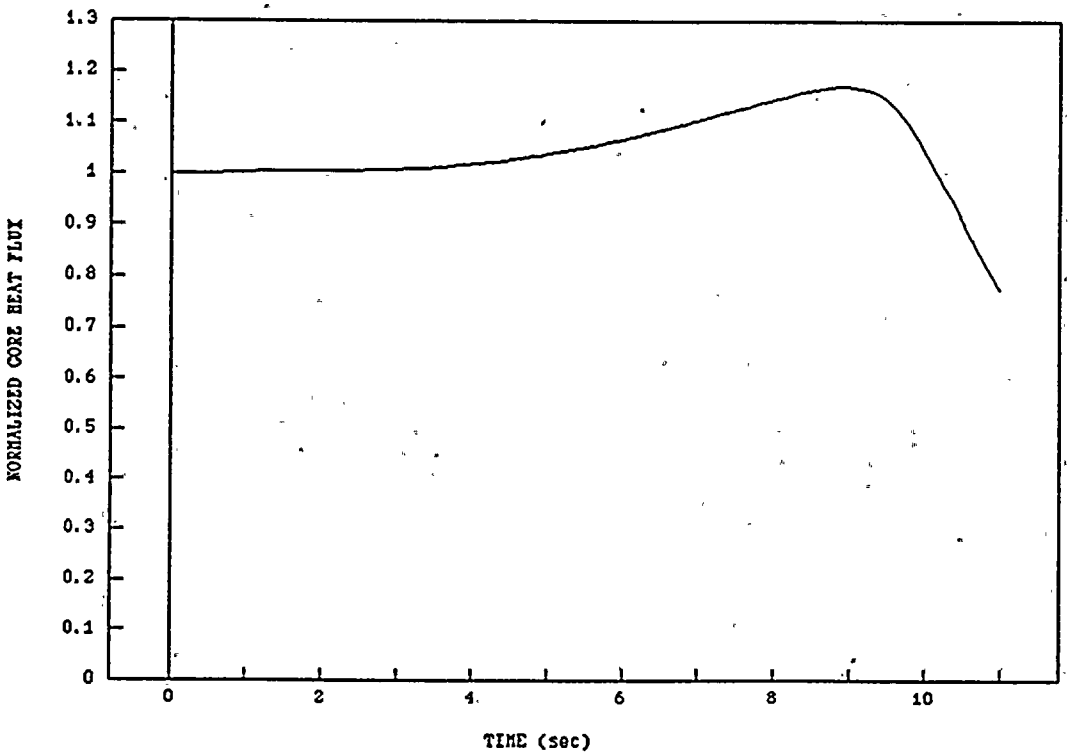

Figure 3: Normalized Core Heat Flux

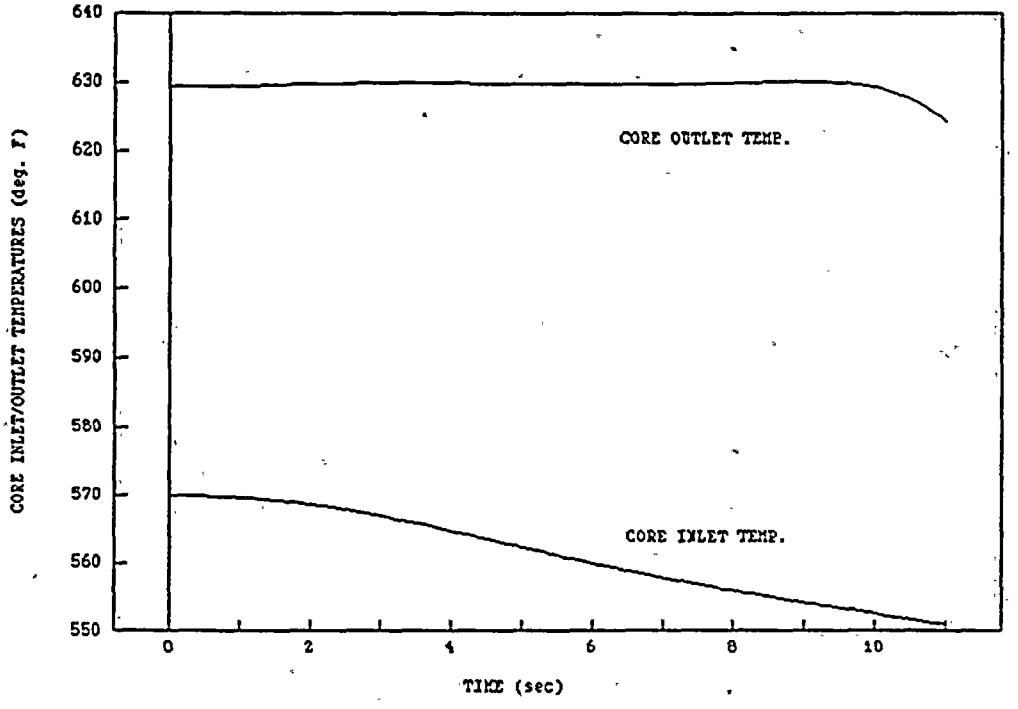

Figure 4: Core Inlet & Outlet Temperatures

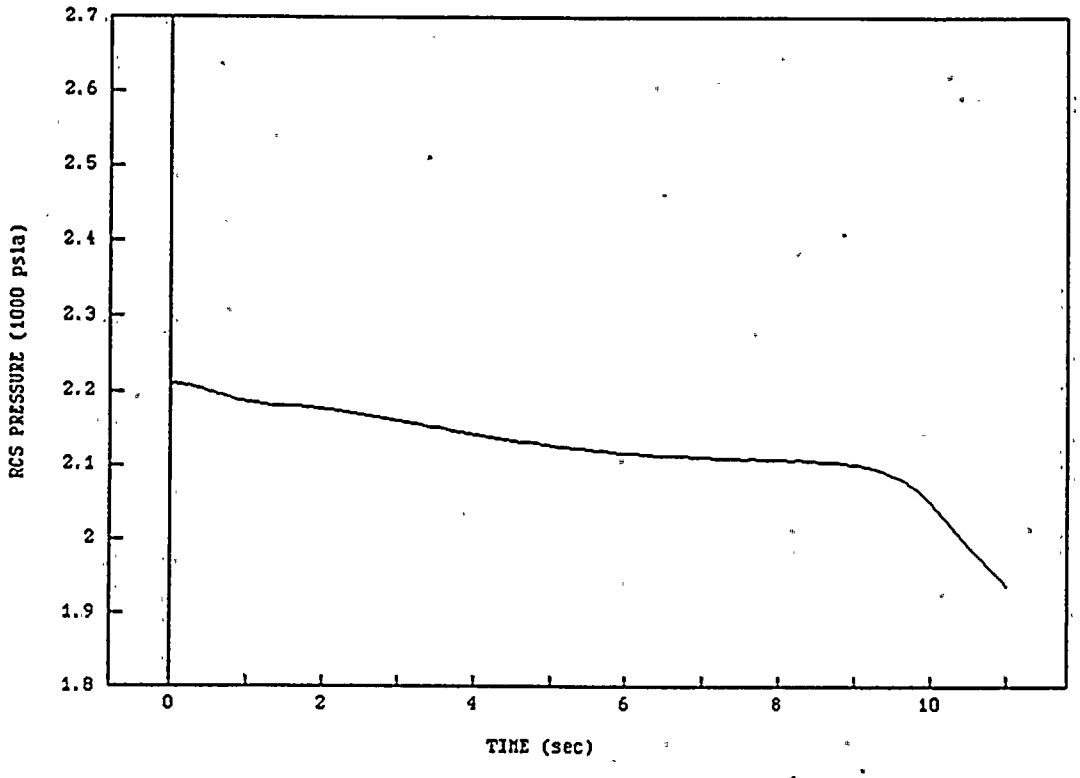

Figure 5: RCS Pressure

VI. CORRECTIVE ACTION PLAN

The following corrective actions have been or are being performed:

An interim Justification for Continued Operation was prepared and prudent compensatory action was taken to place an operator at the SBCS control panel to terminate any spurious SBCS actuation. This compensatory action was prudent until inadvertent opening of all SBCVs at full power had been evaluated.

A root cause analysis of the Power Distribution Module failure and its effect on SBCS operation has been performed. The results of this analysis showed a random failure of a diode caused the failure of the Power Distribution Module which resulted in a voltage transient to both steam generator pressure transmitters which fed the SBCS. The fact that both steam generator pressure transmitters shared a common power supply was not in accordance with SBCS interface criteria which required independence in the power to the transmitters. These two root causes in combination caused the SBCS actuation. A review of the event by ABB-Combustion Engineering using a computer simulation was performed to determine if the SBCS responded in accordance with its design given the simultaneous failure of power to the two pressure transmitter. The simulation showed excellent agreement with the data from the actual event confirming the root cause. Engineering will evaluate corrective actions to restore steam generator pressure transmitter independence as part of the SBCS design review discussed later in this section. Further discussion of the root cause was provided in Section V of this JCO.

An analysis was performed of the Unit 3 event using conservative assumptions (100% power, end of core life, minimum margin to DNBR SAFDL, maximum negative temperature coefficient). The analysis demonstrated that margin to SAFDLs existed throughout the event and that the Plant Protection System provided adequate protection for an event of this nature. The actual trip data taken during the event confirmed the results of the analysis.

A licensing basis analysis has been performed for the 102% power inadvertent opening of all 8 SBCVs. The normal operating configuration of 7 SBCVs is conservative with respect to this analysis. The analysis demonstrated that no SAFDLs would be exceeded. The results of this analysis are presented in the Safety Analysis Section of this JCO.

The excess steam demand event from 102% power described above is judged to be a bounding event, but as an additional conservatism APS has placed a 5 percent power margin penalty in the Core Operating Limit Supervisory System (COLSS) until such time as events initiating from lower power levels are evaluated. In the

event COLSS is out of service this 5 percent penalty will be applied to the CPCs to provide equivalent protection. The 5 percent penalty will provide additional margin to a power operating limit and in the judgement of APS and ABB-Combustion Engineering will more than adequately mitigate the possibility that an excess steam demand event occurring from less than 102% power could have worse consequences than the 102% power condition. The analysis of events initiating from lower power levels will be completed by November 15, 1990.

APS will analyze the impact of SBCS malfunctions on the following events. These events were chosen from a review of Chapter 15 by APS and ABB-Combustion Engineering. This review utilized the single failure criteria described in the UFSAR. Additional reviews of Chapter 15 events are being conducted to determine if any other events are affected. The events determined to potentially be affected and a date for completion of the analysis of each follows:

Event	Forecast Date
Opening of all 8 SBCVs with Loss of Offsite Power	November 19, 1990
CEA Ejection	November 21, 1990

Should a problem be identified as a result of these two analyses, APS will disable seven SBCVs, leaving one valve per unit in service. Operation in this mode has been analyzed in the Chapter 15 Safety Analysis with acceptable results and APS has procedures available which can be put into effect promptly to implement this mode of operation.

APS will complete a detailed design review to identify and evaluate corrective actions for any other potential single failures of SBCS interfaces which could cause a spurious opening of more than one steam bypass control valve. The purpose of this review is to evaluate the need for plant modifications which would restore the interface requirements and ensure reliable operation of the SBCS. APS will determine a practical schedule for any design changes recommended.

In the longer term the following actions will be accomplished:

Perform and submit for Nuclear Regulatory Commission approval a complete analysis of the opening of more than one steam bypass valve opening. This analysis will supplement the current increased steam demand Chapter 15 analysis of the UFSAR.

Complete a Failure Modes and Effects Analysis (FMEA) study on the SBCS interfaces.

The corrective actions outlined above provide a comprehensive and conservative solution to potential future SBCS malfunctions. The parallel approaches of analyzing the potential events caused by SBCS malfunctions and reviewing the design to eliminate the potential for future SBCS malfunctions address the problem from both a safety and reliability perspective.

VII. Justification for Continued Operation

Justification for continued operation of PVNGS until such time as the SBCS design basis is restored (no single failure can cause the opening of more than one SBCV), or APS has submitted and the Nuclear Regulatory Commission has approved an UFSAR Chapter 15 analysis for the inadvertent opening of more than one SBCV is provided by the following:

The October 20, 1990 event was reviewed and data from the COLSS, which maintains the initial conditions of analyzed events, showed that 11% power margin existed from the COLSS Departure from Nucleate Boiling Ratio Limit (DNBR). Subsequent analysis of the event demonstrated that the Plant Protection System provides adequate protection for excess steam demand events of this nature.

APS has performed a licensing basis analysis of a an excess steam demand event in which all 8 SBCVs quick open and remain open from an initial power level of 102% percent. The normal operating configuration of 7 SBCVs in service is conservative with respect to this analysis. The analysis demonstrated that no SAFDL would be exceeded. The analysis was reviewed and concurred with by ABB-Combustion Engineering Inc. The results of this analysis are shown in the Safety Analysis Section of this JCO.

The excess steam demand event from 102% power described above is judged to be a bounding event, but as an additional conservatism APS has placed a 5 percent power margin penalty in the COLSS until such time as events initiating from lower power levels are evaluated. The 5 percent power margin penalty will provide additional margin to a power operating limit and in the judgement of APS and ABB-Combustion Engineering will more than adequately mitigate the possibility that an excess steam demand event occurring from less than 102% power could have worse consequences than the 102% power condition. The analysis of events initiating from lower power levels will be completed by November 15, 1990.

APS will analyze the impact of SBCS malfunctions on the following events. These events were chosen from a review of Chapter 15 by APS and ABB-Combustion Engineering. This review utilized the methodology described in the UFSAR. Additional reviews of Chapter 15 events are being conducted to determine if any other events are affected. The events determined to potentially be affected and a

date for completion of the analysis of each follows:

Event	Forecast Date
Opening of all 8 SBCVs with Loss of Offsite Power	November 19, 1990
CEA Ejection	November 21, 1990

Should a problem be identified as a result of these two analyses APS will disable seven SBCVs, leaving one valve per unit in service. Operation in this mode has been analyzed in the Chapter 15 Safety Analysis with acceptable results and APS has procedures available which can be put into effect promptly to implement this mode of operation.

The root cause of the power distribution module failure was determined to be a faulty diode. The power distribution module has been replaced. The failure of the diode was a random low frequency event.

These actions provide assurance that continued operation will not result in a reduction in safety.