15.13 PCS High Pressure Anomalies

High pressure can occur in the PCS as a consequence of failure of components or as a result of misoperation. These high pressures may be local and transient such as pressure waves caused by water hammer, or may involve significant portions of the PCS. High pressure throughout the system can result as a consequence of loss of heat removal or increased inventory. These events were discussed in Sections 15.2 and 15.5, respectively. Additional faults, such as valve closure, will be evaluated in this section. Faults which can result in high pressure in the PCS are as follows:

A. A primary pump discharge valve or check valve closes abruptly

B. An emergency coolant pump discharge check valve is open with PCPs in operation

C. Startup of a PCP against a fully closed discharge valve with suction pressure significantly higher than 230 psig

D. The FCV (butterfly) fails.

Items A-C are considered to be Condition 3 events based on analysis in the DBR (EG&G Idaho 1994). Item D is a Condition 4 event (Brower 1993). The acceptance criteria for these events that result in an increase in pressure is that the pressure not exceed 110% of design pressure for high-probability events (Condition 2) and to not exceed 120% of design pressure for low-probability events (Condition 3 and 4).

15.13.1 A Primary Pump Discharge Valve or Check Valve Closes Abruptly

15.13.1.1 Identification of Causes and Accident Description. The faults are initiated by a mechanical failure which allows the valves to close rapidly when the coolant velocity provides a significant driving force for closure.

The PCP discharge valves are gate valves. Mechanical failure of the valve shaft could potentially result in closure of the valve slide. However, the valves are mounted such that the slide closure is inhibited by gravity. Therefore, if closure occurs, it is not likely to be rapid.

The check valves have a flapper which rotates on a shaft. Wear or galling of this shaft can result in a sticky valve which could hang up. This, in conjunction with shutoff of the PCP while other PCPs are operating, could result in high backflow through the valve and then sudden closure.

These events result in a dynamic pressure pulse resulting from water hammer. The check valve will have the more serious consequences because of the potential for more rapid closure.

15.13.1.2 Analysis of Effects and Consequences

15.13.1.2.1 Method of Analysis—The check valve failure was analyzed previously (Bridges and Burr 1968). The check valves were modified to correct problems resulting in slow closing times and failure to close. The problems were encountered during routine testing. The modifications were evaluated to show that there was no change in failure modes, probability or consequences (Dwight 1996).

The pump discharge valve mechanical failure was not specifically analyzed since the pressure transient is not expected to exceed the pressure experienced during check valve failure. (Both valves are located in essentially the same section of piping.) Control system failures causing the PCP discharge valve to shut would result in a very slow transient with the resulting system pressures enveloped by item C (Startup of a PCP against a fully closed discharge valve with suction pressure significantly higher than 230 psig).

15.13.1.2.2 Results—A PCP check valve failed to close properly during a trip of one out of three primary pumps on December 11, 1967. Analysis of this fault showed the maximum calculated pressure was 900 psig. No observable damage occurred to the PCP discharge piping, which has a design pressure of 576 psig. Some pipe hangers were damaged. (Under dynamic conditions, higher pressures may not be damaging to the piping.) Although the PCS has operated successfully since this event, a repeat of the event should be avoided. Consequently, preventive maintenance and testing of the valve are in place to limit degradation of the valves.

15.13.1.2.3 Conclusions—The fault results in pressure pulses greater than design pressure. The piping between the pumps and the check valve has experienced the event without failure. Surveillance and maintenance of the valves are required to ensure the abrupt closure is a low probability event. The surveillance monitors closure time (e.g., signature tests) to verify the characteristics are consistent with design.

15.13.2 The Flow Control Valve (Butterfly) Fails

15.13.2.1 Identification of Causes and Accident Description. The FCV is a rotating disk inside the inlet piping that is adjusted to obtain the desired coolant flow into the vessel. The valve is designed with an external stop (on the valve body rather than internal to the valve) to limit the amount of closure. Since the valve disk has 6 holes in it and is smaller than the valve throat, a complete stoppage of flow cannot occur should the flow stop fail and the valve close completely. Operating data indicate that the flow induced forces on the disk over the normal operating range are in the direction to close the valve. Failure of the driving system for the disk could potentially allow the disk to be driven to the stop resulting in a reduction in the flow. The impact of flow reduction on the heat removal is addressed in Section 15.3.4. The effect of the closure on the pressure within the piping is considered below.

The valve failure is initiated by mechanical failure of the linkage to the motor and/or components in the valve. The failure of the universal joints in the drive result in an as is failure; the disk does not move (Brower 1993). Mechanical failures within the valve (shaft, key, or pins) may result in closure that is not limited by the stop. Mechanical failures outside the valve generally would result in disk motion limited by the stop. An analysis of the valve design (Brower 1993) indicates substantial design margins for the significant components. Based on this evaluation, the probability of failure resulting in valve closure (either to the stop or the closed position) is considered very low and consistent with a Condition 4 event.

15.13.2.2 Analysis of Effects and Consequences

15.13.2.2.1 Method of Analysis—The pressure transients associated with rapid closure of the disk were evaluated using RELAP5/MOD 2.5 assuming the valve closed linearly to the stop in 0.016 sec for two-pump operation and 0.0149 sec for three-pump operation.

An active low pressure scram (inlet) at 324.8 psia with a 0.1 sec response time was also modelled. The pressure histories for closure to the stop and for continuing through the closed position were generated (Pafford 1994) and evaluated (Durney 1994). The disk is relatively massive, and once in motion it will not stop quickly. Therefore, the disk would pass through the minimum flow position if the failure makes the stop ineffective. The disk will stop before reaching a position that is a mirror image of the initial position and return to the minimum flow position after having passed through it. Although the disk cannot rotate to the fully open position, the fully-opened position results in consequences addressed in Section 15.14. The effects of the final position are to result in a low flow condition and pressure spikes followed by increased pressure upstream of the valve (minimum flow position). Since there is more momentum in the coolant for three-pump flow, the three-pump case results in more-significant pressure pulses.

15.13.2.2.2 Results—The sequence of events for the RELAP5 calculations is shown in Tables 15.3-4 and 15.3-5. The peak pressure for closure to the stop is 494 psig at 0.072 sec directly upstream from the valve as shown in Figure 15.13-1. (Gage pressure is obtained from absolute pressure by subtracting 12.2 psi from the absolute pressure shown in the Figure). The design pressure in this section of piping is 485 psig; the pressure allowed (safety limit) for transient conditions is 533 psig (Burr 1978). The pressure history for passing through the stop is shown in Figure 15.13-2. The peak pressure is 499 psig at about 0.024 sec which is well below safety limit. A pressure transient occurs downstream from the valve as it passes through the zero position as shown in Figure 15.13-3. The peak pressure downstream is about 445 psig at 0.059 s. The peak is within the safety limit of 468 psig for this section of piping. When the valve returns to the minimum flow position, the stable pressure upstream from the disk would be about 388 psig (Durney 1994). This result assumes that all three pumps remain in operation.

15.13.2.2.3 Conclusions—The failure of the butterfly valve will result in a modest pressure transient of about 86 psid over normal (the pressure difference for zero time and 0.024 s in Figure 15.13-2). The transient is well within the static loading considered in off normal events.

15.13.3 Bounded Events - PCS High Pressure Anomalies

15.13.3.1 An Emergency Coolant Pump Discharge Check Valve is Open with Primary Coolant Pumps In Operation. The normal operating pressure upstream of the butterfly valve is shown in Figure 15.13-1; the pressure at zero time is the pressure that would occur in the emergency coolant piping for a check valve failed open. The pressure shown in the figure is about 425 psia (413 psig). The design pressure for the discharge portion of the emergency coolant piping is 485 psig; the design pressure for the suction piping is 390 psig (Davidson 1979). Assuming no pressure drop across the emergency coolant pump, the suction pressure would be about 6% over design with the check valve open. The piping code allows a 20-percent overpressure for low probability events; therefore, the overpressure is acceptable. The pressure in the discharge piping is within the design value with the check valve open.

15.13.3.2 Startup of a Primary Coolant Pump Against a Fully Closed Discharge Valve with Suction Pressure Significantly Higher than 230 psig. The maximum possible suction pressure of the PCPs will occur just as the PPS over-pressure protection features actuate (McCracken 1996). For purposes of this evaluation the worst-case setpoints (401 psig for the relief valve setting and 408.6 psig for the pump shutoff ESF) are used. Based on these worst-case setpoints and adjusting for position dependencies in pressure, the maximum PCP suction pressure is 405 psig. This suction pressure could only occur if procedures covering operation of the gland seal pumps were violated and the gland seal pumps were allowed to pressurize the plant above the prescribed shutoff pressure. Further procedure or control system failures would have to occur to start a PCP with the discharge valve fully closed. The worst-case pressure in the pump discharge piping would be 656 psig adding 251 psig pump shutoff head for the PCP (Chapter 5 (Primary Coolant System)). The resulting pressure is less than 120% of the design pressure (1.2 × 576 = 691 psig) for the pump discharge piping and therefore meets the acceptance criteria for a Condition 3 event.

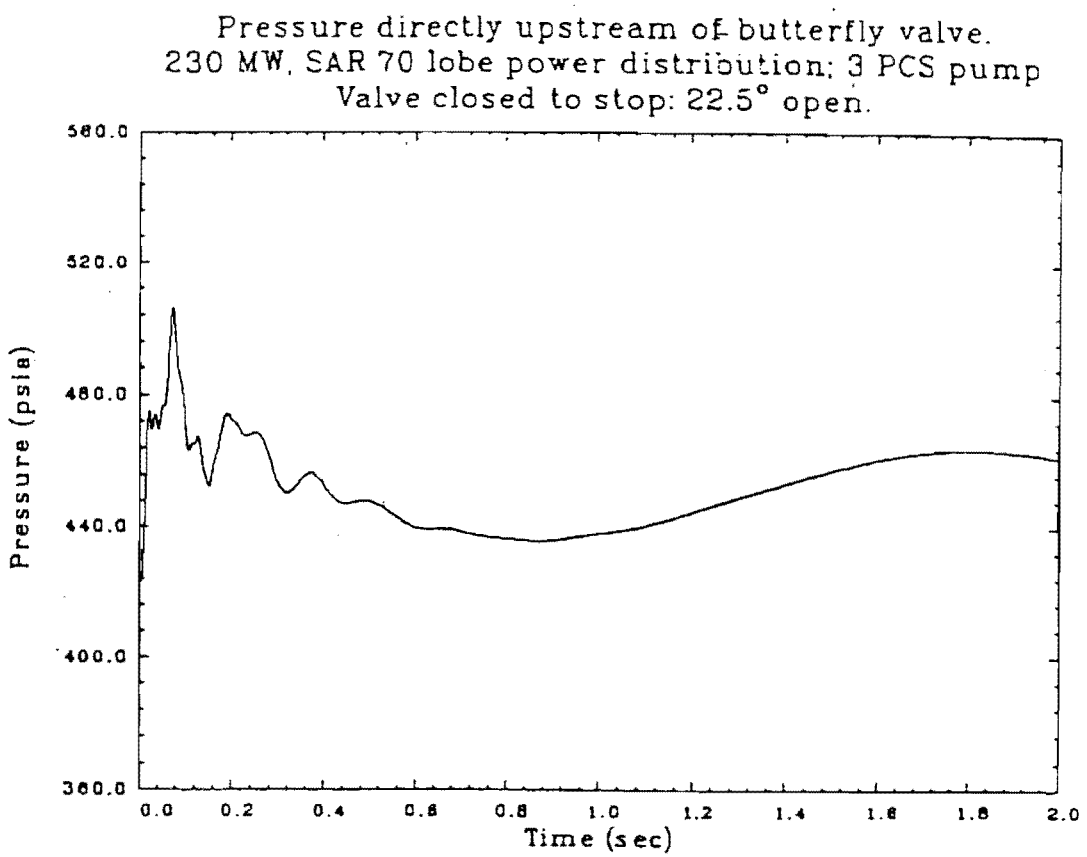

Figure 15.13-1. Pressure directly upstream of the butterfly valve: valve closure to the stop at 22.5° open. **(For Information Only)**

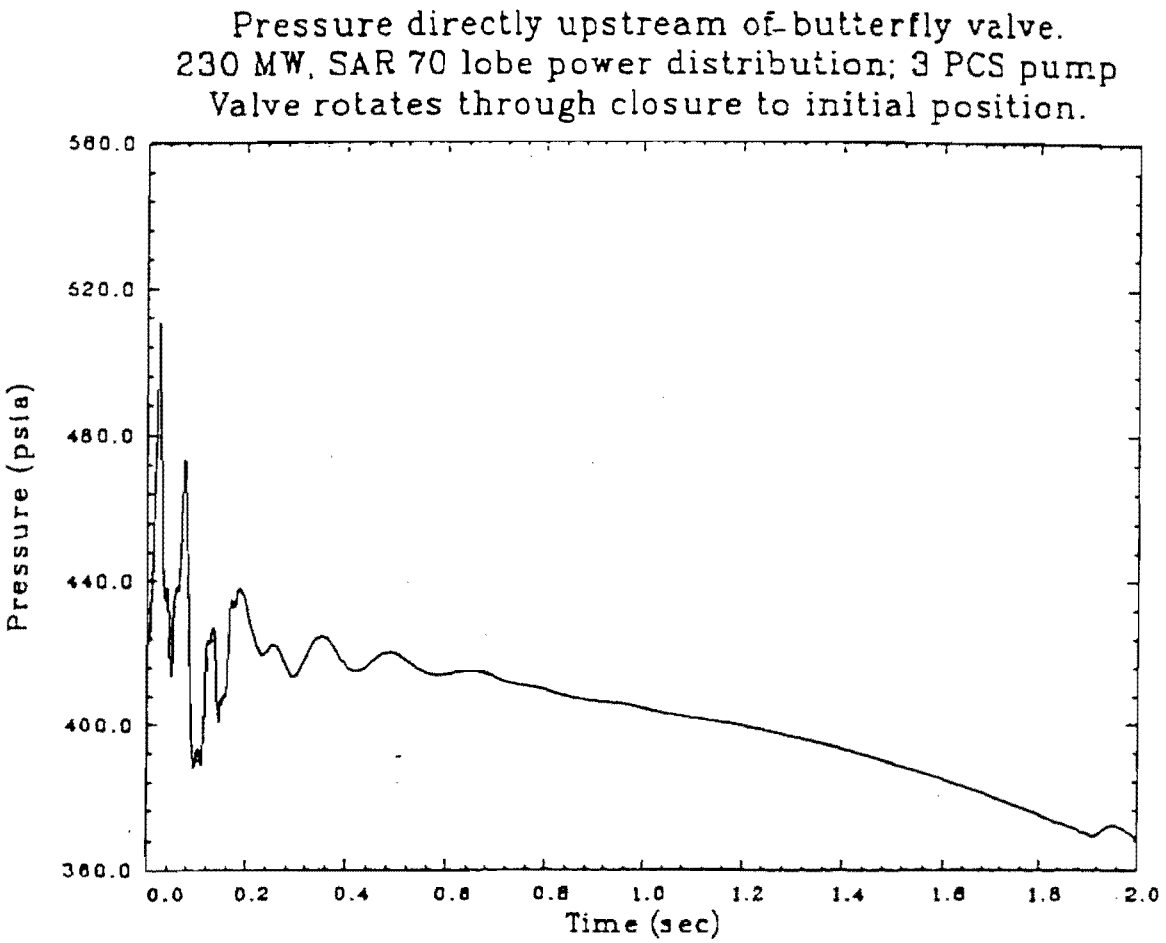

Figure 15.13-2. Pressure directly upstream of the butterfly valve: valve rotated through the closed position and back to the initial position. **(For Information Only)**

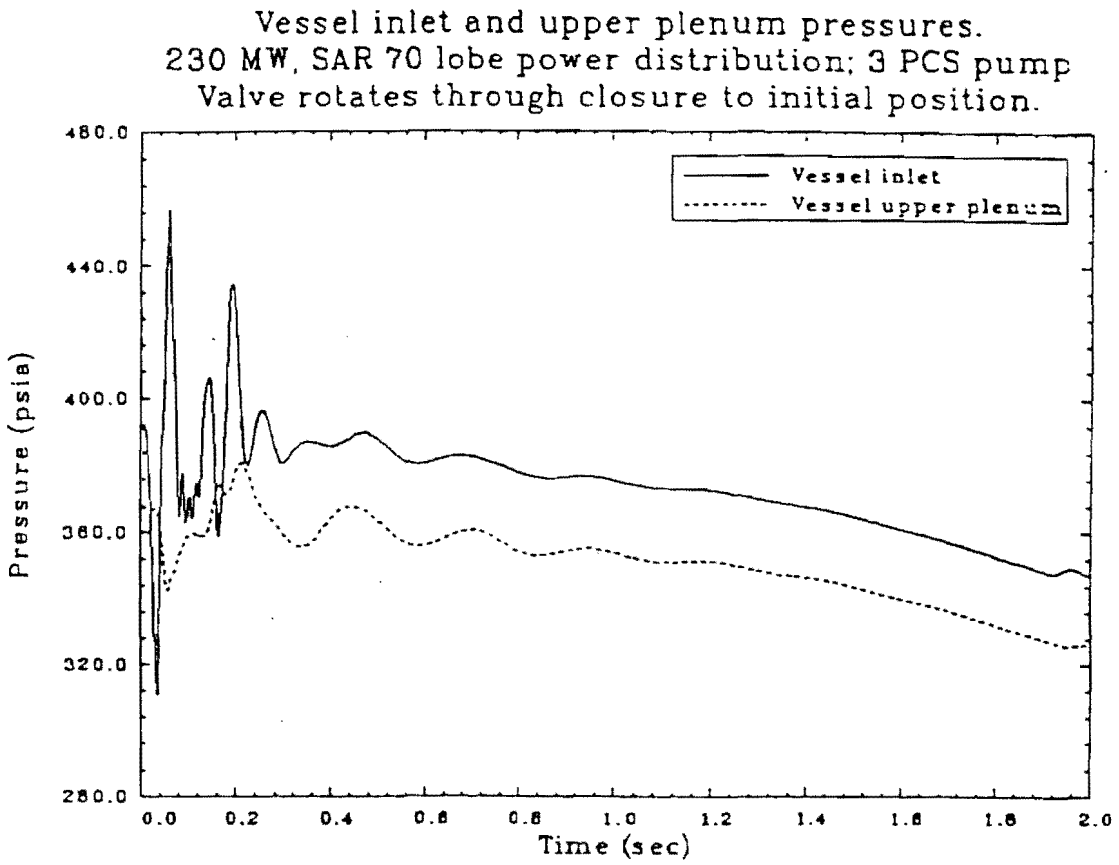

Figure 15.13-3. Vessel inlet and upper plenum pressure for the butterfly valve closure transient: valve rotated through closed position and back to the initial position. **(For Information Only)**

15.13.4 References

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15.14 PCS High Flow Anomalies

High primary coolant flow can occur as a result of control system failure, commercial power overfrequency, or operator error. High flow enhances the heat transfer characteristics and will result in larger margins for the plant protective criteria. Thus, the fuel plate thermal conditions do not require evaluation. The high flow does result in higher than normal loading of the core support and increased loading on the fuel plates.

Faults which can result in increased primary coolant flow with a resultant increase in the differential pressure across the reactor core are as follows:

A. Opening of the flow control butterfly valve to full open or the starting of third PCP with two PCPs already in operation

B. Commercial power overfrequency (<3%)

C. Startup of the fourth PCP

D. Extreme commercial power overfrequency (>3%).

Based on analysis in the DBR (EG&G Idaho 1994), items A and B are considered to be Condition 2 events. Item C is a Condition 3 event, while item D is a Condition 4 event.

These faults were analyzed previously in the DBR (EG&G Idaho 1994). The analyses did not result in system modifications. None of the events were reevaluated for this presentation for the following reasons:

- Modeling for differential pressure as a function of velocity is equivalent between RELAP4 and RELAP5.
- No PPS setpoints are respecified.
- Reactor fuel protective margins do not require evaluation.
- No PCS modifications have been made that would change the PCS flow versus core differential pressure relationship significantly. (The core configuration changes that removed some of the nine loops included design consideration and testing to verify this assumption.)

It has been determined that the damage thresholds for ATR in-vessel components are as follows (Hanson 1976; Burr 1977; Tomberlin 1993):

Components	Damage Threshold Core ΔP (psid)	Equivalent Vessel ΔP (psid)[a]
Fuel element and most in-core components	> 150	
Shim drum support beam	140	166
Core reflector tank	190	
Bearing raceways in shim drum support beam	> 130	> 158

a. Vessel ΔP is measured from taps in the 36-in. inlet and outlet lines.

The limiting Condition 2 event is item A. Items C and D are Condition 3 and Condition 4 faults, respectively. These events are discussed in Sections 15.14.1 through 15.14.3, respectively. The bounded event is discussed in Section 15.14.

15.14.1 Opening of the Flow Control Butterfly Valve to Full Open or the Starting of Third PCP with Two PCPs Already in Operation

15.14.1.1 Identification of Causes and Accident Description. The FCV provides a means of adjusting flow through the core. In three-pump operation, there is a relatively large pressure drop across the valve. If the valve is opened, the pressure drop is reduced across the valve and is increased across the core. This high flow condition will result in additional loading of the core internals; the loading has the potential for resulting in damage to the core and compromising the integrity of the fuel element cladding. Information from the flow control butterfly valve vendor indicates that the butterfly valve disk, upon shaft failure, will always close (Anselmi 1976). Therefore, valve opening will occur only as a result of control or operator failure. The FCV is nearly fully opened during operation with only two PCPs. If a standby pump is started under these conditions, the effect is the same as if the valve were opened with three coolant pumps initially in operation. The two conditions are considered to be the same accident sequence and are described by the three-pump case. The start of a standby pump is judged to be a lower probability event than opening the FCV, but it is adequately treated by this approach.

15.14.1.2 Analysis of Effects and Consequences

15.14.1.2.1 Method of Analysis—Various analyses and measurements have been performed to predict the core ΔP when the butterfly valve is opened (Burr 1977; Varacalle 1976). The RELAP4 analysis assumed the valve was approximately 45% open at the start of the transient, and the valve full-open time was 20 seconds. A PCP and the reactor were tripped when the vessel ΔP was 146 psid, with a response time of 0.6 seconds.

15.14.1.2.2 Results—The maximum core differential is 124.2 psid at 2.7 seconds. The time response is illustrated in Figure 15.14-1. The maximum potential pressure drop across the core without the pump shutoff action is not obtained by the analysis. However, evaluations during the CIC in 1977 (Whitehead 1977) indicated the maximum would be less than 130 psid, providing support for the calculation.

15.14.1.2.3 Conclusions—There are no core components stressed beyond their rated capacity. Thus, a vessel ΔP, high, PPS subsystem with a setpoint of 146 psid and a response time of 0.6 seconds will prevent damage that would impair operability of reactor core components. The action of the PPS subsystem safely limits the effect of the butterfly valve opening with three pumps in operation or the effect of starting a standby pump during operation with two primary pumps.

15.14.2 Startup of the Fourth Primary Coolant Pump

15.14.2.1 Identification of Causes and Accident Description. Startup of the fourth PCP can occur as a result of operator error or by fault in the process distributed control system.

15.14.2.2 Analysis of Effects and Consequences

15.14.2.2.1 Method of Analysis—Analysis was completed using RELAP4 with a one node core model (Varacalle 1976). The analysis assumed a 60-second opening time for the PCP discharge valve.

15.14.2.2.2 Results—The RELAP4 results gave a maximum core ΔP of 119 psid. The time history is plotted in Figure 15.14-2.

15.14.2.2.3 Conclusions—Starting the fourth PCP results in a core ΔP less than for a butterfly valve opening event. The consequences are bounded by the discussion in Section 15.14.1.

15.14.3 Extreme Commercial Power Overfrequency (> 3%)

15.14.3.1 Identification of Causes and Accident Description. A frequency variation in commercial power to the PCPs can occur due to generation faults. Extreme overfrequency is defined as greater than 3%. A Bonneville Power Administration representative stated that a significant intertie failure resulted in less than 3% increase in frequency. Based on that experience it is assumed that an extreme overfrequency would not exceed 10% and that the overfrequency condition would only last a few seconds (Atkinson 1974).

15.14.3.2 Analysis of Effects and Consequences. The credible overfrequency event will cause an increase in flow that is estimated to be less than the increase due to opening the FCV. Therefore, the overfrequency event is enveloped by the discussion in Section 15.14.1. If the flow increase were substantial, the scram and pump shutoff would be expected to limit the differential pressure consistent with the analysis of Section 15.14.1.

15.14.4 Bounded Events - PCS High Flow

15.14.4.1 Commercial Power Overfrequency (<3%). A 3% overfrequency will result in a small increase in flow and ΔP. The increase will be less than for the butterfly valve opening, as discussed in Section 15.14.1.

The consequences for this fault are bounded by the butterfly valve opening, discussed in Section 15.14.1.

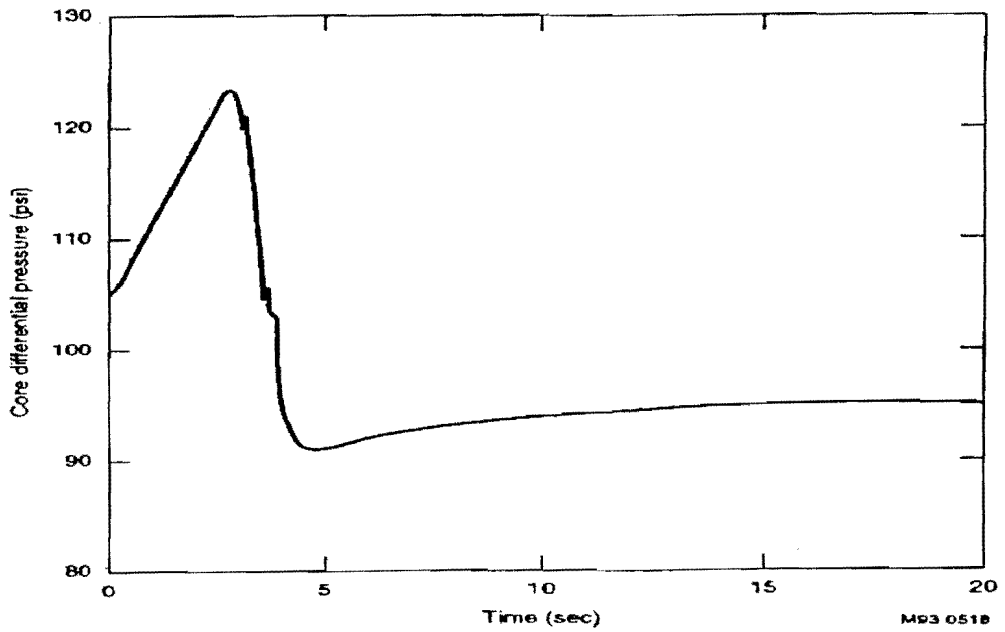

Figure 15.14-1. Core differential pressure history for butterfly valve full-open with protective action. **(For Information Only)**

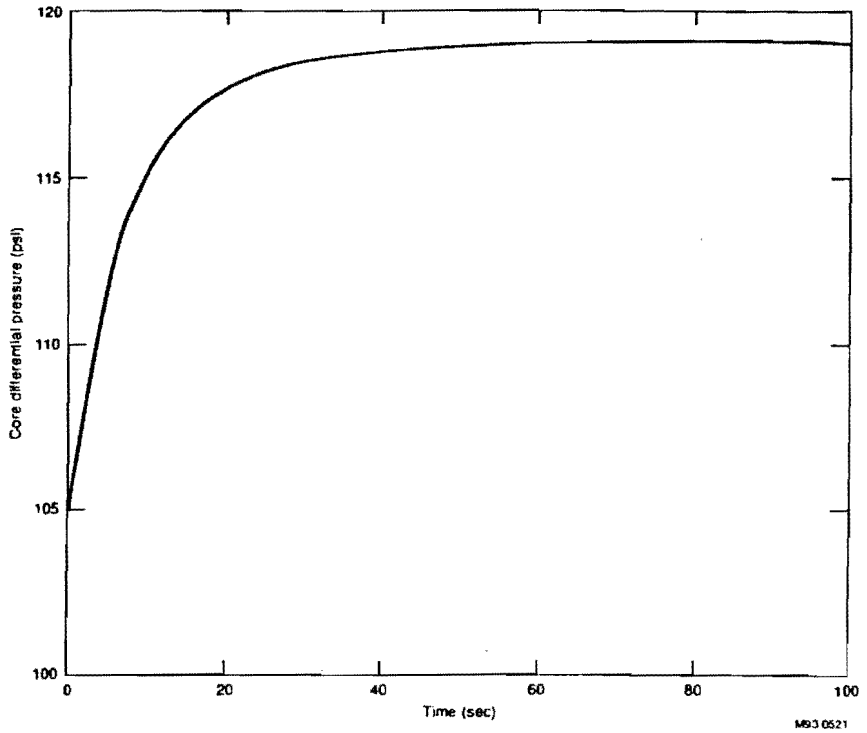

Figure 15.14-2. Core differential pressure history with startup of fourth primary pump. **(For Information Only)**

15.14.5 References

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15.15 Reflector Aging

The ATR reflector is a machined beryllium structure located in regions of significant gradients in the neutron flux. The resulting nonuniform exposures result in nonuniform growth and internal stresses. The internal stresses eventually result in cracking of the thin ligaments and spalling along the cracks. This aging of the reflector relative to safety issues is examined in Tomberlin (1989) and Durney (1994).

The aging of the reflector results in cracking that may lead to loose pieces of beryllium. Tomberlin (1989) considers the impact of the loose pieces on the normal operation as well as the off-normal events. The off-normal events are reconsidered in Durney (1994) using the codes and formalisms developed for the analysis in this Chapter 15. The analysis reconsiders the events limited by Plate 19 performance (relatively-slow, thermal-hydraulic events such as the flow coastdown) with Plate 19 insulated to simulate a loose piece of beryllium. The rapidly-progressing events (power transients) limited by the inner plates are reconsidered with increased power peaking. The increased power peaking results from a crack or similar effect of aging which replaces beryllium with water.

The analysis determines the limits for operation of the aged reflector (one in which cracking is expected to occur) to maintain the risk consistent with that accepted for the new reflector. When cracking is expected (ligament stresses are within two standard deviations of the mean strength), the lobe power is limited with the standard 7F fuel element (Durney 1994). Higher lobe powers are accommodated with the YA fuel prescription which has a non-fueled plate adjacent to the reflector ligaments with high stresses. Perturbations due to reflector cracking (holes or loose pieces that might insulate the adjacent plate) have limited impact on the adjacent fuel element performance if Plate 19 does not contain fuel. As described below, the effective plate power is the parameter that results from the analysis of the fuel plate performance. The acceptable lobe power for operation with the standard 7F fuel element is determined by these effective plate power limits.

The ligament cracking can result in replacement of beryllium with water. This replacement increases the power peaking in the adjacent fuel element. In order to anticipate this increased peaking during operation, the power peaking limit must be reduced or the calculated power peaking must be increased in the evaluation of acceptable operation. The peaking increase is enveloped by a 2.5% change (Tomberlin 1989). The need for these limitations (effective plate power resulting in modified fuel element requirements and 2.5% adjustment of power peaking) is based on the stress analysis completed for the operating reflector. The applicability of the stress analysis is supported by routine surveillance to ensure aging is progressing consistent with the analytical assumptions. Additional information on the reflector performance and operating conditions including the surveillance is contained in Chapter 4 (Reactor).

The analyses for fuel elements adjacent to reflector ligaments that are cracked (or may be near cracking) established an acceptable (reduced) lobe power for the standard 7F fuel element. The reduction is consistent with an effective plate power for Plate 19 of 358 MW for two-pump operation and 357 MW for three-pump operation (Polkinghorne 1994). The effective plate powers for the inner plates remain the same as for the new reflector (417 MW for two-pump operation and 443 MW for three-pump operation). However, as noted above, the power peaking limit must be reduced or the calculated power peaking must be increased in the evaluation process (anticipates the reflector crack occurring during the operation). Therefore, the inner plate limits are reduced by 2.5% to 406 MW for two-pump operation and to 431 MW for three-pump operation. The power adjustment is not applied to Plate 19 since the enveloping condition is a fully-blocked coolant channel which does not result in a localized increase in power peaking.

Operation with a reflector that is experiencing normal aging is supported by increased surveillance requirements and operational limits that are initiated when the calculated stress in the A or E ligaments are within 2σ of the failure stress (Tomberlin 1989). Additional surveillance requirements are imposed when cracking of the beryllium is first observed (Tomberlin 1998). The reflector status may also be evaluated in order to support continued operation with B ligament stresses within 2σ of the failure stress. Operation with B ligament stresses within 2σ of the failure stress has been historically supported by insertion of retainer pins in the B holes of the affected reflector blocks (Sharp 2003).

Abnormal reflector aging includes all changes in the geometry of the reflector as a result of aging that are not expected based on previous experience and are not addressed in the safety analysis. Full-length cracks in the B, D, and F ligaments or full-length cracks from the I-holes into the outer shim cylinder holes indicate abnormal reflector aging. This definition of abnormal aging is used to ensure that the reflector status is consistent with the status assumed in the reflector safety analysis.

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15.15.1 References

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15.16 External Events

As discussed in Chapter 3 (Design of Structures, Components, Equipment, and Systems), the ATR was designed and built considering external design factors. Since original construction, new systems have been added to the facility and selected systems have been upgraded. In general, new and upgraded systems have been designed to later criteria (e.g., updated design basis seismic criteria). External events can cause abnormal conditions in ATR such as internal fires and floods. This section discusses such internal events in addition to the external events. Beyond design basis external events such as extreme winds, earthquakes, and floods, which can cause abnormal conditions in the ATR and potential fuel damage, are discussed herein.

Results of the PRA (Atkinson and Thatcher 1994) indicate a total fuel damage frequency for all external initiated events of 2.5E-5/yr which is 76% of the total fuel damage frequency for all events (3.3E-5/yr). Of the total fuel damage frequency for external initiated events, seismic (reactor core fuel damage) events contributed 84%, extreme wind, internal flooding, seismic (canal), and internal fire events each contributed approximately 4% while the other identified external events combined contributed less than 1% to the core damage frequency. (The internal fire and flooding are contained in this discussion of external events for consistency with the PRA which discussed and analyzed the two internal events with the external events.)

Eide, Khericha, and Thatcher (1991) screened an exhaustive list of external events applicable to the ATR. The screening criteria were (a) the event is more severe than those for which the plant has been designed, (b) the event can not be included in another event definition, and (c) the event has a site-independent frequency that is not negligible (fuel damage frequency was greater than 1.0E-7/yr.). Ten unscreened external events were identified:

- Internal fire
- Internal flooding
- Seismic activity
- External flooding
- Volcanic activity
- Accidental release of chemicals from onsite storage
- Industrial facility accident
- Transportation accident
- Aircraft impact
- Extreme wind and tornado.

Many of these external events could initiate design basis events for example, loss of commercial or other power systems, loss of the firewater system, loss of instrumentation and controls, low PCS flow, loss of heat sink, loss of PCS inventory, and reactivity insertions. The design basis events are discussed in other sections of this chapter. More severe, very low probability external events or failures of protective systems and actions in response to an external event result in the beyond design basis events analyzed for the PRA. The design basis seismic, external flooding, volcanic, transportation, aircraft, and extreme wind and tornado events are discussed in Chapter 3 (Design of Structures, Components, Equipment, and Systems). The remaining beyond design basis external events are discussed in this section.

15.16.1 Internal Fire

Eide, Khericha, and Thatcher (1991) performed a comprehensive internal fire analysis for the ATR. The analysis included plant walkdowns, a vital area analysis using the SETS (Worrell 1985) computer program, fire-specific human reliability analyses, and analyses of fire propagation for select areas using the COMPBRN (Apostolakis, Siu, and Ho 1985) computer program. The analysis examined fire-induced threats to core safety by fire in a single location with or without additional random failures. Fire spread due to barrier failure, and damage due to fire suppression activities (when a fire has occurred) were considered. Transient combustible fires, self-ignited cable fires, self-ignited electrical panel fires, and machinery fires also were considered in this analysis. An update to address additional complete loss of flow accidents (CLOFAs) and relocation of emergency pump conduits is summarized in Thatcher (1999). These fire-induced CLOFAs in the pump motor corridor or switchgear dominate the previous fire PRA results because of the new accident analysis success criteria in the UFSAR (Section 15.0.14).

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An additional evaluation of fire-induced threats to the ATR facility considered both design basis Chapter 15 accident initiators and beyond design basis accidents (Thatcher 2000). This analysis identified the administrative controls and fire protection features necessary to maintain an acceptably low frequency of fire-induced threats to fuel safety. The conclusions of the analysis and those elements required to be designated as SAR commitments are identified in Table 15.16-1. Administrative controls to control transient combustibles and ensure fire protection system adequacy have been implemented in the ATR facility.

15.16.2 Internal Flooding

Eide, Khericha, and Thatcher (1991) performed a comprehensive internal flooding analysis for the ATR. The analysis included plant walkdowns, a SETS (Worrell 1985) vital area analysis, and a flooding-specific human reliability analysis. Both core-related and fuel-storage-related events were considered. The definition of internal flooding encompassed:

- Equipment submergence
- Water spray
- Inadvertent actuation of fire sprinkler systems.

The dominant sequences involve failure to depressurize in response to a loss of power and forced flow to the reactor or ATWS. Areas of importance with respect to internal flooding include the switchgear room and the reactor main floor. The operators are separated from these areas and are expected to be able to perform needed functions to safely shut down the reactor following the occurrence of flooding. The total core damage frequency from internal flooding is 9.3E-7/yr (Atkinson and Thatcher 1994).

15.16.3 Accidental Release of Chemicals from Onsite Storage

Eide, Khericha, and Thatcher (1991) performed a comprehensive analysis of onsite chemical release. Core damage may occur if a chemical release results in an explosion that damages the safe shutdown equipment at ATR or a release results in toxic vapors that cause the control room to become uninhabitable. In both cases, additional events would have to occur for core damage to result.

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15.16.4 Industrial Facility Accident

Eide, Khericha, and Thatcher (1991) summarizes comprehensive and detailed analysis of industrial facility accidents (Rood 1991). The risk to ATR from industrial facility accidents arises from the chemicals transported to and stored at the Idaho Nuclear Technology and Engineering Center (INTEC).

The potential risk to ATR from INTEC arises from the chemicals transported to and stored at INTEC. A detailed survey of chemicals used at INTEC was conducted. The chemicals were then screened based on toxicity, volatility, and quantity. Also, a walkdown of the INTEC was conducted to determine the mode of storage and transfer for each chemical, its exact location at INTEC, and the existence of any containment structure. Nine chemicals were identified to be analyzed. The chemicals are ammonium hydroxide, anhydrous ammonia, chlorine, gasoline, hexone, hydrofluoric acid, nitric acid, nitrogen, and propane.

For all cases the Immediately Dangerous to Life and Health (DOL 1985) limit would not be exceeded. The release modeling used for this analysis (complete release and spreading of the chemical over the entire roadbed and shoulders) is conservative. Less conservative assumptions such as only partial release from the tank truck and a smaller spill area would result in the Immediately Dangerous to Life and Health limit not being reached. Evaluation of some events required use of realistic release models rather than the most conservative puff release assumption. The release of chemicals transported to or stored at INTEC will not disable the ATR operators such that they can not perform their duties during their shift (Eide, Khericha, and Thatcher 1991). This indicates that the ATR core damage risk from industrial facility accidents is negligible.

Table 15.16-1. Summary of SAR commitments and recommended long-term fire protection upgrades by building area.

Area	SAR Commitments	*Recommendations*
Reactor Main Floor	Power Operation: Transient combustible loading restricted within 5 ft of tubing and reactor raised shielding areas to "very low" a and tractor-trailer compensatory actions.	Transient combustible loading restrictions within 5 ft of cask of "very low." Long-term: Ensure sprinkler heads are adequate, i.e. consider installing fast response sprinklers.
Canal Area		Transient combustible loading restrictions within 5 ft of cask of "very low." Long-term: Ensure sprinkler heads are adequate, i.e. consider installing fast response sprinklers.
Diesel Area	Power Operation and 30 Minutes After Shutdown: Transient combustible loading restrictions near PPS rooms, commercial power feeder, and pit cable trays as low as practicable.	*Long-term: Ensure design adequacy of protection of at least one commercial power feeder, and provide protective barriers for pit cable trays.* *Long-term: Find ways to reduce the fire-contributing combustible loading in this area such as special lube oil storage.*
Nozzle Trench	Power Operation: Transient combustible loading restrictions of "very low."	*Long-term: Install low voltage trip or alarm for WR and N level PPS channels.*
First Basement East Hall	**Power Operation: Transient combustible loading restrictions underneath Wide Range and High Neutron PPS subsystem cabling of "very low."** **Transient combustible loading restrictions underneath Quadrant Differential Temperature PPS subsystem cabling that is near 670-E-80 of "very low."**	*Long-term: Install low voltage trip or alarm for WR and N level PPS channels.* *Long-term: Install low voltage trip or alarm for Quadrant Differential Temperature PPS channels.*
Switchgear Room	**Power Operation and 30 Minutes After Shutdown: Maintain low transient combustible limits of "very low" near pump motor room door and 670-E-15, and "low" everywhere else in the room. Limit sprinkler system unavailability and use compensatory measures (Reference 5) to limit the probability of suppression failure to 1.0E-/demand.**	*Address possible adverse fire fighting effects.* *Long-term: Install a fully or partially redundant fire protection system and/or add cable wrap to protect cabling to alleviate reliance on the fire department for reducing CLOFA event frequency.* *During power operation, maintain transient combustible loading restrictions that address areas involving the high temperature PPS conduits of "very low" or low voltage trip or alarm in the control room.*

Table 15.16-1. (continued).

Area	SAR Commitments	*Recommendations*
Pump Motor Room	**Power Operation and 30 Minutes After Shutdown: Maintain transient combustible limits of "very low" within 5 ft of ECPs, M-10 conduit, and between the M-9 and M-10 pumps. Maintain transient combustible limits of "low" everywhere else in the room. Limit sprinkler system unavailability and use compensatory measures (Reference 5) to limit the probability of suppression failure to 1.0E-2/demand.**	*Long-term: Install a fully or partially redundant fire protection system and/or add cable wrap to protect cabling to alleviate reliance on the fire department for reducing CLOFA event frequency.*
Heat Exchanger Area and Pipe Tunnel	**Power Operation and Reactor Fueled: Transient combustible loading restrictions of "very low" within 5 ft of the surge tank and "low" everywhere else.**	*Find ways to prevent overgrowth of transient combustibles for scaffolding, etc. that stay in the area during power operations.*
Subpile Room	**Power Operation and Reactor Fueled: Transient combustible loading restrictions of "low."[a]**	
Safety Rod Drive Area	**Power Operation: Transient combustible loading restrictions of "low."**	
OSCC and pipe corridor	**Power Operation: Transient combustible loading restrictions of "low."**	
HDW room and second basement east hall near UPS panels	**Power Operation and 30 Minutes After Shutdown: Transient combustible loading restrictions of "low."**	
Basement hallways		*During power operation, limit fire protection system unavailability and seek ways to avoid excessive transient combustible material loading.*

a. Two specific transient combustible control categories were identified and are characterized as "low" or 1 million BTU per ft^2 area and "very low" (1/8th of low).

15.16.5 References

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