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September 18, 1992
LIC-92-291R

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Station P1-137
Washington, DC 20555

Reference: 1. Docket 50-285
2. Letter from OPPD (W. G. Gates) to NRC (Document Control Desk) dated May 18, 1992 (LIC-92-135L)

Gentlemen:

SUBJECT: Change in Commitment to AEC Safety Guide 1 (Regulatory Guide 1.1)

Omaha Public Power District (OPPD) is revising a commitment to AEC Safety Guide 1 contained in Section 6.2 of the Fort Calhoun Station (FCS) Updated Safety Analysis Report (USAR). This changes the method of calculating the available Net Positive Suction Head (NPSH) for the Containment Spray system during the recirculation mode of operation. OPPD committed to this action in Licensee Event Report (LER) 92-016 (Reference 2), which reported the potential for inadequate NPSH for the FCS Containment Spray system during the recirculation mode of operation.

This issue was discussed between Mr. R. W. Short of my staff and the NRC prior to Fort Calhoun returning to power operation following the 1992 refueling outage. The attachment contains the approved revision and marked-up page changes to USAR Section 6.2. This revision will be included in the next USAR update as required by 10 CFR 50.71(e). Details supporting this revision are noted below.

IDENTIFICATION OF CHANGE

AEC Safety Guide 1, Regulatory Position C, states that "Emergency core cooling and containment heat removal systems should be designed so that adequate net positive suction head (NPSH) is provided to system pumps assuming maximum expected temperatures of pumped fluids and no increase in containment pressure from that present prior to postulated loss of coolant accidents." OPPD has been committed to this Safety Guide position in USAR Section 6.2.

OPPD has completed a 10 CFR 50.59 evaluation supporting revision of Section 6.2 of the USAR to reflect taking credit for a portion of the suction head provided by containment sump water subcooling during the recirculation mode of operation. This subcooling is due to temperatures less than the saturation temperature as calculated in the FCS containment transient analysis. The new NPSH calculation conservatively credits only 25 percent of the minimum available sump water subcooling. Since use of the new NPSH analysis is contrary to the above noted position in AEC Safety Guide 1, OPPD is revising the commitment to this position.

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REASON FOR CHANGE

During OPPD's Design Basis Reconstitution of the Containment Spray (CS) system, it was discovered that an as-built hydraulic analysis of the CS system was not available. As part of the resolution of the Design Basis Document open item, a hydraulic analysis of the CS system was performed. The analysis revealed that using the NPSH calculation criteria of AEC Safety Guide 1 (Regulatory Guide 1.1), the CS pumps would deliver higher flow rates than previously analyzed and as a result would not have adequate suction head during the recirculation phase of operation for all postulated accidents. In LER 92-016, OPPD reported this condition and committed to revise USAR Section 6.2.1 to reflect a change in the method of calculating the available NPSH.

BASIS FOR CONCLUSION

ABB Combustion Engineering evaluated the NPSH required ($NPSH_r$) against NPSH available ($NPSH_a$) under various operating modes to determine the scenario with the highest $NPSH_r$ and the lowest $NPSH_a$. Using the previous values contained in USAR Section 6.2 for sump water elevation, friction losses and the revised calculated flow, a deficit of approximately 4 feet existed between the $NPSH_r$ and $NPSH_a$.

Based on the FCS containment transient analysis, the amount of subcooling available at the time of recirculation actuation would be 90 feet of head. As containment pressure continued to decrease, the amount of subcooling would decrease; however, the water in the sump would continue to cool since the heat load due to containment temperature and decay heat load would be decreasing. The minimum amount of subcooling calculated to be available would be 35.95 feet of head.

As stated in Safety Guide 1, the basis for not depending on the increase in pressure within containment is to ensure that too low an internal pressure, resulting from impaired containment integrity, or operation of the containment heat removal system at too high a rate would not significantly affect the ability of the system to accomplish its safety function.

The previous USAR Section 6.2, which did not credit subcooling, is based on a pump flow of 2000 gpm. The analysis performed to address the Design Basis Document open item has calculated the maximum $NPSH_r$ with the minimum $NPSH_a$ at a flow rate of 3100 gpm. Since the maximum flows were calculated, the potential of operating the CS system at too high a rate as discussed in Safety Guide 1 is not a concern. The analysis conservatively credits only 25 percent of the minimum NPSH available from subcooling, thereby maintaining a 75 percent margin. Therefore, adequate margin exists to ensure that no deliberate continuation of a high containment pressure would be required to maintain adequate pump NPSH.

CONCLUSION

The plant-specific analysis noted above credits 25 percent of the minimum NPSH available from sump subcooling. OPPD has concluded through a 10 CFR 50.59 evaluation that, using this analysis, the required NPSH for the Containment Spray system would be maintained during the recirculation mode of operation and an unreviewed safety question is not involved. However, use of this analysis is contrary to a previous commitment to AEC Safety Guide 1 contained in USAR Section 6.2. OPPD has therefore rescinded this commitment.

If you should have any questions, please contact me.

Sincerely,

W. G. Gates

W. G. Gates
Division Manager
Nuclear Operations

WGG/brh

Attachment

c: LeBeouf, Lamb, Leiby & MacRae
J. L. Milhoan, NRC Regional Administrator, Region IV
R. P. Mullikin, NRC Senior Resident Inspector
S. D. Bloom, NRC Acting Project Manager

MARKED-UP USAR REVISION

~~NPSH requirements for the ECCS pumps were in compliance with the design criteria set forth in Safety Guide #1 and Design Criteria 35 and 38 as shown and explained in the calculations given below.~~ Adequate NPSH is available in the redundant ECCS injection and containment spray systems as shown and explained in the calculations given below. ~~NPSH calculations do not take credit for subcooling in the containment during the recirculation mode of operation. The NPSH calculations are as follows:~~

I. Safety Injection

During the safety injection operating mode, the HPSI, LPSI, and the containment spray pumps receive suction from the safety injection refueling water tank. The available NPSH for the HPSI, LPSI and containment spray pumps during safety injection was evaluated as follows:

$$NPSH\ (available) = \frac{(P+Pa-Pvp)}{sp.gravity} 2.31 + Z - h_f$$

P = pressure on liquid in SIRW tank or sump

Pa = atmospheric pressure (psia)

Pvp = vapor pressure of liquid at specific temperature T (psia)

Z = vertical distance from liquid surface to centerline of pump suction (ft)

h = water level above baseline elevation of SIRWT (ft)

h_f = max. friction losses in suction lines (ft)

A. LPSI Pumps

Required NPSH of LPSI pumps (2400 gpm/pump)	=	20 ft.
Centerline suction nozzle elevation	=	973.25 ft.
Minimum water level elevation in SIRWT	=	989 ft.
P (psig)	=	0.0
Pa (psia)	=	14.7
Pvp @ 100°F (psia)	=	.95
Z (ft)	=	15.75
h_f maximum (ft)	=	6.3

$$Minimum\ NPSH\ (available) = \frac{(0+14.7-.95)}{1.0} (2.31)+(15.75-6.3) = 41.21\ ft.$$

Since the maximum available NPSH of 41.51 ft. is above the required NPSH of 11.0 ft., adequate NPSH is always available to the HPSI pumps during the safety injection operating mode.

Summarizing the above NPSH evaluations for the HPSI, LPSI, and containment spray pumps, it is concluded that adequate NPSH will always be available for the emergency core cooling systems and the containment spray pumps.

II. <u>Recirculation</u>

A. Containment Spray Pumps

Required NPSH of containment spray pumps (~~2000~~ 3100 gpm/pump) = ~~16.8~~ 26.0 ft.

True centerline suction elevation = 973.25 ft

Minimum water level elevation inside containment = 996.8 ft.

Subcooling

P (~~psia~~ ft) = ~~Pvp*~~ 8.99*

~~Pvp (psia) = p*~~

Z (ft) = 23.55

h_f maximum (ft) = ~~2.76~~ 3.87

Minimum NPSH (available) = ~~(23.55-2.76) = 20.79 ft.~~
(23.55+8.99-3.87) = 28.67 ft.

Since the suction pressure NPSH is above the required NPSH of the CS pumps, adequate NPSH will always be available during recirculation.

B. LPSI Pumps

Note that the LPSI pumps are not required for recirculation, and they will be secured upon receipt of the recirculation actuation signal.

C. HPSI Pumps

NPSH required for HPSI pumps (400 gpm/pump) = 11 ft.

Centerline suction nozzle elevation = 973.25 ft.

Minimum water level elevation inside containment = 996.8 ft.

Subcooling

P (~~psia~~ ft) = ~~Pvp*~~ 8.99*

~~Pvp (psia) = p*~~

h_f maximum (ft) = 2.21

Minimum NPSH (available) = ~~23.55-2.21 = 21.34 ft.~~
(23.55+8.99-2.21) = 30.33 ft.

Since the suction pressure NPSH is above the required NPSH of the HPSI pumps, adequate NPSH will always be available during recirculation.

A comparison between the minimum available NPSH and the required NPSH of the containment spray pumps and HPSI pumps leads to the conclusion that adequate NPSH will be always available to the above mentioned pumps during the recirculation mode of operation.

* - ~~No credit~~ Credit is taken for subcooling. The subcooling head is above the vapor pressure of the water; therefore vapor pressure is appropriately considered.

Figures 6.2-1 and 6.2-2 show pump elevations and piping runs.

A portion of the recirculation piping shown in Figure 6.2-1 is buried directly in concrete. Under post accident conditions compressive thermal stresses will occur in the pipe. These thermal stresses will not cause failure of the piping since the stainless steel is a ductile material and the stresses are compressive. Reinforcing bars will absorb the tensile stress in the surrounding concrete.

If degradation of the buried piping is suspected, it can be inspected from the inside.

6.2.2 <u>System Description</u>

The safety injection system and the containment spray system piping and instrument diagram is shown in P&ID E-23866-210-130, SHTS 1 and 2.

The safety injection system for this plant consists of both passive and active components. The four pressurized safety injection tanks are of the passive type and require no outside power or safety injection actuation signal to operate. The safety injection tanks inject large quantities of borated water into the reactor coolant system immediately following a large pipe break. The water rapidly covers and cools the core, thereby limiting clad melting and metal water reaction. The separate and independent tanks are each connected to one of the four safety injection nozzles; one nozzle is located on each of the four reactor coolant system cold legs. The driving head for water injection is provided by a nitrogen cover gas at a pressure of 240 psig minimum (255 psig normal). As the reactor coolant system pressure falls below tank pressure, check valves open in the line connecting each tank to the system. Thus, these tanks will initiate their discharge when the reactor coolant pressure drops below approximately 240 psig minimum (255 psig normal).

The active components which require safeguard actuation signals include the high and low pressure safety injection pumps as well as the containment spray pumps.

Safety injection is initiated by either a low-pressure signal from the pressurizer or a high containment pressure signal. A description of the derivation of the safeguard actuation signals is presented in Section 7.3.2.

Figure 6.2-4 presents a plot of time to actuate the safeguards via the containment high pressure and the pressurizer low pressure signals as a function of break size. Figure 6.2-4 also presents a plot of time to uncover the core

The containment water temperature transients following a LOCA were analyzed with respect to possible adverse effects on the available net positive suction head (NPSH) for the safety injection and containment spray pumps when the system shifted to the recirculation mode. The analyses were calculated based on the same conservative conditions and assumptions utilized in the containment pressure transient analyses as described in Section 14.16 of the USAR. The heat transfer coefficients' initial conditions, and heat sinks are as listed in Section 14.16.

The containment water temperature transients were calculated assuming that when the coolant flashes, it comes into equilibrium with the containment at the containment atmosphere temperature. The portion of reactor coolant which does not flash drops to the floor as saturated liquid. The initial water mass on the containment floor is reactor coolant from the blowdown (T=0 Sec.) and the contents of one stored energy flask that does not reach the core. No spray or pumped safety injection is assumed until 30 seconds after the accident. Water is added to the sump by spillage from the core, condensation of steam from the containment atmosphere, and by the sprays. The water from all sources is assumed to be at containment atmosphere temperature. With three spray pumps and one spray header available, the containment water temperature from a double ended rupture of a 32 inch diameter reactor coolant pipe is considered for two safety injection modes.

A. Minimum safety injection, per Section 14.16 of the USAR, consists of three of the four stored energy tanks, one charging pump, one low pressure safety injection pump and one high pressure safety injection pump.

B. Full safety injection, per Section 14.16 of the USAR, consists of three of the four stored energy tanks, two charging pumps, two low pressure safety injection pumps and two high pressure safety injection pumps.

Assuming that the safety injection and refueling water (SIRW) tank is at its most adverse condition, minimum level of 283,000 gallons (314,000 gallons design), the following are the system parameters at the start of recirculation:

	Minimum Safety Injection	Full Safety Injection
Recirculation		
Start Time	3740 Sec.	2815 Sec.
Containment Water	172 °F.	174 °F.
Atmosphere	150 °F.	148 °F.

With regard to net positive suction head, ~~the emergency core cooling and containment spray systems have been designed assuming no increase in containment pressure from the initial atmosphere pressure present prior to the postulated loss of coolant accidents. The NPSH values listed in the USAR are based on this assumption and do not include the NPSH that is available due to the containment water being less than 212°F in temperature. Therefore,~~

the recirculation phase calculation takes credit for suction head provided by containment sump water subcooling due to temperatures less than saturation as calculated in the containment transient analysis. This is an exception from the design criteria set forth in Safety Guide #1; however, the NPSH calculation conservatively credits only 25% of the available sump water subcooling with the conclusion that adequate NPSH is available. ~~these conditions comply with the requirements of Safety Guide No. 1. Further a~~Assuming that only one shutdown cooling heat exchanger is available at recirculation, the spray temperature for minimum safety injection would be 144°F and for full safety injection 145°F. Figures 6.2-5 and 6.2-6 show plots of the containment water temperature vs. time.

6.2.6 Availability and Reliability

6.2.6.1 Normal Operation

During normal plant operation, there are no components of the system in operation. All components are on standby for possible emergency operation.

6.2.6.2 Plant Shutdown

System operation for shutdown cooling is discussed in Section 9.3.

6.2.6.3 Emergency Operation

Safety Injection

The five safety injection pumps (three high-pressure and two low-pressure) are started via the sequencers by PPLS and/or CPHS. PPLS and/or CPHS also energize the safety injection actuator relays (SIAS), opening the safety injection valves and closing the check valve leakage cooler valves. If all normal power sources are lost and one emergency diesel-generator fails to start, one low-pressure and at least one high-pressure pump are automatically started (see Section 8.4). The rest of the system is always aligned for safety injection during power operation. The safety injection tanks will discharge into the reactor coolant system when the pressure drops below approximately 255 psig.

Spill through the break is limited to a maximum of 25 percent by use of the flowmeter in each injection line and the remote-manual throttling capability of each safety injection valve.

Recirculation

When the water in the SIRW tank reaches a predetermined low level, the STLS is initiated by coincident low level signals from two of four level switches in the SIRW tank. An STLS in coincidence with either a CPHS or PPLS will initiate the recirculation actuation signal (RAS). The RAS opens the containment recirculation valves, closes the SIRW tank valves, stops the low- pressure pumps, closes the valves in the pump minimum recirculation lines and cuts in full component cooling water flow to the shutdown heat exchangers. The valves are arranged to ensure at least a 1-minute overlapping stroke to allow mixing and ensure adequate NPSH during the transfer. If cool water is available

from the spray pumps and shutdown cooling heat exchangers, a portion of the water discharged from the shutdown cooling heat exchangers may be manually diverted to the high-pressure pump suction. This is a preferred mode of operation, but is not necessary to meet core cool ng requirements. The low-pressure pumps may be manually restarted by operation of override switches to obtain increased cooling flow when the reactor coolant system pressure is reduced. One or more spray pumps can also be used to augment flow to the core after the pressure is reduced.

TABLE 6.3-1

CONTAINMENT SPRAY SYSTEM COMPONENT PERFORMANCE

Containment Spray Pumps, Item No's. SI-3A, 3B & 3C

Number of Units	3
Motor Nameplate Voltage	460
Horsepower, hp	300

	Mode	
	Injection	Recirculation
Capacity (each), gpm	1700	~~2000~~ 3100
Head, ft	450	~~437~~ 322
NPSH Available, ft	20	~~18~~ 28.67
NPSH Required, ft	14.5	~~16.8~~ 26.0
NPSH Margin, ft	5.5	~~1.2~~ 2.67

Shutdown Heat Exchangers, Item No's. AC-4A & 4B

Number of Units	2
Capacity (each) component	$87.5x10^6$ Btu/hr based on 4,000 gpm of cooling water at 114°F inlet temperature and 1,420 gpm of spray water at 283°F inlet temperature

TABLE 6.3-2

SUMMARY OF PIPING, VALVE AND SPRAY NOZZLE CHARACTERISTICS

Code	USAS B31.7 1968, Class II
Material	
Valves & Piping	304 Stainless Steel
Design Temperature, °F	300
Design Pressures, psig	
Piping, Suction	60
Piping, Discharge	500
Valves, Suction	150
Valves, Discharge, 2 in.	300
Valves, Discharge, 1-1/2 in.	600
Wall thickness, piping	
2 in. and smaller (suction)	Sch. 40S
2-1/2 in. through 12 in.	Sch. 10S
14 in. through 20 in., nominal, in.	0.250

USAR REVISION

Adequate NPSH is available in the redundant ECCS injection and containment spray systems as shown and explained in the calculations given below.

I. Safety Injection

During the safety injection operating mode, the HPSI, LPSI, and the containment spray pumps receive suction from the safety injection refueling water tank. The available NPSH for the HPSI, LPSI and containment spray pumps during safety injection was evaluated as follows:

$$\text{NPSH (available)} = \frac{(P+Pa-Pvp)}{\text{sp.gravity}} 2.31 + Z - h_f$$

P = pressure on liquid in SIRW tank or sump

Pa = atmospheric pressure (psia)

Pvp = vapor pressure of liquid at specific temperature T (psia)

Z = vertical distance from liquid surface to centerline of pump suction (ft)

h = water level above baseline elevation of SIRWT (ft)

h_f = max. friction losses in suction lines (ft)

A. LPSI Pumps

Required NPSH of LPSI pumps (2400 gpm/pump)	=	20 ft.
Centerline suction nozzle elevation	=	973.25 ft.
Minimum water level elevation in SIRWT	=	989 ft.
(psig)	=	0.0
Pa (psia)	=	14.7
Pvp @ 100°F (psia)	=	.95
Z (ft)	=	15.75
h_f maximum (ft)	=	6.3

$$\text{Minimum NPSH (available)} = \frac{(0+14.7-.95)}{1.0}(2.31)+(15.75-6.3) = 41.21 \text{ ft.}$$

Since the maximum available NPSH of 41.51 ft. is above the required NPSH of 11.0 ft., adequate NPSH is always available to the HPSI pumps during the safety injection operating mode.

Summarizing the above NPSH evaluations for the HPSI, LPSI, and containment spray pumps, it is concluded that adequate NPSH will always be available for the emergency core cooling systems and the containment spray pumps.

II. Recirculation

A. Containment Spray Pumps

Required NPSH of containment spray pumps (3100 gpm/pump)		= 26.0 ft.
True centerline suction elevation		= 973.25 ft.
Minimum water level elevation inside containment		= 996.8 ft.
Subcooling	P (ft)	= 8.99*
	Z (ft)	= 23.55
	h_f maximum (ft)	= 3.87

Minimum NPSH (available) = (23.55+8.99-3.87) = 28.67 ft.

Since the suction pressure NPSH is above the required NPSH of the CS pumps, adequate NPSH will always be available during recirculation.

B. LPSI Pumps

Note that the LPSI pumps are not required for recirculation, and they will be secured upon receipt of the recirculation actuation signal.

C. HPSI Pumps

NPSH required for HPSI pumps (400 gpm/pump)		= 11 ft.
Centerline suction nozzle elevation		= 973.25 ft.
Minimum water level elevation inside containment		= 996.8 ft.
Subcooling	P (ft)	= 8.99*
	h_f maximum (ft)	= 2.21

Minimum NPSH (available) = (23.55+8.99-2.21) = 30.33 ft.

Since the suction pressure NPSH is above the required NPSH of the HPSI pumps, adequate NPSH will always be available during recirculation.

A comparison between the minimum available NPSH and the required NPSH of the containment spray pumps and HPSI pumps leads to the conclusion that adequate NPSH will be always available to the above mentioned pumps during the recirculation mode of operation.

* - Credit is taken for subcooling. The subcooling head is above the vapor pressure of the water; therefore vapor pressure is appropriately considered.

Figures 6.2-1 and 6.2-2 show pump elevations and piping runs.

A portion of the recirculation piping shown in Figure 6.2-1 is buried directly in concrete. Under post accident conditions compressive thermal stresses will occur in the pipe. These thermal stresses will not cause failure of the piping since the stainless steel is a ductile material and the stresses are compressive. Reinforcing bars will absorb the tensile stress in the surrounding concrete.

If degradation of the buried piping is suspected, it can be inspected from the inside.

6.2.2 System Description

The safety injection system and the containment spray system piping and instrument diagram is shown in P&ID E-23866-210-130, SHTS 1 and 2.

The safety injection system for this plant consists of both passive and active components. The four pressurized safety injection tanks are of the passive type and require no outside power or safety injection actuation signal to operate. The safety injection tanks inject large quantities of borated water into the reactor coolant system immediately following a large pipe break. The water rapidly covers and cools the core, thereby limiting clad melting and metal water reaction. The separate and independent tanks are each connected to one of the four safety injection nozzles; one nozzle is located on each of the four reactor coolant system cold legs. The driving head for water injection is provided by a nitrogen cover gas at a pressure of 240 psig minimum (255 psig normal). As the reactor coolant system pressure falls below tank pressure, check valves open in the line connecting each tank to the system. Thus, these tanks will initiate their discharge when the reactor coolant pressure drops below approximately 240 psig minimum (255 psig normal).

The active components which require safeguard actuation signals include the high and low pressure safety injection pumps as well as the containment spray pumps.

Safety injection is initiated by either a low-pressure signal from the pressurizer or a high containment pressure signal. A description of the derivation of the safeguard actuation signals is presented in Section 7.3.2.
Figure 6.2-4 presents a plot of time to actuate the safeguards via the containment high pressure and the pressurizer low pressure signals as a function of break size. Figure 6.2-4 also presents a plot of time to uncover the core

The containment water temperature transients following a LOCA were analyzed with respect to possible adverse effects on the available net positive suction head (NPSH) for the safety injection and containment spray pumps when the system shifted to the recirculation mode. The analyses were calculated based on the same conservative conditions and assumptions utilized in the containment pressure transient analyses as described in Section 14.16 of the USAR. The heat transfer coefficients' initial conditions, and heat sinks are as listed in Section 14.16.

The containment water temperature transients were calculated assuming that when the coolant flashes, it comes into equilibrium with the containment at the containment atmosphere temperature. The portion of reactor coolant which does not flash drops to the floor as saturated liquid. The initial water mass on the containment floor is reactor coolant from the blowdown (T=0 Sec.) and the contents of one stored energy flask that does not reach the core. No spray or pumped safety injection is assumed until 30 seconds after the accident. Water is added to the sump by spillage from the core, condensation of steam from the containment atmosphere, and by the sprays. The water from all sources is assumed to be at containment atmosphere temperature. With three spray pumps and one spray header available, the containment water temperature from a double ended rupture of a 32 inch diameter reactor coolant pipe is considered for two safety injection modes.

A. Minimum safety injection, per Section 14.16 of the USAR, consists of three of the four stored energy tanks, one charging pump, one low pressure safety injection pump and one high pressure safety injection pump.

B. Full safety injection, per Section 14.16 of the USAR, consists of three of the four stored energy tanks, two charging pumps, two low pressure safety injection pumps and two high pressure safety injection pumps.

Assuming that the safety injection and refueling water (SIRW) tank is at its most adverse condition, minimum level of 283,000 gallons (314,000 gallons design), the following are the system parameters at the start of recirculation:

	Minimum Safety Injection	Full Safety Injection
Recirculation		
Start Time	3740 Sec.	2815 Sec.
Containment Water	172 °F.	174 °F.
Atmosphere	150 °F.	148 °F.

With regard to net positive suction head, the recirculation phase calculation takes credit for suction head provided by containment sump water subcooling due to temperatures less than saturation as calculated in the containment transient analysis. This is an exception from the design criteria set forth in Safety Guide #1; however, the NPSH calculation conservatively credits only 25% of the available sump water subcooling with the conclusion that adequate NPSH is available.

Assuming that only one shutdown cooling heat exchanger is available at recirculation, the spray temperature for minimum safety injection would be 144°F and for full safety injection 145°F. Figures 6.2-5 and 6.2-6 show plots of the containment water temperature vs. time.

6 2.6 Availability and Reliability

6.2.6.1 Normal Operation

During normal plant operation, there are no components of the system in operation. All components are on standby for possible emergency operation.

6.2.6.2 Plant Shutdown

System operation for shutdown cooling is discussed in Section 9.3.

6.2.6.3 Emergency Operation

Safety Injection

The five safety injection pumps (three high-pressure and two low-pressure) are started via the sequencers by PPLS and/or CPHS. PPLS and/or CPHS also energize the safety injection actuator relays (SIAS), opening the safety injection valves and closing the check valve leakage cooler valves. If all normal power sources are lost and one emergency diesel-generator fails to start, one low-pressure and at least one high-pressure pump are automatically started (see Section 8.4). The rest of the system is always aligned for safety injection during power operation. The safety injection tanks will discharge into the reactor coolant system when the pressure drops below approximately 255 psig.

Spill through the break is limited to a maximum of 25 percent by use of the flowmeter in each injection line and the remote-manual throttling capability of each safety injection valve.

Recirculation

When the water in the SIRW tank reaches a predetermined low level, the STLS is initiated by coincident low level signals from two of four level switches in the SIRW tank. An STLS in coincidence with either a CPHS or PPLS will initiate the recirculation actuation signal (RAS). The RAS opens the containment recirculation valves, closes the SIRW tank valves, stops the low-pressure pumps, closes the valves in the pump minimum recirculation lines and cuts in full component cooling water flow to the shutdown heat exchangers The valves are arranged to ensure at least a 1-minute overlapping stroke to allow mixing and ensure adequate NPSH during the transfer. If cool water is available from the spray pumps and shutdown cooling heat exchangers, a portion of the water discharged from the shutdown cooling heat exchangers may be manually diverted to the high-pressure pump suction. This is a preferred mode of operation, but is not necessary to meet core cooling requirements. The low-pressure pumps may be manually restarted by operation of override switches to obtain increased cooling flow when the reactor coolant system pressure is reduced. One or more spray pumps can also be used to augment flow to the core after the pressure is reduced.

TABLE 6.3-1

CONTAINMENT SPRAY SYSTEM COMPONENT PERFORMANCE

Containment Spray Pumps, Item No's. SI-3A, 3B & 3C

Number of Units	3
Motor Nameplate Voltage	460
Horsepower, hp	300

	Mode	
	Injection	Recirculation
Capacity (each), gpm	1700	3100
Head, ft	450	322
NPSH Available, ft	20	28.67
NPSH Required, ft	14.5	26.0
NPSH Margin, ft	5.5	2.67

Shutdown Heat Exchangers, Item No's. AC-4A & 4B

Number of Units	2
Capacity (each) component	$87.5x10^6$ Btu/hr based on 4,000 gpm of cooling water at 114°F inlet temperature and 1,420 gpm of spray water at 283°F inlet temperature

TABLE 6.3-2

SUMMARY OF PIPING, VALVE AND SPRAY NOZZLE CHARACTERISTICS

Code	USAS B31.7 1968, Class II
Material	
Valves & Piping	304 Stainless Steel
Design Temperature, °F	300
Design Pressures, psig	
Piping, Suction	60
Piping, Discharge	500
Valves, Suction	150
Valves, Discharge, 2 in.	300
Valves, Discharge, 1-1/2 in.	600
Wall thickness, piping	
2 in. and smaller (suction)	Sch. 40S
2-1/2 in. through 12 in.	Sch. 10S
14 in. through 20 in., nominal, in.	0.250