GULF STATES UTILITIES COMPANY

RIVER BEND STATION POST OFFICE BOX 220 ST. FRANCISVILLE, LOUISIANA 70775

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U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Gentlemen:

River Bend Station - Unit 1
Docket No. 50-458

Please find enclosed Supplement 3 to Licensee Event Report No. 91-008 for River Bend Station - Unit 1. This supplement is submitted to document [illegible] identified safe shutdown equipment that was omitted from the main control room fire analysis.

Sincerely,

W. H. Odell
Manager - Oversight
River Bend Nuclear Group

LAE/PDG/FRC/JRH/DCH/RJK/DSN/kvm

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NRC FORM 366 (6-89)

U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER)

APPROVED OMB NO. 3150-0104
EXPIRES 4/30/92

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE RECORDS AND REPORTS MANAGEMENT BRANCH (P-530), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
RIVER BEND STATION	0 5 0 0 0 4 5 8	1 OF 1 0

TITLE (4) FIRE HAZARDS ANALYSIS DEFICIENCIES INCLUDING LACK OF FIRE WRAP/ INADEQUATE FIRE BARRIER

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAMES	DOCKET NUMBER(S)
										0 5 0 0 0
0 4	1 5	9 1	9 1	— 0 0 8	— 0 3	0 8	0 3	9 2		0 5 0 0 0

OPERATING MODE (9)	1	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)			
POWER LEVEL (10)	1 0 0	20.402(b)	20.405(c)	50.73(a)(2)(iv)	73.71(b)
		20.405(a)(1)(i)	50.36(c)(1)	50.73(a)(2)(v)	73.71(c)
		20.405(a)(1)(ii)	50.36(c)(2)	50.73(a)(2)(vii)	OTHER (Specify in Abstract below and in Text, NRC Form 366A)
		20.405(a)(1)(iii)	X 50.73(a)(2)(i)	50.73(a)(2)(viii)(A)	
		20.405(a)(1)(iv)	50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)	
		20.405(a)(1)(v)	50.73(a)(2)(iii)	50.73(a)(2)(x)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER
L.A. ENGLAND, DIRECTOR - NUCLEAR LICENSING	AREA CODE 5 0 4 3 8 1 - 4 1 4 5

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS	

SUPPLEMENTAL REPORT EXPECTED (14)

		EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE)	X NO				

ABSTRACT (Limit to 1400 spaces, i.e., approximately fifteen single-space typewritten lines) (16)

At 1345 hours on 4/15/91, with the reactor at full power in Operational Condition 1, it was discovered that electrical cables located in fire area ET-2, which may cause spurious operation of valves 1E51*MOVF063 (RCIC inboard steam isolation valve) and 1E51*MOVF078 (RCIC vacuum breaker valve), did not have fire wrap contrary to Fire Hazards Analysis (FHA) requirements. At 1300 on 4/23/91, additional cables, which could cause the same problem were found in fire areas AB-2, C-2 and C-6. RCIC is required by the FHA for safe shutdown in these fire areas. Since these valves are required not to change position for operation of RCIC and fire damage to these cables may cause loss of RCIC, the cables would require wrapping in these fire areas.

Upon discovery of this condition, the affected cables were treated as having missing fire barriers and the action statement prescribed in Technical Specification 3/4.7.7, "Fire Rated Assemblies", was implemented for areas containing these cables. Errors made during the original development of the FHA were the cause for the identified cables not being wrapped in the identified fire areas. Additional deficiencies have been discovered during the FHA review. These deficiencies concern Appendix R separation, a fire area that was not previously identified, and safe shutdown equipment that was omitted from the main control room fire analysis. GSU has implemented corrective actions to address each of these conditions.

REPORTED CONDITION

At 1345 hours on 4/15/91, with the reactor at full power in Operational Condition 1, it was reported to the shift supervisor that certain electrical cables associated with valves 1E51*MOVF063 (*ISV*) (RCIC inboard steam isolation valve) and 1E51*MOVF078 (*VTV*) (RCIC vacuum breaker valve) located in fire area ET-2 (Electrical Tunnel "B" West), did not have fire wrap. This discovered condition is contrary to requirements contained in the FHA. While working on resolution of this issue, additional cables which could cause the same problem were found in fire areas AB-2, C-2 and C-6. At 1300 hours on 4/23/91, these additional areas of concern were reported to the shift supervisor. The FHA lists Method 1 as the analyzed method of shutdown for fire areas AB-2, C-2, C-6 and ET-2. Method 1 shutdown is identified as using 3 safety relief valves (SRVs) (*RV*) for reactor pressure vessel (RPV) (*JE*) pressure control, RCIC for RPV level control, and RHR-A for suppression pool cooling and shutdown cooling. The FHA lists these valves as "Passive Valves" required for Method 1 shutdown which means the valves must not change position due to fire damage on their cables. The FHA states the identified cables for these valves should be wrapped in these fire areas.

The affected cables did not have the required fire wrap (fire barrier) since plant startup; therefore, the fire barrier is considered inoperable per Technical Specification 3/4.7.7 and this report is submitted pursuant to 10CFR50.73(a)(2)(i)(B) as operation prohibited by the Technical Specification.

Additional reportable conditions have been discovered as a result of the FHA review. These conditions concern Appendix R separation, the discovery of a previously unidentified fire area, and safe shutdown equipment omitted from the main control room fire analysis. These conditions are described in the Investigation section below.

INVESTIGATION

The River Bend Station - Unit 1 Appendix R Data Management System lists equipment, raceways, and cables by fire area. A review of this data base found inconsistencies between the data base and the FHA for the identified cables which may cause spurious operation of valves 1E51*MOVF063 and 1E51*MOVF078. The FHA indicates the cables should be wrapped in these fire areas but the data base indicates the cables do not require wrap.

FHA Section V "Fire Hazards Evaluation Conclusions" states that for fire areas AB-2, C-2, C-6 and ET-2 shutdown can be achieved by Method 1. FHA Section I and Tables 1, 2 and 6 identify Method 1 shutdown equipment. Reactor core isolation cooling (RCIC) (*BN*) is used for reactor pressure vessel (RPV) level control in Method 1 shutdown. The

RCIC inboard steam isolation valve 1E51*MOVF063 and the RCIC vacuum breaker valve 1E51*MOVF078 are passive valves for Method 1 shutdown which means they must not change position due to fire damage. FHA Table 2 states that cables for these two valves, which may result in spurious signals, are wrapped in these fire areas. Circuit analysis on cables 1ICSABC001 and 1ICSABC004 (*CBL2*) found that fire damage can cause spurious closure of valve 1E51*MOVF063 which would prevent steam from reaching the RCIC turbine (*TBR*). Circuit analysis on cables 1ICSEBC001 and 1ICSEBC003 found that fire damage can cause spurious opening of valve 1E51*MOVF078 which would adversely affect RCIC vacuum breaker capabilities.

Since these valves are required not to change position for operation of RCIC and RCIC is required for safe shutdown in the affected fire areas, the valves are correctly classified in the FHA as "Passive - Method 1 Components". Therefore, to comply with the USAR, FHA, and 10CFR50 Appendix R Section III.G, the cables would require wrapping in fire areas AB-2, C-2, C-6 and ET-2. With the exception of FHA Table 8 with regards to fire area AB-2, the FHA correctly indicates these cables require wrapping in these fire areas. The Appendix R data base is incorrect as it indicates the cables are not required to be wrapped.

Additional reportable conditions have been discovered as a result of the FHA review. These conditions concerned Appendix R separation and the discovery of a previously unidentified fire area. The Appendix R separation concerns involve fire area C-25 (main control room), FB-1 (fuel building), and RC-5/Z-13 (containment building). The previously unidentified fire area is a small electrical cable chase room located in the Northeast corner of D Tunnel on elevation 70' in the auxiliary building. These additional concerns are discussed individually below.

Fire Area C-25 (main control room):

The FHA identifies fire area C-25 as an area where alternate shutdown capability is provided. FHA Table 3 (method 1E - main control room fire required items) lists specific spent fuel pool cooling & cleanup (SFC) system and fuel building ventilation (HVF) system equipment as being required and therefore, independent of the fire in the control room. Review of circuits for this equipment determined the circuits are not electrically independent from the control room and potential fire damage could cause loss of the equipment which may result in loss of spent fuel pool cooling.

During a review of safe shutdown equipment which could spuriously actuate during a main control room fire, eight standby service water system solenoid operated valves (SOVs) were identified as having been omitted from the original analysis. These valves are 1SWP*SOV522A, B, C, D, 1SWP*SOV523A, B, C, and D. The design function of these valves

was to prevent water hammer by admitting air into the standby service water system when the system automatically starts following a loss of the normal service water system. Prior to the fourth refueling outage, this condition made the system piping vulnerable to a severe water hammer in the event of a loss of offsite power combined with a main control room fire. The main control room fire is assumed to disable the SOVs. In such an event, the water level in the service water system piping would be drained to approximately 139'. Due to the concurrent fire in the main control room, the eight standby service water SOVs could fail to admit air into the system. This would create a vacuum in the piping. A severe water hammer could result upon the automatic start of the standby service water system.

Fire Area FB-1 (fuel building):

Fuel building ventilation dampers 1HVF*AOD037A, 102 and 122 are identified in the FHA as equipment required for spent fuel pool cooling. Potential fire damage to electrical cables, located in fire area FB-1, for these dampers may cause spurious operation of the dampers which could potentially cause loss of the spent fuel pool cooling pump and thus loss of spent fuel pool cooling. Pre-fire strategies for this area stated these dampers must be verified to be in their proper position and if not, remove power so they fail to the correct position. Removing power to these dampers may not cause the dampers to go to the correct position since a potential hot short could cause the damper to remain in the incorrect position.

Fire Area RC-5/Z-13 (containment building):

USAR Section 9A.2.2.1 states "Safe shutdown Method 1 and 2 equipment, instrumentation and electrical cables are well separated in the Containment. The east (Division II - blue) side of containment is separated from the west (Division I - red) side by the main steam tunnel on the south and by an area free of combustibles on the north. Safe shutdown by either Method 1 or 2 can be used, depending on the actual location of the fire in the containment." With a fire in the west side (Division I), safe shutdown could be achieved using Method 2 equipment (Division II).

The FHA identifies the fact that containment unit cooler 1HVR*UC1B and related valves 1SWP*MOV502B & 503B (Method 2 equipment) are located on the west side of containment on elevation 162'-3" in Fire Area RC-5/Z-13. Valves 1SWP*MOV502B & 503B are inlet and outlet valves controlling cooling water to the unit cooler heat exchanger. The FHA states that this equipment is separated from its alternate counterpart by 24 ft. In addition, a 10 ft. missile barrier serves as a radiant energy shield and intervening combustibles are wrapped with a 3-hour rated product.

Unit coolers 1HVR*UC1A & 1B are separated from each other by a minimum distance of approximately 11'-2" (not 24' as reported in the FHA). A 10' high, 18" thick reinforced concrete missile barrier, which acts as a radiant energy shield, is located between the redundant unit coolers and related SWP valves. However, electrical cables for the redundant unit coolers and valves are routed such that the missile barrier is not located between redundant cables. Electrical cables for 1HVR*UC1B are in conduit # 1CL540BB and are routed along the containment liner. One portion of this conduit that is located within 20' of the redundant conduit # 1CL540RC (electric cables for 1HVR*UC1A) is wrapped with a three hour rated Thermo-lag conduit fire wrap material. The 20' dimension used was taken along the direct line between the two conduits, not horizontal distance as required by Appendix R. Since both conduits are routed along the containment liner but at different elevations, this application of the 20' rule allowed one of these redundant cables to be located directly over the other (separated by a minimum distance of 20' vertical but 0' horizontal) and not provided with the fire wrap material. Cables associated with the SWP valves also do not meet the 20 ft. horizontal separation criteria as identified in 10CFR50 Appendix R, Section III.G.

Valve 1SWP*MOV5A is listed as a component required for Method 2 safe shutdown in the FHA. This valve isolates Division II from Division 1 standby service water and is also located on the west side of the containment. This valve is located on elevation 153'-9" and is separated from its counterpart by a horizontal distance of 20'-2", however; this distance is not free of intervening combustibles. The intervening combustibles consist of electrical cables located in two 18" wide cable trays. A review of the cable routing for the 5A valve found that the cables do not meet the 20 ft. horizontal separation criteria as identified in 10CFR50 Appendix R, Section III.G.

Fire Area AB-18 (previously unidentified)

During the final FHA review, all fire areas except one were found to have a fire hazards analysis and 58 of 62 fire areas were found to have administrative controls identified in the FHA included in their pre-fire strategies. A fire hazards analysis for the new fire area, not previously identified in the FHA, was performed to determine potential impact on safe shutdown capability. The analysis determined that safe shutdown for this new fire area is provided utilizing Method 1 shutdown equipment and by initiating high pressure core spray (HPCS) in lieu of reactor core isolation cooling (RCIC) for level control during a fire. Also, administrative controls to align valve 1SFC*MOV120 to supply cooling to the upper fuel pools were necessary. Modification request (MR) 92-0013 was initiated on January 27, 1992, to make necessary document changes to the FHA and USAR for the new fire area. A new pre-fire strategy was prepared to identify this

information to reactor operators and the fire brigade. Pre-fire strategies for the four fire areas were revised to include the omitted administrative controls identified in the FHA.

CORRECTIVE ACTIONS

A detailed review and verification of the FHA by an independent contractor was initiated as a result of NRC Inspection Report No. 50-458/90-02. The conditions as described in this report were identified by the independent contractor during resolution of questions identified in the review and verification process. Evaluations of all questions arising from the final review of the FHA by the independent contractor were completed in January 1992.

Upon discovery of the condition identified on 4/15/91, the affected cables were treated as having missing fire barriers and the action statement prescribed in Technical Specification 3/4.7.7, "Fire Rated Assemblies", was implemented for areas containing these cables. With the exception of the Division II electrical room located in the northeast corner of "D" tunnel on elevation 70', fire watches had been previously in place for the affected areas due to operability questions associated with penetration seals. However, there is no assurance that fire watches had been in place for the entire time period since startup.

For the affected fire areas, an analysis has been performed to determine what alternate system for RCIC is available (free of fire damage). The analysis determined that low pressure core spray (LPCS) (*BM*) is free of fire damage in Fire Areas AB-2, C-2, & C-6 and high pressure core spray (HPCS) (*BJ*) is free of fire damage in Fire Area ET-2.

Errors made during the original development of the FHA were the cause of inconsistencies found within the FHA and between the FHA and the Appendix R data base. These inconsistencies resulted in the identified circuits not being protected in accordance with 10CFR50, Appendix R, Section III G. A contributing factor involving these errors appears to be the fact that the affected components are Division II and are required for Method 1 shutdown, which primarily uses Division I and III components. Review of this condition has determined there are also Division I cables/equipment which are required for Method 2 shutdown, which primarily uses Division II components. The cables for this type of equipment are considered "Appendix R Crossover Cables". Analysis has determined that there are approximately 80 of these crossover cables. A review of these crossover cables was performed and with one exception no similar deficiencies exist. The exception is the Division II cable chase area located in the northeast corner of D-Tunnel. In this area, RCIC may be lost due to fire damage on crossover cables. As previously stated

in the investigation, it was found that this area had not been previously identified or evaluated in the FHA. Analysis for this new fire area (AB-18) demonstrates safe shutdown capability is provided. Since the area contains only Division II cabling, safe shutdown can be achieved utilizing Method 1 shutdown methodology and substituting HPCS for RCIC for RPV level control. The corrective actions to address the new fire area included the identification of the proper safe shutdown method, implementation of administrative controls to align valve 1SFC*MOV120 to provide cooling to the upper fuel pools, documentation changes to the FHA and USAR, and the preparation of a pre-fire strategy for this area.

Fire Area C-25 (Main Control Room):

Immediate actions were taken and administrative controls implemented to address the concerns with spent fuel pool cooling until permanent corrective actions could be identified and implemented. Engineering analysis determined that the time required for the spent fuel pool temperature to reach the cooling system design limit of 155.6 degrees F with the existing fuel load conditions prior to RF-4 was approximately 5.3 days. Administrative controls were implemented and AOP-0031 ("Shutdown From Outside Main Control Room") was revised to provide the necessary manual actions to restore spent fuel pool cooling with a fire in the main control room. The entire reactor core was offloaded to the fuel building spent fuel pool for RF-4. With the increased heat load in the fuel pool, the minimum time required to reach the cooling system design limit of 155.6 degrees F was approximately 4 hours. This is sufficient time to take the manual actions identified in AOP-0031.

The corrective action for addressing the concerns with spent fuel pool cooling is to complete an analysis which demonstrates a design which allows a higher spent fuel pool temperature and still allows sufficient time to restore spent fuel pool cooling. With this revised design bases, the spent fuel pool cooling equipment presently identified as required by the FHA would not be immediately required. This analysis is scheduled to be completed by July 10, 1992. Any modifications found necessary will be scheduled during Fuel Cycle 5. MR 92-0038 has been approved to complete analysis of long term corrective actions. The administrative controls and manual actions discussed above will be maintained until long term corrective actions are implemented.

The corrective action for addressing the omission of safe shutdown equipment from the main control room fire analysis is as follows. During the ongoing refueling outage, the open loop service water system has been in the process of conversion to a closed loop service water system. This modification is being implemented to improve the service water system chemistry and minimize corrosion. The new design

will provide a solid system with a pressurized surge tank containing nitrogen. Thus, the potential for a severe water hammer occurring upon the automatic start of the standby service water pumps in the event of a loss of offsite power combined with a fire in the main control room no longer exists.

Fire Area FB-1 (Fuel Building):

The immediate action taken was to treat the electrical cables as having missing fire barriers and initiate a continuous fire watch per RBS Technical Specification. After actions identified above for the main control room was implemented and pre-fire strategies for Fire Area FB-1 were revised to identify the manual actions required to place the dampers in the correct position, the continuous fire watch was removed. The permanent corrective action for this condition will be addressed with completion of the analysis and modifications, if required, as discussed above for the main control room.

Fire Area RC-5/Z-13 (Containment Building):

The immediate action taken was to treat the cables as having missing fire barriers and initiate an hourly fire watch per RBS Technical Specification.

The permanent corrective action for this condition will be to provide an analysis which demonstrates the unit coolers are not required or install noncombustible radiant energy shields to provided separation in accordance with Appendix R, Section III.G.2.f. Modification request (MR) 92-0037 has been approved to install the required radiant energy shields if needed. The analysis to demonstrate the unit coolers are not required and the preparation of MR 92-0037 will proceed concurrently. This approach will allow the analysis and/or installation of the radiant energy shields to be completed prior to startup from RF-4.

Similar events have been reported in LERs 87-005, 89-009, 89-036, and 90-003. LERs 87-005, 89-009 and 90-003 reported installation-related deficiencies in Thermo-Lag fire barriers. LER 89-036 reported an event in which the fire hazards analysis specified that certain motor-operated valves (MOVs) should be normally de-energized. The actual condition of the valves was that they were energized. New issues identified during the FHA review have revealed FHA deficiencies concerning spent fuel pool cooling and a previously unidentified fire area.

SAFETY ASSESSMENT

The FHA states safe shutdown can be achieved in fire areas AB-2, C-2, C-6 and ET-2 using Method 1 shutdown. Method 1 is identified as using 3 SRVs for RPV pressure control, RCIC for RPV level control, and RHR-A for suppression pool cooling and shutdown cooling. Since the affected cables were not wrapped in these fire areas, fire damage could cause loss of RCIC. With the loss of RCIC, a review was made to determine what alternate method of RPV level control was available in these fire areas. Analysis has demonstrated that for Fire Areas AB-2, C-2 & C-6, LPCS is free of fire damage and for ET-2 & the new fire area (AB-18), HPCS is free of fire damage. This demonstrates that with a fire in any of these fire areas, at least one method of safe shutdown is unaffected.

Fire Areas C-25 (main control room) and FB-1 (fuel bldg.) were identified as areas where potential fire damage could cause a loss of spent fuel pool cooling. Calculation No. G13.18.14.0*46-0 was developed which demonstrates the time required for the spent fuel pool temperature to reach the design limit of 155.6 degrees F with the present fuel load is approximately 5.3 days. Abnormal Operating Procedure (AOP)-0031 "Shutdown From Outside Main Control Room" and pre-fire strategies for fire area FB-1 have been revised to address manual actions which may be required to restore spent fuel pool cooling with a fire in these areas. These corrective actions and administrative controls have been implemented to address these concerns under present fuel pool load conditions until permanent corrective actions are identified and implemented.

The FHA indicates safe shutdown can be achieved in Fire Area RC-5/Z-13 (reactor containment bldg.) using Method 1 or 2 depending on the location of the fire. The FHA states containment unit cooler 1HVR*UC1B is separated from its alternate counterpart by 24 ft. and a 10 ft. radiant energy shield and is being protected from intervening combustibles by wrapping the intervening combustibles with a 3-hour rated barrier. Since the cables for this unit cooler were not wrapped in accordance with Appendix R, Section III.G requirements, fire damage could cause a loss of containment cooling. The affected cables were treated as having missing fire barriers and fire watch requirements specified in Technical Specification 3/4.7.7, "Fire Rated Assemblies" have been implemented.

To evaluate the safety implications of the omission of the eight service water system SOVs from the FHA, the impact before, during and after the fourth refueling outage was reviewed, as follows.

Prior to RF-4, as described in the Investigation section, this event could have resulted in a severe water hammer in the service water system. GSU has calculated the frequency of the loss of offsite power

concurrent with a main control room fire. This event has not occurred and has a frequency of occurrence of 2.4E-5 per year. Therefore, GSU concludes that this is a low probability event.

In addition, a review of the piping runs was performed. The piping in the auxiliary building above elevation 139' is the piping associated with the auxiliary building unit coolers. This piping, if damaged during a water hammer event, could be isolated from the essential loads. The piping in the containment above elevation 139' that is open to the normal service water system is the non-safety-related piping associated with the drywell unit coolers. The safety related containment unit coolers are normally operated on the turbine building chilled water system which is a closed loop system which is not subject to the drain down. The drywell unit cooler piping, if damaged by a water hammer event, could be isolated before the containment unit cooler portion was valved in to the service water system. The remaining undamaged portion of the system would perform its required safety function in safely shutting the plant down.

During RF-4, the plant was shutdown for refueling purposes with the entire core off-loaded. The service water system has been chemically cleaned and modification to a closed-loop system is in progress. The chemical cleaning was performed one division at a time. The other division of standby service water was operated to provide cooling to required loads, principally the offloaded fuel in the spent fuel pool. The minimum elevation that water would drain to is elevation 182' due to the higher elevation of suction and return to the standby cooling tower. All safety related piping in the service water system is below elevation 165', therefore no vacuum would be created and the severe water hammer would not have occurred. Cooling was assured to the spent fuel cooling system at all times while the core was off-loaded.

As described in the Corrective Action section, the modification of the service water system from an open loop to a closed loop will be completed prior to startup from RF-4. Following RF-4, in the event of a main control fire concurrent with a loss of offsite power, the eight SOV's could be rendered inoperable. However, the new closed loop design of the service water system assures that the safety related portions of the system will remain solid. The possibility of severe water hammer no longer exists.

NOTE: Energy Industry Identification System Codes are identified in the text as (*XX*).