GULF STATES UTILITIES COMPANY

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

AREA CODE 504 635-6094 346-8651

June 17 , 1992
RBG- 37011
File Nos. G9.5, G9.25.1.3

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

Gentlemen:

River Bend Station - Unit 1
Docket Nos. 50-458

Please find enclosed Supplement 2 to Licensee Event Report No. 91-014 for River Bend Station - Unit 1. This report is submitted to clarify the usage of relay internal temperature data, presented on page 14. During the investigation, it was envisioned that the results of GSU's calculations might be provided to Potter and Brumfield for use in their evaluation. However, the use of this data was limited to GSU's internal investigation. Therefore, the text on page 14 of 15 of this LER has been revised. All other text reflects the status as of November 13, 1991.

Sincerely,

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

LAE/DNL/DCH/JLB/kvm

240010

IE22 1/1

cc: U.S. Nuclear Regulatory Commission
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Nuclear Energy Division
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ATTN: Administrator

NRC FORM 366 (6-89)

U.S. NUCLEAR REGULATORY COMMISSION

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

LICENSEE EVENT REPORT (LER)

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

TITLE (4): ESF ACTUATIONS DUE TO RELAY MALFUNCTIONS HAVING THE SAME FAILURE MODE

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 7	1 9	9 1	9 1	0 1 4	0 2	0 6	1 7	9 2		0 5 0 0 0
										0 5 0 0 0

OPERATING MODE (9): 1

POWER LEVEL (10): 1 0 0

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)

[ ] 20.402(b)	[ ] 20.405(c)	[X] 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)	[ ] 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
B	J E	R L Y	P 2 9 7	Y					
B	J E	R L Y	P 2 9 7	Y					

SUPPLEMENTAL REPORT EXPECTED (14)

[ ] YES (If yes, complete EXPECTED SUBMISSION DATE) [X] NO

EXPECTED SUBMISSION DATE (15): MONTH | DAY | YEAR

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

On 07/19/91 at 2028 and on 07/23/91 at 2110, with the plant at 100 percent power (Operational Condition 1) in each case, engineered safety feature (ESF) actuations occurred due to relay malfunctions having the same failure mode. On 07/19/91, the failure of relay 1C71*K45D resulted in the isolation of numerous balance-of-plant (BOP) containment isolation valves, and actuation of the control room filter trains, the standby gas treatment system, and the fuel building filter trains. On 07/23/91, the failure of relay 1B21H*K204C resulted in the isolation of valve 1B33*MOVF019, reactor water upstream sample valve. This valve is a containment isolation valve. This event is reported pursuant to 10CFR50.72(a)(2)(iv) to document the ESF actuations.

The immediate corrective action was to restore the ESF systems and clear the isolations. Subsequent action was to replace both suspect relays, 1C71A*K45D and 1B21H*K204C. GSU has completed its evaluation and is submitting this supplemental report to document the results and corrective actions. GSU's safety assessment indicates that the failure rates of these relays result in an increased probability of RPS failures. However, the impact on core damage frequency due to anticipated transient without scram (ATWS) events is insignificant.

Reported Condition

On 07/19/91 at 2028 and on 07/23/91 at 2110, with the plant at 100 percent power (Operational Condition 1) in each case, engineered safety feature (ESF) actuations occurred due to relay malfunctions having the same failure mode. On 07/19/91, the failure of relay (*RLY*) 1C71*K45D resulted in the isolation of numerous balance-of-plant (BOP) containment isolation valves (*ISV*), and actuation of the control room filter trains (*VI*), the standby gas treatment system (*BH*), and the fuel building filter trains (*VG*).

On 07/23/91, the failure of relay (*RLY*) 1B21H*K204C resulted in the isolation of valve (*ISV*) 1B33*MOVF019, reactor water upstream sample valve. This valve is a containment isolation valve.

This event is reported pursuant to 10CFR50.73(a)(2)(iv) to document the ESF actuations. In addition, GSU has evaluated this condition for reportability under 10CFR21. Our analysis concludes, based on failure history, surveillance test program, and system applications that this does not constitute a substantial safety hazard at River Bend Station. However, since certain applications of these relays and operating practices at other plants may result in a different determination, the following information is provided.

Basic Component: Relay, Model MDR

Manufacturer: Potter and Brumfield

Installation By: General Electric Company

Model number, quantity and location of all of these components in use at River Bend Station:

Reactor Protection System (RPS)	92
MDR 4130-1 (120VAC)	12
MDR 4134-1 (120VAC)	32
MDR 4135-1 (120VAC)	36
MDR 5111-1 (24VDC)	8
MDR 5112-1 (125VDC)	4
Nuclear Steam Supply Shutoff System (NSSSS)	35
MDR 4130-1 (120VAC)	18
MDR 4134-1 (120VAC)	11
MDR 4135-1 (120VAC)	2
MDR 5111-1 (24VDC)	4
Remote Shutdown (Reactor Core Isolation Cooling)	3
MDR 5118 (125VDC)	3
Division III Standby Service Water Annunciation	2

MDR 4134-1 (120VAC) 2

Total...132

INVESTIGATION

At the time of the event on 07/19/91, I&C was performing STP-508-4591, "RPS/Isolation Actuation instrumentation Drywell Pressure - High Monthly Channel Functional", which requires placing switches (*HS*) 1B21H-S19A and 1B21H-S21A to their test positions. As soon as these switches (*HS*) were taken to test an outboard ESF isolation occurred. Switches (*HS*) 1B21H-S19A and 1B21H-S21A were taken back to their normal position, the isolation signal reset, and the isolations were restored. Further investigation revealed that one set of contacts on relay (*RLY*) C71A*K45D which should have been closed, were indicating a high resistance causing excessive voltage drop to the downstream relays. The relay is a 24VDC, model MDR-5111-1 manufactured by Potter and Brumfield.

This contact is in one leg of a parallel circuit and switch 1B21-S19A is in the other leg so that when 1B21-S19A was placed in the test position opening its contacts per STP-508-4591, downstream relays 1B21H*K145A and 1B21H*K66A had insufficient voltage available through the other leg. This caused them to drop out which resulted in the isolations.

Relay (*RLY*) 1C71A*K45D is a normally energized relay whose function is to actuate (de-energize) on high drywell pressure to cause isolation of the Division 1 residual heat removal shutdown cooling isolation valves, BOP isolations, and initiation of numerous Division 1 balance of plant systems. It was replaced under maintenance work order (MWO) R056868. During bench testing of the removed relay it activated properly and all contacts changed state properly. The coil was meggered and found to be acceptable. The relay was disassembled and an internal inspection was performed. The contacts all appeared to be clean and shiny with no evidence of pitting or residue. There was no evidence of foreign material in the relay or on the rotor shaft. During this inspection, nothing was found which may have contributed to the high resistance across the contacts. The relay was operated numerous times and operated properly each time with all contacts exhibiting proper continuity.

On 07/23/91 a similar event occurred while I&C was performing STP-058-4501, "Containment and Drywell Manual Isolation Actuation Monthly Channel Functional Test". When switch B21H-S71B was taken to its test position in accordance with the STP an inboard isolation occurred closing valve 1B33*MOVF019 (*ISV*). Switch B21H-S71B was put back to

its normal position, the isolation signal reset, and all isolations were restored. Investigation revealed that contacts 2A/2B of relay 1B21H*K204C were open and the coil was in its energized state. Contacts 2A/2B should have been closed while the relay was energized. This relay is also a 24VDC Potter and Brumfield Model MDR 5111-1. The function of relay 1B21H*K204C, which is also normally energized, is to actuate (de-energize) on reactor low level (Level 2) to cause isolation of Division 2 reactor water cleanup valves, reactor sample valve (1B33*MOVF019) and initiation and isolation of Division 2 BOP systems.

Maintenance Work Order (MWO) R56874 was used to replace the relay. Testing results for the failed relay found that contact operation was intermittent with some contacts closing several minutes after the coil was energized or sometimes not at all.

Both of the failed relays are mounted in stainless steel "isolation cans" for divisional separation which are then mounted inside control room panels. Previous studies done on control room panels have found internal temperatures to average approximately 92 degrees F. Using MWO R144439 a reading was taken inside the isolation can housing where 1B21H*K204C is mounted and the temperature was found to be 113 degrees F. According to the manufacturer's specifications, the relay should be capable of functioning properly up to 120 degrees F with a minimum of 20VDC applied to the coil, and 156 degrees F with 21VDC applied to the coil. This was later confirmed in a telephone conversation with the manufacturer. A voltage measurement at the coil found 21.45VDC available. This voltage is supplied by a non-adjustable, regulated DC power supply which is designed to maintain its output between 23.5VDC to 26.5VDC from 20% to 100% load and input voltage variations of 102 to 127VAC.

Input to the power supply is from the RPS 'A' bus which is tightly controlled via the motor-generator set (primary) or a regulating transformer (alternate). The input to the power supply was measured at 121.87VAC with an output of 24.19VDC both of which are well within specifications. Due to voltage drop in the wiring from the power supply to the trip unit rack, 23.18VDC was measured at the input to the card file and output voltages from the various trip cards ranged from 21.66VDC to 21.45VDC. Due to the regulation of both the input AC voltage and the output voltage, a very stable voltage is applied to the relay.

Seventeen days prior to the discovery of the 1C71A*K45D failure, on 7/02/91, a loss of power had occurred to the RPS 'B' bus. This bus feeds the power supply to 1C71A*K45D. On 7/22/91, one day prior to the discovery of the 1B21H*K204C failure, a loss of power to the RPS 'A' bus had occurred. This bus feeds the power supply for

1B21H*K204C. The cause of these RPS power losses was unrelated to the relay failures but would have resulted in the relays dropping out on the power losses and picking up on the power restoration a few minutes later. It was likely during these power losses that the relays cycled and all contacts did not make proper continuity upon power restoration. It was during the next performance of the monthly surveillance test procedures (STP's) that the malfunctions were discovered.

ROOT CAUSE

GSU Engineering has worked closely with Potter and Brumfield to determine the root cause of the relay failures. A subsequent disassembly and inspection of the relay internals at the manufacturer's facility revealed that the root cause of the failures was small deposits of material which are released from the varnished coating applied to the relay coil. These small deposits may not be obvious to the naked eye or to those unfamiliar with this phenomenon, but are readily apparent under magnification and/or to those cognizant of the phenomenon and what to look for. This phenomenon, called "outgassing", occurs as the coil is heated by remaining continuously energized for extended periods of time. Additionally, Potter and Brumfield has stated that rubber grommets used in the relay may release chlorine causing corrosion of the relay shaft or bearings. The combination of varnish deposits and corrosion will accumulate in the area of the bottom end-bell bearing which will eventually result in bonding or sticking of the relay shaft to the bearing. The relay contacts may then stick in either the normally energized or de-energized states. It is also possible, as was the case with these two failures, for the rotary motion of the relay to be impaired such that it may not turn through its full arc (approximately 30 degrees). The end result is that some or all of the relay contacts may exhibit intermittent operation.

Potter and Brumfield type MDR relays are manufactured in several different voltages and contact arrangements. River Bend Station utilizes MDR relays with 125VDC and 120VAC coils in addition to the 24VDC model involved in these failures. Since 1986, due to reported failures of 125VDC rated MDR relays from the same mechanism, Potter and Brumfield changed their manufacturing process to utilize an epoxy material in place of the varnish utilized previously on the coils and to address concerns regarding the rubber grommets. All type MDR relays, regardless of voltage underwent this modification in the manufacturing process. However, the relays involved in these two failures at RBS were manufactured in 1981, prior to the change in the manufacturing process. In September 1990, General Electric (GE) issued RICSIL 053 followed by potentially reportable condition (PRC) 90-011 in November, 1990 due to reported failures of MDR relays at

other sites. GE concluded that the problem was confined to the 125VDC MDR relays and that the 24VDC and 120VAC relays were not susceptible to this failure mechanism. This conclusion was based on the fact that the 125VDC model operates at higher wattage, and hence higher temperatures than the other two models, and on the failure histories of the three types of relays. The failure histories at that time revealed that there were no reported failures of the 24VDC relays at any GE BWR plants. In addition, the failure rate of the 120VAC relays was very low and appeared to be random in nature. GE concluded that this condition did not constitute a substantial safety hazard based on the applications of the 125VDC relays and the low failure rates.

The evidence from GSU's investigation suggests that all types of Potter and Brumfield MDR relays are susceptible to this failure mechanism. GSU has removed from service, disassembled and performed an inspection of eight (8) relays, all of which were placed in service in approximately December, 1984. In addition to the two failures discussed previously in this LER, GSU removed six 120 VAC MDR relays from service which had not failed. Working with Potter and Brumfield engineers at their facility, three of these relays were subjected to the same series of tests utilized by Potter and Brumfield for initial manufacturing acceptance, i.e., a hipot test, a contact check and a pickup and dropout voltage test. As expected, all three relays were found to operate satisfactorily. All six relays were then disassembled and an internal inspection performed under a microscope as had been done with the two failed DC relays discussed previously. All six of these relays were found to have deposits on the relay rotor and in the area of the end bearings indicative of the same outgassing phenomenon found on the failed DC relays.

Although it cannot be specifically quantified, GSU's analysis indicates that the 125VDC relays are the most susceptible to this phenomenon, followed by the 24VDC, with the 120VAC being least susceptible or requiring the longest time period for the phenomenon to result in heavy accumulations of deposits. This is based on a subjective evaluation of the amount of material deposited on the 24VDC relays as opposed to the 120VAC, and on an understanding of the phenomenon. Specifically, the outgassing phenomenon is related to total heat generation integrated over the time the relays are energized. The 125VDC operates at the highest wattage (15.6 watts) followed by the 24VDC (9.6 watts) and the 120VAC (6.0 watts). Additionally, Potter and Brumfield and GE have stated that the frequency of cycling the relay has an impact on its failure rate. Those that are cycled most frequently are least susceptible to failure. Many of the 125VDC failures documented previously throughout the industry involved relays which were cycled only once per 18 months. GSU's analysis supports this position as well, since the removed relays which are cycled on an 18 month basis indicated heavier

deposits than those which are cycled monthly.

However, even though GSU's analysis of the physical condition of the relays supports the position that the higher wattage, less frequently cycled relays are more likely to have heavier deposits, and thus should be more likely to fail, the actual failure history does not prove this to necessarily be the case. There are a number of variables involving manufacturing tolerances, mounting configuration and enclosures, temperature, test frequency, operational cycling, etc. which may influence the actual failure rate which cannot be quantified. For example, based on discussions with the manufacturer during a visit to witness the assembly of the relays, the varnish coating applied to the relay coils is applied by dipping by hand without strict acceptance criteria and the varnish is supplied by a third party as an off the shelf item without strict control over the ingredients. Examination of the coils of the eight relays removed from service indicates wide variations in the thickness, uniformity and color of the varnish coating. For these reasons, actual field experience indicates a very small and essentially random failure history of these relays to date. Therefore, GSU believes that, although the factors discussed above constitute a common failure mechanism which will have an influence on relay life, this failure mode is simply one mechanism which may lead to a reduced operational lifetime for these relays. However, due to the large number of variables involved and the random manner in which the phenomenon affects the relays, GSU does not believe that this phenomenon will result in multiple, concurrent failures which will simultaneously affect redundant safety related functions. Individual failures would be detected through the surveillance test program as occurred with the two failures documented in this LER and corrective action would be taken.

GSU's investigation has uncovered two other cases of MDR relay failures at River Bend Station since commercial operation. Since the individuals involved in troubleshooting these failures had no knowledge of the outgassing phenomenon and they were separated by approximately nine months in time, (12-16-87 and 9-15-88) they were judged to be random failures. Since the relays have been discarded, it cannot be determined if the failures were due to this same mechanism. Both relays were 120VAC relays. The failure on 12-16-87 was of relay 1C71A*K51C, which actuates the backup scram valves on any full scram signal. This relay is tested once per 18 months. The failure on 9-15-88 was of relay 1C71A*K8C which causes an RPS scram actuation on turbine control valve fast closure. This relay was previously tested each week but has recently been changed to a monthly testing interval.

Of the 132 total MDR relays installed at RBS 113 are 120VAC, 12 are 24VDC and 7 are 125VDC. Of these, 92 are installed in the reactor protection system, 35 in the NSSSS, 3 in the remote shutdown system, and 2 in the Division 3 standby service water system. The 3 installed in the remote shutdown system are involved in operation and indication of the Reactor Core Isolation Cooling (RCIC) system gland seal compressor.

A review of previous LERs revealed no similar events.

CORRECTIVE ACTION

The immediate corrective action was to restore the ESF systems and clear the isolations. Subsequent action was to replace both suspect relays (*RLY*), 1C71A*K45D and 1B21H*K204C.

As discussed above, GSU has determined that all model MDR relays, regardless of voltage rating or wattage are susceptible to this failure mechanism. Therefore, a plan has been established to begin replacing all 132 MDR relays installed at RBS. Due to the failures discussed in this LER and the higher probability of failure of the 24VDC and 125VDC continuously energized relays, GSU has already replaced a total of six (6) DC relays in continuously energized applications. Since the modified version of the relay has not yet been received, these replacements were made with like for like models from warehouse stock. Based on experience at River Bend and a review of industry experiences, this replacement should ensure at least a 2 to 3 year period of reliable operation without the outgassing phenomenon becoming a factor. In addition to the two failures reported in this LER, the following DC relays have also been replaced:

I.D. No.	Volt.	Function
1B21H*K204D	24VDC	Rx. Lvl. 2 isolation similar to 1B21H*K204C
1C71A*K45C	24VDC	Drywell Press. isolation of RHR and BOP
1C71A*K52C	125VDC	Backup Scram actuation
1C71A*K52D	125VDC	Backup Scram actuation

The first two relays above were replaced because they were used in identical applications and environments, had the same model numbers and had the same test frequency (MDR 5111-1) as the two which failed. The last two were replaced because they were continuously energized 125VDC relays which are tested only once per 18 months. This places them into the highest failure rate category. They are model numbers MDR 5112-1.

A total of six (6) 120VAC MDR relays have also been replaced in order to obtain a sampling of various applications for analysis as well as to ensure higher reliability in certain higher priority applications.

The AC relays replaced are as follows:

I.D. No.	Model	Function
1C71A*K51C	4130-1	Backup Scram actuation
1C71A*K51D	4130-1	Backup Scram actuation
1C71A*K62	4135-1	RPS 'C' Logic reactor scram
1C71A*K96	4135-1	Turb Cont Vlv Fast closure recirc pump trip
1C71A*K76	4135-1	Main Stm Isol Valve Closure scram
1C71A*K77	4135-1	Main Stm Isol Valve Closure scram

The first two relays listed above were replaced because they were continuously energized and tested only once per 18 months. The remainder were selected to give samples of relays in varying applications, test frequencies and environments. All are normally energized. The 1C71A*K62 relay is cycled on any half scram signal on the RPS 'C' logic which averages 10 to 12 times per month. The last 3 relays are tested on a monthly basis.

Potter and Brumfield has made modifications to the materials used in the construction of the MDR relays to eliminate the outgassing phenomenon. GSU has evaluated the quantities of each model number required to replace the installed relays as well as to provide an adequate number for warehouse stock. An order is currently being processed for the modified relays.

It is anticipated that the new improved relays will arrive on site prior to the beginning of refueling outage 4 (RF04), currently scheduled to begin on March 15, 1992.

Meanwhile, a prioritization list is being generated based on relay function and model number, surveillance frequency, difficulty of replacement and retest, relay voltage and wattage rating and length of service. This list will be completed by December 31, 1991, and will be used to prioritize the maintenance work order planning effort and the schedule for actual relay replacement. The previously replaced relays documented above will be replaced again with the improved relay model based on the prioritization list being developed. Even though this phenomenon does not constitute a substantial safety hazard, an aggressive effort will be made to replace all 132 MDR relays beginning in RF04, continuing through the next fuel cycle and the remainder will be completed prior to startup from the fifth refueling outage (RF05). The highest priority relays will be replaced during RF04. This represents a population of approximately 40 relays. Failure of these relays would pose the greatest risks based on relay type and application.

SAFETY ASSESSMENT

All actuations occurred as designed during both events, with systems being restored within minutes.

The safety assessment of this condition involved a probabilistic safety assessment (PSA), which consisted of a probabilistic risk analysis (PRA) for the RPS system, an engineering evaluation of the failure history, relay applications and surveillance frequency, and a deterministic analysis consisting of a calculation of relay internal temperatures. Details of these analyses are provided below.

Engineering Evaluation

As discussed previously, GSU's evaluation of this issue has concluded that, although all model relays are affected by this failure mechanism, this constitutes only one mechanism by which a reduced operational lifetime may result. All failure mechanisms which affect relay service life or lead to end-of-life failures, may be classified as common mode failure mechanisms. However, due to the large number of variables and factors which may influence the failure rate from this phenomenon, failures will occur randomly. These relays are installed in mild environments and are not subject to EQ regulations as given in 10CFR50.49 and therefore have no specific qualified lifetimes assigned.

GSU has determined and/or verified several important factors related to this failure mechanism which play a role in the safety analysis. Although most of these were discussed previously, they are repeated and grouped here for clarity and emphasis:

1. Higher wattage relays will operate hotter and thus tend to develop more outgassing and heavier accumulations of deposits in the rotor assembly. This ultimately leads to a shorter lifetime or a higher probability of failure for these relays.

2. Normally de-energized relays are not as likely to fail as normally energized relays simply due to the fact that the heating effect of the coil is not present. Most relays that are classified as normally de-energized are categorized as such based on normal plant operating conditions. They will however, be energized during certain plant modes or system operating configurations. Therefore, they will ultimately be affected by this failure mechanism. For this reason, although GSU considers their service life to be much greater than those which are continuously energized, they will be prioritized and replaced along with the others.

3. Those relays which are more frequently cycled are less likely to stick in the energized or de-energized states. Additionally, frequent testing increases the possibility of finding an individual failure before a second failure occurs.

4. DC relays operated at over-voltage conditions operate at higher wattage and thus are hotter leading to decreased service life.

5. Although the factors given above tend to influence the relay service life in general terms, a number of variables affect when any individual relay may fail, thus leading to a random distribution of failures.

The factors given above were considered in making the safety assessment given below.

Due to operating at higher wattages, the 125VDC and 24VDC relays will experience greater probability of failure and will begin failing sooner than the 120VAC. This is supported by a review of NPRDS data and information from GE about their knowledge of failures at other BWR plants. Although a number of MDR relay failures have been reported throughout the industry, almost all of these were of DC relays. The NPRDS data base contains 77 entries related to Potter & Brumfield MDR relay failures. Of these, 9 were actually not due to the relays themselves or are not similar to this failure mode (i.e. coil failures, etc.) Of the remaining 68 entries, 58 or 85% are of DC powered relays. In addition to operating at higher wattage, many of the DC powered relays were subjected to overvoltage conditions. Of the 10 AC powered relay failures listed in the NPRDS data base, 4 of these are of latching relays which are not utilized at River Bend and which utilize a dual coil construction which results in a substantially higher wattage rating (17 watts versus 6 watts) than the other AC relays. This leaves only 6 failures of AC powered relays similar to those used at RBS which may be related to this failure mechanism.

A detailed review was performed of all 132 MDR relays to determine their voltage, function, failure effect, surveillance and/or operation frequency, system redundancy, and whether normally energized. Of the 92 MDR relays installed in the reactor protection system, 12 serve no significant safety function while the plant is operating in Mode 1, six are normally de-energized and 10 were replaced during or prior to the mid-cycle outage. Of the remaining 64 relays, 12 are tested 10 to 12 times per month, on average, as part of surveillances which input a half-scram signal to the relay logic channels and all but four are

cycled as part of a surveillance test on a weekly or monthly basis. These four monitor and generate a scram signal on high scram discharge volume level and are operated once per 92 days. They are 120VAC relays which have the highest reliability and perform an essentially redundant function with four other relays which are not MDR relays.

As indicated previously in this LER, 80 of the 92 MDR relays installed in the RPS system are 120VAC which have the highest reliability. Of the 12 DC relays, six of these are normally de-energized. One of the remaining six was replaced due to the failure documented in this LER and GSU undertook an aggressive program to replace three of the remaining five prior to or during the mid-cycle outage, as they were considered high risk and high priority as discussed in the corrective action section above. The remaining 2 are involved in Level 3 isolation of residual heat removal shut down cooling valves which are normally closed when the reactor is at power.

Of the 35 relays installed in the nuclear steam supply shutoff system (NSSSS), 2 are normally de-energized when the plant is at power, and 9 perform no significant safety function in operational condition 1. Six are operated on any MSIV half-isolation signal on its logic channel and thus are tested 6 to 7 times per month. All but four of the remaining 18 relays are tested on a monthly basis. These four are tested on an alternating divisional basis each month so that each relay is tested once per 62 days. The function of these four relays is to cause an isolation of reactor water cleanup due to a standby liquid control system pump start on its respective division. Verification that this isolation has occurred is performed by the operator as proceduralized in both the system operating procedure (SOP-0028) and the abnormal operating procedure for isolations (AOP-0003).

All but 4 of the 35 MDR relays in the NSSSS are 120VAC. One of these 4 was replaced due to the failures documented in this LER and another one in a similar application as documented in the corrective action section above. The remaining 2 relays are normally de-energized at power and cause an RHR shutdown cooling isolation due to reactor pressure.

The three relays installed in the remote shutdown system are related to operation of the reactor core isolation cooling system (RCIC) gland seal compressor. These three relays are powered from non-divisional power and are not considered safety-related. One of the three relays starts the RCIC gland seal compressor. The other two are for indicating lights and annunciation only. One of these three 125VDC relays is continuously energized. The other two, including the one responsible for the compressor start function are normally de-energized except when the RCIC system is operating. These two relays are tested once each 92 days.

The two relays installed in the Division III Stanaby Service Water System provide annunciation only.

Relay PRA

To assess the impact of the failures of Potter and Brumfield relays, GSU used a PRA model of the reactor protection system (RPS) developed for the RBS ATWS/stability analysis. This model contains detailed fault trees of RPS mechanical and electrical components, including actuation relays. The model also incorporates alternate rod insertion (ARI), the standby liquid control (SLC) system, and operator actions provided in Emergency Operating Procedure (EOP)-1A "ATWS". The top event in the PRA model is the ATWS core damage frequency (CDF) conditional probability.

The RPS model utilizes generic relay failure rates for single and common-mode failures. Based on actual failures of Potter and Brumfie.
relays a 3S, plant-specific failure rates were calculated and applied

to the RPS model. A new RPS failure rate and a new ATWS CDF probability were calculated from the model (see Table 1).

Table 1

RPS MODEL RESULTS

	GENERIC RELAY	POTTER AND BRUMFIELD
RELAY FAILURE RATE*	1.3 E-4	6.64 E-4
RELAY COMMON CAUSE	1.3 E-5	3.32 E-4
RPS FAILURE RATE	1.31 E-5	3.32 E-4
ATWS CDF CONDITIONAL PROBABILITY	1.55 E-9	1.72 E-9

* All numbers are failures per demand.

The largest increase in relay failure rates is for common-cause failures (a factor of 25). This failure mode dominates RPS failures. However, although an ATWS occurs when RPS fails, an ATWS leading to core damage requires the failure of RPS <u>plus</u> the failure of recovery actions (e.g., ARI failure, SLC failure, and operator errors in executing EOP-1A). ARI and Manual Rod Insertion do not utilize MDR relays. A common cause failure was also imposed on SLC due to MDR

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6) YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	PAGE (3)
RIVER BEND STATION	0 5 0 0 0 4 5 8	9 1	— 0 1 4 —	0 2	1 4 OF 1 5

TEXT (If more space is required, use additional NRC Form 366A's) (17)

relays utilized for isolation of Reactor Water Cleanup on SLC initiation.

ATWS CDF is dominated by control rod drive (CRD) mechanical failures and human errors, not RPS failures.

For comparison purposes, the preliminary total CDF for the River Bend individual plant examination (IPE) is estimated to be 5.0 E-5 per year. The ATWS CDF is four orders of magnitude smaller (1.55 E-9 for the generic relay data and 1.72 E-9 using Potter and Brumfield relay data), regardless of the increased failures due to Potter and Brumfield relays.

A calculation was also performed to determine the number of failures per relay-hour. This was determined to be 6.68 E-7 failures/relay-hr.

Relay Temperatures

To determine the internal temperature, one of the failed Potter and Brumfield relays was disassembled. Detailed measurements were made of relay internal components. This information was used to build a finite-element computer model of the relay. This model was used in the calculation of relay internal temperatures (see Table 2).

Table 2

RELAY INTERNAL TEMPERATURE

RELAY VOLTAGE	RELAY POWER (watts)	TEMPERATURE (degrees F)
125 VDC	15.6	149
25 VDC	9.6	135
120 VAC	6.0	127

These temperatures are based on certain assumptions, such as convection coefficients with a 113 degree F ambient air temperature as measured in a relay isolation can.

Conclusions

GSU has concluded the following regarding the safety implications of the Potter and Brumfield MDR relays:

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6) YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	PAGE (3)
RIVER BEND STATION	0 5 0 0 0 4 5 8	9 1	— 0 1 4	— 0 2	1 5 OF 1 5

TEXT (If more space is required, use additional NRC Form 366A's) (17)

1. As described in the engineering evaluation, several conditions contribute to the outgassing failure mechanism (e.g., higher wattage, normally energized versus normally de-energized, frequent cycling, etc.). In general, the outgassing phenomenon leads to a failure distribution that is essentially random in nature.

2. The impact of the increase in relay failure rates on core damage frequency due to ATWS is insignificant.

Based on the above considerations, GSU concludes that this condition does not constitute a substantial safety hazard. In addition, as described in the corrective actions section of this report, GSU is committed to replace all 132 of the MDR relays with new MDR relays that are specifically modified to address the outgassing phenomenon.