CEOG COMBUSTION ENGINEERING OWNERS GROUP

Arizona Public Service Co.
Palo Verde 1, 2, 3
Baltimore Gas & Electric
Calvert Cliffs 1, 2

Consumers Power Co.
Palisades
Florida Power & Light Co.
St. Lucie 1, 2

Entergy Operations Inc.
ANO 2
WSES Unit 3

Maine Yankee Atomic Power Co.
Maine Yankee
Northeast Utilities Service Co.
Millstone 2

Omaha Public Power District
Ft. Calhoun
Southern California Edison Co.
SONGS 2, 3

Raymond Burski, Chairman
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September 21, 1993
CEOG-93-461

Mr. Scott Newberry, Chief
Instrumentation and Control Systems Branch
Division of Systems Technology
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Subject: **Response to NRC Questions on CEN-403, "Relaxation of Surveillance Test Interval for ESFAS Subgroup Relay Testing"**

References: A) Scott Newberry (NRC) letter to Paul Hijeck (ABB) dated July 7, 1992, "Request for Additional Information in Support of the Staff Review of Topical Report CEN-403, 'ESFAS Subgroup Relay Testing,' dated July 1991."

B) CEN-403, "ESFAS Subgroup Relay Test Interval Extension," July 1991; transmitted to NRC by John J. Hutchinson (CEOG) letter CEOG-91-415, dated July 31, 1991.

Dear Mr. Newberry:

The purpose of this letter is to submit the CEOG response to the Staff questions, Reference (A), on our topical report, Reference (B). Attached is our response to these questions.

Since the time of submittal of CEN-403 much has transpired. Concerns with Potter Brumfield MDR relays have been discussed in NRC Information Notices 92-04 and 92-77, and concerns with Westinghouse ARD, BFD and NBFD relays have been discussed in IN 91-45. Experience has been gained with the improved relays discussed in IN 92-04. The attached responses to the questions of Reference (A) take this additional information into account.

What was found is that while some failures still occur, the "new" Potter Brumfield "rotary" relays exhibit a failure rate of 3.8 E-8/hour (5 failures out of 887 relays, for 17 years in service at 7 units). The failure rate for the "old" MDR relays was 1.1 E-6/hour (for 41 years in service) The "new" MDR failure rate is comparable to the average failure rate of 2.5 E-7/hour (58 failures out of (about) 1,600 relays, for 132 years in service at 8 units) for "mechanical" type relays. The calculated failure rates are conservatively high (e.g., only 3 of

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the 5 "new" MDR failures were "subgroup" relays) but are on the order of the industry average of 5.0 E-7/hour used in the EPRI "ALWR Industry Requirements Document."

Based on this, and the fact that 2/3 of the subgroup relays at C-E plants are currently being tested at refueling intervals (most plants licensed prior to 1982 plus those relays not testable at power), we recommend that all subgroup relays be tested at refueling intervals.

If you have any questions regarding the enclosure please call me at (504) 739-6774, or Mr. Paul Hijeck of the CEOG Project Office at (203) 285-3115.

Very truly yours,

Raymond Burski, Chairman
C-E Owners Group

Enclosure: Response to Questions

cc: Clifford Doutt (NRC), w/3 enclosures
NRC Document Control Desk, w/3 enclosures
CEOG Participants in Task 750
Bruce Montgomery, BG&E (Chairman LSC)

RESPONSE TO NRC QUESTIONS

1.0 NRC Information Notice 92-04

1.1 Statement

Although not referenced by CEN-403, NRC Information Notice 92-04, "Potter & Brumfield Model MDR Rotary Relay Failures," dated January 6, 1992, is pertinent to both the Report and the staff's evaluation of the Report.

NRC Information Notice 92-04 described extensive changes that were made to the MDR starting in October 1985 and finishing in May 1990 and contained the statement "P&B had implemented all these modifications to its MDR rotary relay design by May 1990." The information Notice then described events occurring after May 1990, at General Electric (GE) supplied nuclear power plants that appear to be failures of the MDR relay. The Information Notice went on to note that: "While each of the MDR relays failed between 1 month to 13 years after it was placed in service, with most failed within 2 to 5 years." This statement covers the May 1990 modifications.

1.2 Questions

1.2.1 *Do the "new" relays mentioned in CEN-403 contain the modifications that are described in NRC Information Notice 92-04 and completed by May 1990? The Information Notice also noted MDR relay failures that have occurred after May 1990.*

Response: In 1989 Palo Verde Units 1, 2, & 3 and San Onofre Units 2 & 3 replaced their Subgroup relays with relays containing most, but not all, of the improvements listed in IN 92-04. The replacement relays were procured prior to June of 1989. Due to the problems with improperly cured epoxy discovered at Palo Verde Unit 3, the changeout on the Palo Verde units was not completed for about 6 months. The San Onofre Units were able to take advantage of the experience at Palo Verde Unit 3 and did not experience problems with the epoxy cure on the batch they used for replacement. Waterford Unit 3 has replaced its subgroup relays with relays containing the improvements of IN 92-04. Arkansas One Unit 2 replaced one train of its ESFAS relays in the Fall 1992 outage and plans to replace the second train during its next refueling outage; these replacements contain all the improvements of IN 92-04. Specifically the relays were replaced as follows:

Palo Verde-1:	Mid-1990
Palo Verde-2:	Mid-1990
Palo Verde-3:	Late -1989
San Onofre-2:	Mid-1989 (after Palo Verde problems discovered)

San Onofre-3:	Late 1989
Waterford-3:	December 1992
ANO-2:	Train A - October 1992 Train B - Scheduled for 1994

Some failures have been experienced since these replacements. These include the following:

Palo Verde-1:	10/4/90 - Relay contacts on CSAS-K114 (MDR-7061) would not close - contact pressure was below minimum specified and some contamination was present (glass filled diallyl phthalate - same material as switch ring insulators).
Palo Verde-3:	4/12/91 - Relay LS-K225-B (MDR-5146) - attributed to oversize coil - CCW pump starting relay, not a subgroup relay.
Palo Verde-2:	7/6/90 - Relay K727 (MDR-5147) - normally open contacts 2A/2B were found in the open (actuated) state when the relay was in the energized (non-actuated) state - could not duplicate failure when bench tested.
San Onofre-3:	9/6/92 - Relay contacts on AFW-K724 (MDR-136-1) would not close, attributed to oversize coil motor assembly.
Waterford-3:	12/1/92 - Pressurizer heater relay (MDR-170) experienced a failed rotor return spring due to excessive chattering caused by failure of circuit board elsewhere in system. Potter Brumfield recalled a batch of springs that appeared to have received improper passivation to remove surface contaminants, which is postulated to have caused chloride stress corrosion cracking of the spring. This was reported in S. A. Toelle (ABB) letter to NRC LD-93-003, dated January 13, 1993, "10 CFR Part 21 Report on Potter & Brumfield MDR Model 170-1, 7032, 7033, and 7034 Relays."

This is five failures of the "new" MDR relays in 17 years (ca 208 months) of operating history out of 887 subgroup relays at 7 units. This represents a failure rate of 3.8 E-8/hour; an order of magnitude better than the industry average failure rate of 5.0 E-7/hour used in the EPRI ALWR Utility Requirements Document. This counts some (2) failures that are in non-subgroup relay

applications; there are about 3,544 Potter Brumfield MDR relays in use at these 7 units. Even if the bad batch of improperly cured epoxy at PV-3 is counted (25% of 109 = 27 bad relays) the failure rate is still about half of the industry average.

1.2.2 *NRC Information notice reported on failures of MDR relays at nuclear power plants other than those supplied by Combustion Engineering (CE). CEN-403 attempted to establish the reliability of the MDR relay using the operating history from 13 CE supplied operating nuclear plants. Is this valid?*

Would not CEN-403 be more representative of the MDR reliability if it had taken into account MDR relay failures within the safety systems of all operating nuclear plants

Response: The CEOG has access to information regarding relays at their units. While other NSSS vendor plant information can be obtained from INPO's LER and NPRDS data bases, the application of the relays is not readily available to the CEOG. With about 3,600 MDR relays installed at seven CE units, it is believed that valid conclusions can be drawn from this data.

It is also believed that the information on other types of relays, which may be taken from only one or two CE units, is sufficient to permit one to draw the conclusion that the relays used in these applications generally perform satisfactorily, as CEN-403 does. Specifically:

Palisades (which uses GE relays) and Maine Yankee (which uses Westinghouse relays in these applications) report two failures in 22 years, and two failures in 21 years, respectively.

Fort Calhoun uses GE relays and reports 41 failures of subgroup relays in 20 years of operation, and 57 failures of similar type relays in other applications.

St. Lucie Units 1 and 2, and Millstone-2 use Deutsch/Couch model KEN431A relays and report 10 failures in 44 years of operation.

Calvert Cliffs Units 1 and 2 use Genicom (non-rotary) relays and reports 4 failures in 34 years of operation.

These are listed in the Attached Table 1 (an updated version of Table 1 in CEN-403).

1.2.3 *In as much as NRC Information Notice 92-04 and CEN-403 discuss the same subject, i.e., the reliability of the MDR relay, how did the CEOG resolve the concern of NRC 92-04 prior to the issuance of CEN-403?*

Response: Prior to the work on CEN-403, CEOG utilities were proactive in identifying and remedying problems with the MDR relays, but were addressing the reliability of the MDR relays on an individual basis. Palo Verde and San Onofre worked together to establish a formal testing and improvement program with the manufacturer and independent testing labs. This work led to some of the improvements mentioned in IN 92-04. The resulting improvements have been incorporated on the operating units as they became available.

The concern of varnish outgassing was addressed by changing the coil coatings from a varnish to an epoxy material. Relay operating voltages were also addressed to ensure that the MDRs were not operated under conditions they were not designed for. Chloride corrosion has been addressed by reducing the amount of brass used, and by using chloride free materials. These are discussed in IN 92-04.

In 1991, Entergy Operations Waterford Unit 3, with assistance from ABB, worked with Potter Brumfield to develop most of the remaining improvements to the MDR relays listed in IN 92-04.

2.0 CEN-403

2.1 Statement

The MDR relay is currently used in the safety related systems of nearly all currently licensed and operating nuclear power plants. The purpose of CEN-403 is to justify extending the Surveillance Test Interval for the ESFAS subgroup relays used in CE plants.

2.2 Questions

2.2.1 *What is the period of time covered by the data contained in Table 1 and analyzed in Section 4.0 of CEN-403?*

Response: As stated in the explanatory material for Table 1, the information was taken from the INPO NPRDS data base. This started in 1984, and contained information through November 1990 as of the time it was queried for this project. The attached Revision to Table 1 includes additional data from the "old" LER data base (prior to 1984 - the earliest reported relay failure being in 1972), and the "new" LER data base (1984 to date - which includes some early 1993 failures). The dates of initial criticality of C-E units are given in Table 2.

TABLE 1
SUBGROUP RELAY INFORMATION SUMMARY

PLANT	CE DESIGNED ESFAS	RELAY MFR	SUBGROUP RELAY FAILURES					SURV. INTERVAL	NOTES
			OLD LER	NEW LER	NPRDS		TOTAL		
Palisades	No	GE	1	1	0		2	Refueling	
Maine Yankee	No	West.	0	0	2		2	Refueling	
Fort Calhoun	No	GE	10	0	31		41	Refueling	
Calvert Cliffs 1	No	Genicom	2	0	1		3	31 days	
Calvert Cliffs 2	No	Genicom	0	0	1		1	31 days	
Millstone 2	No	Deutsch	1	0	3		3	Refueling	
St. Lucie 1	No	Couch	0	1	5		6	Refueling	
St. Lucie 2	No	Couch	0	0	1		1	6 months	
					"old" MDR	"new" MDR			
Arkansas 2	Yes	PB	1	0	8	0	9	Refueling	
SONGS 2	Yes	PB	1	0	5	0	6	6 months	
SONGS 3	Yes	PB	0	0	2	1	3	6 months	
Waterford 3	Yes	PB	-	0	3	1	4	62 days STB	(1)
Palo Verde 1	Yes	PB	-	1	6	1	8	62 days STB	
Palo Verde 2	Yes	PB	-	1	10	1	12	62 days STB	
Palo Verde 3	Yes	PB	-	6	4	1	11+	62 days STB	(2)

Notes to Table 1:

(1) STB is Staggered Test Basis, i.e., one train is tested every 31 days.

(2) Palo Verde 3 indicates 11+ in the total failures column. This does not include the batch of new relays that had improperly cured epoxy as they were discovered before being used in plant operation.

TABLE 2
DATES OF INITIAL CRITICALITY

PLANT	DATE (of I.C.)	OPERATING YEARS (THROUGH 1/93)
Palisades	5/71	21
Maine Yankee	10/72	20
Fort Calhoun	8/73	19
Calvert Cliffs 1	10/74	18
Calvert Cliffs 2	11/76	16
Millstone 2	10/75	17
St. Lucie 1	4/76	16
St. Lucie 2	8/83	9
Arkansas 2	12/78	14
SONGS 2	7/82	10
SONGS 3	8/83	9
Waterford 3	3/85	7
Palo Verde 1	1/86	7
Palo Verde 2	9/86	6
Palo Verde 3	1/88	5

Table 1 presents a summary of information on subgroup relays at plants with a Combustion Engineering designed NSSS. The Table is divided into two parts, based on the design of their Engineered Safety Features Actuation System (ESFAS). The first 8 units listed being the older generation of plants (referred to as the "Analog" plants), with their ESFAS designed by the architect engineer. The last 7 units are the newer generation of plants (referred to as "digital" plants) with their ESFAS designed by ABB Combustion Engineering. These 7 digital units utilize Potter Brumfield MDR relays as their subgroup relays. Table 1 presents for each plant whether the ESFAS was designed by CE or others, and the manufacturer of the relays used in the "Subgroup" application. It lists the relay failures reported, and where they were reported, i.e., in INPO's "old LER," "new LER," or "NPRDS" data bases. To avoid duplication a failure is not listed twice,

thus the "new LER" data base contains fewer entries than actually appear there as many of its entries are duplicated entries in the "NPRDS" database. The surveillance interval for the subgroup relays at each plant is also listed.

For the 7 "digital" plants, a change in design of the Potter Brumfield relays was evolving between 1988 and 1990. The "NPRDS" column in Table 1 has been split into "old" and "new" versions of the relays for these plants.

Table 2 presents a summary of the dates of initial criticality of each unit with a CE designed NSSS and the years of operation as of January 1993 based on the date of initial criticality.

2.2.2 *Table 1, "Relay Information Summary," are the NP failures included in the MR failures or should they both be added to the total failures to be taken into account?*

Response: The NP and MR columns report the same failure information from two different sources. They are independent and should not be added. The larger of the two sources was used to assess the number of failures. The accompanying revision to Table 1 reports only the total number of failures; duplication between the LER and NPRDS data bases has now been accounted for.

2.2.3 *Was any of the failure data based on the new P&B relay?*

Response: Other than some initial problems reported on page 15, Revision 0 of CEN-403 did not report any failures of the new relays, as they had not been experienced at that time.

As reported in the response to Question 1.2 1 the following failures have been reported since these replacements:

Palo Verde-1:	10/4/90 - Relay contacts on CSAS-K114 (MDR-7061) would not close - contact pressure was below minimum specified and some contamination was present (glass filled diallyl phthalate - same material as switch ring insulators).
Palo Verde-3:	4/12/91 - Relay LS-K225-B (MDR-5146) - attributed to oversize coil - CCW pump starting relay, not a subgroup relay.
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Waterford-3: 12/1/92 - Pressurizer heater relay (MDR-170) experienced a failed rotor return spring due to excessive chattering caused by failure of circuit board elsewhere in system.

2.2.4 *The Report appears to assign to the relays, even relays from different manufacturers, the same degree of reliability. Explain.*

Response: CEN-403 has not assigned specific levels of reliability to any particular manufacturer or model. While there are some obvious differences in operation, as well as in apparent reliability in the data presented, all relays are highly reliable. It is believed that this information can be appropriately treated generically. Specific problems with individual relay designs have arisen in the past, e.g., IN 91-45, and have been addressed as they occur. However, there is such a difference in operation between the "rotary" relays manufactured by Potter Brumfield, and the "mechanical" relays of other manufacturers, that a distinction is deserving even though the failure data is not significantly different.

2.2.5 *Doesn't the lack of records from Arkansas 2 and Waterford 3 cloud the analysis? Are the relays at these two plants old or new or a combination of both?*

Response: The attached revision to Table 1 includes information on Entergy Operations Arkansas 2 and Waterford 3 units. The MDR relays at Waterford are all of the "new" design. At Arkansas 2, one train has been changed to the "new" design, and the other train is planned to be changed at the next outage of sufficient duration, presently planned for 1994.

2.2.6 *Also, doesn't eliminating Maine Yankee and Palisades from the analysis skew the size of the analysis? This has the effect of reducing the sample size and appears to eliminate many relay malfunctions from the analysis. It also appears that Maine Yankee and Palisades would benefit from a staff approval of the report without having their respective plant relay operating history analyzed.*

Response: The attached revised Table 1 includes data on relay failures at Maine Yankee and Palisades. These older design plants have a mixture of relays in this application, but primarily use Westinghouse type BDF and GE type HFA relays, respectively. For conservatism, all reported ESF relay failures at these two units have been included in Table 1.

2.2.7 *Why wasn't SONGS 2, 3 relay data used? It appears that six of the possible worst offenders were eliminated from the analysis.*

Response: The attached revised Table 1 includes all data and draws no different conclusions. While one might argue that the old data is no longer meaningful, it is apparent that even including such data the reliability of the various relays used is good.

From time to time generic problems have been experienced with various relay designs. It is believed that the following testing scheme is sufficient to detect any common mode failures:

Test any new or reworked relays as part of the standard post-maintenance activity.

Test all relays only once per refueling cycle.

2.2.8 *What is the total number of relays used in the safety systems of CE plants that are not testable at power?*

Response: This varies considerably between units, but averages 18 per unit for 9 units reporting. The remaining 6 units do not run a complete actuation test of any subgroup relays at power.

2.2.9 *Table 1 shows no data from the New P&B relays being used in the analysis yet on page 9, last paragraph, phrase starting with "failures of the new model relays" indicates that the new P&B relay data was used.*

Response: At the time of its preparation there were no reported failures of the "new" MDR relays. The attached revision to Table 1 includes the failures of the "new" MDR relays that have occurred as of Spring 1993. See also the responses to Questions 1.2.1 and 2.2.1.

2.2.10 *For the various relays referenced in CEN-403 why was the reliability study restricted to just CE applications?*

Response: It is believed relay performance at CEOG units may be considered representative of the industry. Detailed information on relay applications was not readily available from other NSSS vendor units.