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**SUBJECT: PROSPECTIVE TREND OF LOW RELIABILITY EMERGENCY
DIESEL GENERATORS**

SUMMARY:

The emergency diesel generators (EDGs) with less than a 95 percent reliability to start and load-run were identified. They account for approximately seven percent of the EDGs yearly. The low reliability EDGs improved to the industry average, but were succeeded by a new group of low reliability EDGs yearly. No overall improving EDG trends were identified from 1988 through 1991.

DISCUSSION

AEOD T92-08 used data from the Nuclear Management and Resource Council (NUMARC) Initiative 5A to show the great variance in the number of times the EDGs were started by different licensees. This report uses the same data to identify EDGs with less than average industry performance and to trend their performance in succeeding years. NUMARC claims that the industry average for the EDGs is better than 99 percent reliability to start and load-run. For this study, a start and load-run reliability of 95 percent or less in any year was selected to identify a sub-par or "troubled" EDG. This threshold was chosen because Unresolved Safety Issue A-44, "Station Blackout" (SBO) established a need for an EDG reliability program that had the capability to achieve and maintain EDG reliability levels in the range of 0.95 per demand or better to cope with a SBO.

The NUMARC data includes 195 EDGs at 63 stations (84 percent of the 232 EDGs at 72 stations) that was partitioned into four yearly periods from 1988 through 1991. The data is identified by number only, so it is not possible, without further identification, to determine the plant name of the nuclear unit. Tables 1 through 4 identify the "troubled" EDGs and their subsequent reliability for the calendar year 1988, 1989, 1990, and 1991, respectively. As the NUMARC data ends with calendar year 1991, the subsequent reliability aggregate in Table 1. includes 3 years of data, Table 2.; 2 years of data, etc.

Tables 1 through 4 follow:

Table 1. "Troubled" EDGs - 1988

Number	EDG Identification	Year of 1988			Years 1989, 1990 and 1991		
		Number of:		Reliability Percent	Number of:		Reliability Percent
		Starts & Loads	Failures		Starts & Loads	Failures	
1.	2B	10	1	90.0	53	0	100.0
2.	18A	68	5	92.6	68	0	100.0
3.	21A	18	2	88.9	40	1	97.5
4.	21B	17	2	88.2	46	2	95.6
5.	25B	19	2	89.5	55	0	100.0
6.	33B	15	1	93.3	51	1	98.0
7.	36B	13	1	92.3	59	1	98.3
8.	37D	19	1	94.7	70	1	98.6
9.	48E	11	1	90.9	53	2	96.2
10.	55B	25	2	92.0	48	0	100.0
11.	57A	19	1	94.7	66	0	100.0
Totals		234	19	91.9	609	8	98.7

Table 2. "Troubled" EDGs - 1989

Number	EDG Identification	Year of 1989			Years 1990 and 1991		
		Number of:		Reliability Percent	Number of:		Reliability Percent
		Starts & Loads	Failures		Starts & Loads	Failures	
1.	6B	19	1	94.7	26	0	100.0
2.	8A	15	1	93.3	56	1	98.2
3.	17B	16	1	93.8	26	0	100.0
4.	21D	18	1	94.4	43	0	100.0
5.	33A	15	2	86.7	31	0	100.0
6.	33B	19	1	94.7	32	0	100.0
7.	39C	13	1	92.3	30	0	100.0
8.	43A	22	2	90.9	28	0	100.0
9.	45B	20	1	95.0	37	0	100.0
10.	52A	20	1	95.0	34	0	100.0
11.	59B	20	1	95.0	116	0	100.0
Totals		197	13	93.4	459	1	99.8

Table 3. "Troubled" EDGs - 1990

Number	EDG Identification	Year of 1990				Year of 1991			
		Number of:		Reliability Percent		Number of:		Reliability Percent	
		Starts & Loads	Failures			Starts & Loads	Failures		
1.	3E	27	2	92.6		29	1	96.6	
2.	4B	15	2	86.7		21	3	85.7	
3.	8A	19	1	94.7		37	0	100.0	
4.	11A	36	2	94.4		19	0	100.0	
5.	11C	31	2	93.5		16	1	93.8	
6.	29B	11	1	90.9		15	0	100.0	
7.	36A	19	2	89.5		16	0	100.0	
8.	37A	17	1	94.1		15	0	100.0	
9.	37C	14	1	92.9		16	0	100.0	
10.	42A	18	1	94.4		16	0	100.0	
11.	43B	15	2	86.7		16	0	100.0	
12.	47B	48	3	93.8		17	0	100.0	
13.	43E	26	2	92.3		15	0	100.0	
14.	50B	19	1	94.7		22	1	95.5	
Totals		315	23	92.7		270	6	97.7	

Table 4. "Troubled" EDGs — 1991

Number	EDG Identification	Year of 1991		
		Number of:		Reliability Percent
		Starts & Loads	Failures	
1.	4B	21	3	85.7
2.	6C	13	1	92.3
3.	11C	16	1	93.8
4.	13E	14	1	92.9
5.	17C	17	2	88.2
6.	18C	36	2	94.2
7.	19C	18	1	94.4
8.	21A	14	1	92.9
9.	21B	18	2	88.9
10.	31B	13	1	92.3
11.	34A	18	2	88.9
12.	36B	19	1	94.7
13.	40A	15	1	93.3
14.	40E	25	2	92.0
15.	41B	16	1	93.8
16.	43C	17	1	94.1
17.	48B	15	1	93.3
18.	48D	37	3	91.9
19.	49A	40	2	95.0
20.	51A	14	1	92.9
21.	62B	27	2	92.6
Totals		423	32	92.4

FINDINGS

The summation data for each year was:

<u>Year</u>	No. of "Troubled" <u>EDGs</u>	<u>Reliability</u>	Subsequent <u>Reliability</u>
1988	11	91.9%	98.7%
1989	11	93.4%	99.8%
1990	14	92.7%	97.8%
<u>1991</u>	<u>21</u>	<u>92.4%</u>	<u>-----</u>
Totals	57	92.6%	98.9%

The number of low reliability EDGs ranged from 5.6 to 10.8 percent with an average of 7.3 percent yearly. The number of low reliability EDGs is increasing yearly.

The composite reliability of the identified "troubled" EDGs in the above table was only 92.6 percent. After identification of a "troubled" diesel, the subsequent reliability of the EDG improved dramatically - to that of the high reliability observed throughout the industry.

The changing identification numbers of the EDGs in each succeeding table show that existing "bad" EDGs are replaced with new "bad" EDGs yearly.

Eight of the 195 EDGs (4.1 percent) had 2 years of below 95 percent reliability in the 4 year period. They were:

	EDG	Initial	Repeat
<u>No.</u>	<u>No.</u>	<u>Year</u>	<u>Year</u>
1.	4B	1990	1991
2.	8A	1989	1990
3.	11C	1990	1991
4.	21A	1988	1991
5.	21B	1988	1991
6.	33B	1988	1989
7.	36B	1988	1991
8.	48E	1988	1990

No EDGs exceeded the unreliability threshold for more than 2 years in the 4 year period.

Three EDGs (1.5 percent) did not achieve an average reliability of 95 percent in the 4 year period from 1988 through 1991. They were EDGs Nos. 4B, 21A, and 21B. The least favorable reliability was 93.7 percent for EDG 21B.

One station (station 36) was the only station where all of their EDGs were below the 95 percent threshold. The "A" EDG exceeded the unreliability threshold in 1990 and the "B" EDG in 1988 and in 1991.

CONCLUSIONS

Approximately seven percent of the EDGs have a start and load-run reliability of less than 95 percent in any given year. These "troubled" EDGs start and load-run reliability improves dramatically in subsequent years to high reliability commensurate with the industry average. However, yearly EDG rotation does occur; one years "troubled" EDGs are replaced with a new set of low reliability EDGs. The trend in the number of low reliability EDGs is increasing yearly, and no yearly improvement is apparent in their composite reliability.

The study did not identify any permanently "troubled" EDGs and no station appears to have an inordinate number of low reliability EDGs onsite.