LOSS OF OFFSITE POWER

SURVEY STATUS REPORT
REVISION 1

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Abstract: This report describes the methods for data analysis and the results of a survey of loss of power events at domestic nuclear power plants.

Introduction: As a result of the staff efforts on several related Generic Activities (e.g., A-35 and A-44) the staff became concerned about the accuracy of the available loss of offsite power data. This concern, along with the results of the Lewis Study, lead the staff to request that all nuclear power plants provide the information specified in Table 1.

Of the 69 licensed nuclear power plants, 20 did not respond. These plants are identified in Table 2.

Discussion: The steps in data reduction and analysis are summarized below.

1. The data was sorted into Type A or B data in accordance with Table 1.*

2. For each event a cause code was assigned. The cause codes are presented in Table 3.

3. A map showing the distribution of the number of each type of failure as a function of each respondant plant was prepared. This is presented as Table 4.

4. The "age" of each plant was determined based on the date of its first reported loss of offsite power until March 3, 1980. This date is presented as Table 5. (Because Duane Arnold reported that no loss of offsite power events, the age could not be established and all data fields were set to zero.)

TABLE 1

REQUEST FOR ADDITIONAL INFORMATION

A. For losses of offsite power where less than all offsite power was lost:

1. How many circuits to the offsite network are normally available and how many were lost during the event?

2. What was the cause of the event?

3. Why did the other lines not fail when some did fail?

4. Was any voltage increase or decrease experienced just prior to or during the outage? If so, please give details, voltages reached, decay rate, affects on equipment operation, etc.?

6. How long was power unavailable from the circuit?

7. Date of Event.

B. For losses of all offsite power:

1. How long was the Power off? How long for partial recovery? Please give details.

2. If turbine trip occurred, how soon after did loss of offsite power occur?

3. If power was recovered promptly (10 minutes or less), was it due to automatic or manual actions?

4. Was any voltage increase or decrease experienced just prior to or during the outage? If so, please give details, voltages reached, affects, etc.

5. Was any frequency decay experienced just prior to or during the outage? If so, please give details, lowest frequency reached, decay rate, affects on equipment operation, etc.

6. Date of Event.

C. Were there any other loss of offsite power events other than we have listed? If so, please give details of each event.

TABLE 2

PLANTS NOT PROVIDING THE DATA REQUESTED IN TABLE 1

ORB#1

50-305 Kewaunee
50-338 North Anna 1
50-261 H.B. Robinson 2
50-280 Surry 1
50-281 Surry 2
50-295 Zion 1
50-304 Zion 2

ORB#3

50-325 Brunswick 1
50-366 E.I. Hatch 2

ORB#4

50-368 Arkansas 2
50-309 Maine Yankee
50-313 Arkansas 1
50-302 Crystal River 3
50-346 Davis-Besse 1
50-269 Oconee 1
50-270 Oconee 2
50-287 Oconee 3
50-312 Rancho Seco
50-289 Three Mile Island 1
50-320 Three Mile Island 2

TABLE 3

Code	Cause
?	Not reported
o	Unknown
1	Failure in an instrument inverter with a second channel bypassed.
2	Turbine generator voltage regulator failure
3	Manual scram
4	Circuit breaker trip during relay testing, improper yard switching operations, improperly set relays, maintenance errors, relay testing errors, test equipment failure, CT failure, maintenance outages
5	Ground fault with or without protective relaying failure or with or without manual scram, bolted faults
7	Protective relay failure
9	Insulator failure (lightening arrester, transmission line insulator, transformer bushing, pot head, cable insulation)
10	Turbine runback due to loss of control rod position indication
11	Lightening with redundant line(s) out of service for maintenance
12	Inadequate line height
13	Foreign conducting object
14	Overload
15	Winter storm
20	Breaker failure
22	Lightening
23	System undervoltage
24	Transformer winding failure
25	Forest fires
28	Lightening with breaker failure
29	Construction activities
31	Summer storm
32	System collapse
33	False relay operation with redundant line(s) out of service for maintenance
34	Mechanical failure of conductors or stays or supporting structures other than code 36
35	Automatic scram
36	Motor vehicle hitting pole
42	System imballance

TABLE 5

3	Indian Point	7.62
10	Dresden 1	13.31
29	Yankee Rowe	16.73
133	Humboldt Bay	9.29
155	Big Rock Point	8.1
206	San Onofre 1	12.12
213	Haddam Neck	11.85
219	Oyster Creek	12.
220	Nine Mile Point	6.29
237	Dresden 2	6.0
244	Ginna	9.17
245	Millstone 1	8.69
247	Indian Point 2	7.62
249	Dresden 3	6.0
250	Turkey Point 3	6.01
251	Turkey Point 4	6.01
254	Quad Cities 1	4.52
255	Palisades	8.66
259	Browns Ferry 1	5.92
260	Browns Ferry 2	5.92
263	Monticello	8.96
265	Quad Cities 2	4.52
266	Point Beach 1	9.07
271	Vermont Yankee	7.84
272	Salem 1	2.84
277	Peach Bottom 2	5.8
278	Peach Bottom 3	5.8
282	Prairie Island 1	2.91
285	Ft. Calhoun	6.51
286	Indian Point 3	2.63
293	Pilgrim 1	8.04
296	Browns Ferry 3	5.92
298	Cooper	4.03
301	Point Beach 2	9.07
306	Prairie Island 2	2.91
315	D.C. Cook 1	5.04
316	D.C. Cook 2	5.04
317	Calvert Cliffs 1	6.2
318	Calvert Cliffs 2	4.09
321	E.I. Hatch 1	2.43
324	Brunswick 2	4.94
331	Duane Arnold	
333	FitzPatrick	1.42
334	Beaver Valley 1	2.89
335	St. Lucie 1	2.8
336	Millstone 2	3.87
344	Trojan	3.88
348	Farley 1	2.46
409	LaCrosse	9.12

5. The data of Table 4 was re-plotted as a function of age to yield failure rates (failures/year).*

6. The data was subjected to several different analyses to determine if it could be characterized on a generic basis. These attempts were not generally successfull because of the large scatter in the data. However, all attempts are identified in the results below.

7. Beyond the attempts to characterize the data on a generic basis, each plant was evaluated, for each of the causes, to determine if its failure experience was significantly different from the average. Significant was defined as a "target" valve (failures/year) greater than or equal to the mean plus three standard deviations.

Results: The following are the numerical results of this study.

1. There have been 806 reported total and partial losses off offsite power. This represents a mean failure rate of 2.29 failures/year with a standard deviation of 3.73 failures/year.

2. There have been 85 total losses of offsite power reported by the 49 respondants. This represents an average rate of 0.24 failures/year.

3. The mean duration of a total loss of offsite power is 3.88 hours with a standard deviation of 5.89 hours.

4. The mean time to partial recovery (from a total loss of offsite power) is 1.83 hours with a standard deviation of 4.54 hours.

5. The duration of a partial loss of offsite power is 10.36 hours with a standard deviation of 162.61 hours.

6. An attempt was made to obtain a least squares fit of the mean valve of the time of outage vs. the percentage of offsite power lost (% lines). No such fit was achieved (confidence level was less than 95%).

7. The mean duration of outage due to lightning strikes is 0.62 hours with a standard deviation of 4.19 hours.

8. The mean voltage drop is 8.98% with a standard deviation of 15.21%.

9. The mean frequency drop is 3.42 Hz with a standard deviation of 5.64 Hz.

10. The mean frequency decay rate is 1.42 Hz/sec with a standard deviation of 1.84 Hz/sec.

11. The Dresden Units 2&3 reported the most significant annual failure rates as noted below:

(a) Total failure rate 17.17 vs. a target of 13.47,

(b) Cause 0 failure rate 4 vs. a target of 2.97,

(c) Cause 7 failure rate 0.67 vs. a target of 0.63,

(d) Cause 9 failure rate 3 vs. a target of 2.38,

(e) Cause 12 failure rate 0.17 vs. a target of 0.12,

(f) Cause 13 failure rate 0.5 vs. a target of 0.5,

(g) Cause 15 failure rate 2 vs. a target of 1.67,

(h) Cause 22 failure rate 3.83 vs. a target of 2.84, and

(i) Cause 42 failure rate 0.17 vs. a target of 0.13.

12. Palisades has exhibited the second largest number of target violations. These are:

(a) Cause 4 failure rate 3.59 vs. a target of 2.29,

(b) Cause 5 failure rate 0.93 vs. a target of 0.55,

(c) Cauase 11 failure rate of 1.5 vs. a target of 0.67,

(d) Cause 14 failure rate of 0.23 vs. a target of 0.1, and

(e) Cause 29 failure rate of 0.93 vs. a target of 0.45.

13. Pilgrim 1 has exhibited the third largest number of target violations. These are:

(a) Cause 13 failure rate of 0.87 vs. a target of 0.5,

(b) Cause 20 failure rate of 0.25 vs. a target of 0.22,

(c) Cause 35 failure rate of 0.12 vs. a target of 0.09, and

(d) Cause 36 failure rate of 0.37 vs. a target of 0.20.

14. Turkey Point 3 had 3 target violations.

15. Turkey Point 4 had 2 target violations.

16. All other correspondents have had one or fewer target violations.

Conclusions

1. The loss of offsite power rate is 2.29 failures/reactor year for a partial loss and 0.24 failures/reactor year for total loss.

2. The Dresden and Palisades stations should be further evaluated to determine the causes for the target violations and to determine if suitable modifications can be made to reduce these rates.

3. Depending on the results of the Dresden 2 and Palisades further evaluation, consideration should be given to similar studies of the Pilgrim station.

Recommendations

1. Pursue the evaluation of Dresden 2 and Palisades.

2. Obtain the data from the plants listed in Table 2.

*Data tables and resulting computer generated analyses are available from the author upon request.