ATTACHMENT A

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3/4.8 ELECTRICAL POWER SYSTEMS

3/4.8.1 A.C. SOURCES

A.C. SOURCES - OPERATING

LIMITING CONDITION FOR OPERATION

3.8.1.1 As a minimum, the following A.C. electrical power sources shall be OPERABLE:

a. Two physically independent circuits between the offsite transmission network and the onsite Class 1E distribution system, and

b. Four separate and independent diesel generators*, each with:

1. Separate engine mounted day fuel tanks containing a minimum of 325 gallons of fuel,
2. A separate fuel storage system containing a minimum of 47,570 gallons of fuel, and
3. A separate fuel transfer pump.

APPLICABILITY: OPERATIONAL CONDITIONS 1, 2, and 3.

ACTION:

a. With either one offsite circuit or one diesel generator of the above required A.C. electrical power sources inoperable, demonstrate the OPERABILITY of the remaining A.C. sources by performing Surveillance Requirements 4.8.1.1.1.a within one hour and 4.8.1.1.2.a.4, for one diesel generator at a time, within four hours and at least once per 8 hours therafter; restore at least two offsite circuits and four diesel generators to OPERABLE status within ~~72 hours~~ 7days or be in at least HOT SHUTDOWN within the next 12 hours and in COLD SHUTDOWN within the following 24 hours.

b. With one offsite circuit and one diesel generator of the above required A.C. electrical power sources inoperable, demonstrate the OPERABILITY of the remaining A.C. sources by performing Surveillance Requirements 4.8.1.1.1.a within one hour and 4.8.1.1.2.a.4, for one diesel generator at a time, within three hours and at least once per 8 hours thereafter; restore at least one of the inoperable A.C. sources to OPERABLE status within 12 hours or be in at least HOT SHUTDOWN within the next 12 hours and in COLD SHUTDOWN within the following 24 hours. Restore at least two offsite circuits and four diesel generators to OPERABLE status within ~~72 hours~~ 7days from time of initial loss or be in at least HOT SHUTDOWN within the next 12 hours and in COLD SHUTDOWN within the following 24 hours.

*Shared with Unit 2.

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LIMITING CONDITION FOR OPERATION (Continued)

ACTION (Continued)

c. With one diesel generator of the above required A.C. electrical power sources inoperable, in addition to ACTION a or b, above, verify within 2 hours that all required systems, subsystems, trains, components and devices that depend on the remaining diesel generators as a source of emergency power are also OPERABLE; otherwise, be in at least HOT SHUTDOWN within the next 12 hours and in COLD SHUTDOWN within the following 24 hours.

d. With two of the above required offsite circuits inoperable, demonstrate the OPERABILITY of four diesel generators by performing Surveillance Requirement 4.8.1.1.2.a.4, for one diesel generator at a time, within four hours and at least once per 8 hours thereafter, unless the diesel generators are already operating; restore at least one of the inoperable offsite circuits to OPERABLE status within 24 hours or be in at least HOT SHUTDOWN within the next 12 hours. With only one offsite circuit restored to OPERABLE status, restore at least two offsite circuits to OPERABLE status within ~~72 hours~~ 7 days from time of initial loss or be in at least HOT SHUTDOWN within the next 12 hours and in COLD SHUTDOWN within the following 24 hours.

e. With two or more of the above required diesel generators inoperable, demonstrate the OPERABILITY of the remaining A.C. sources by performing Surveillance Requirement 4.8.1.1.1.a within one hour and 4.8.1.1.2.a.4, for one diesel generator at a time, within 2 hours, and at least once per 8 hours thereafter; restore at least three of the diesel generators to OPERABLE status within 2 hours or be in at least HOT SHUTDOWN within the next 12 hours and in COLD SHUTDOWN within the following 24 hours. Restore four diesel generators to OPERABLE status within ~~72 hours~~ 7days from time of initial loss or be in at least HOT SHUTDOWN within the next 12 hours and in COLD SHUTDOWN within the following 24 hours.

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4.8.1.1.1 Each of the above required independent circuits between the offsite transmission network and the onsite Class 1E distribution system shall be:

a. Determined OPERABLE at least once per 7 days by verifying correct breaker alignments and indicated power availability, and

b. Demonstrated OPERABLE at least once per 18 months ~~during shutdown~~ by transferring, manually and automatically, unit power supply from the normal circuit to the alternate circuit.

4.8.1.1.2 Each of the above required diesel generators shall be demonstrated OPERABLE:

a. In accordance with the frequency specified in Table 4.8.1.1.2-1 on a STAGGERED TEST BASIS by:

1. Verifying the fuel level in the engine-mounted day fuel tank.

2. Verifying the fuel level in the fuel storage tank.

3. Verifying the fuel transfer pump starts and transfers fuel from the storage system to the engine-mounted day fuel tank.

4. Verifying the diesel starts from ambient condition and accelerates to at least 600 rpm in less than or equal to 10 seconds. The generator voltage and frequency shall be 4160 ± 400 volts and 60 ± 3.0 Hz within 10 seconds after the start signal. The diesel generator shall be started for this test by using one of the following signals:

   a) Manual.
   b) Simulated loss of offsite power by itself.
   c) Simulated loss of offsite power in conjunction with an ESF actuation test signal.
   d) An ESF actuation test signal by itself.

5. Verifying the diesel generator is synchronized, loaded to greater than or equal to 4000 kw in less than or equal to 90 seconds, and operates with this load for at least 60 minutes.

6. Verifying the diesel generator is aligned to provide standby power to the associated emergency busses.

7. Verifying the pressure in all diesel generator air start receivers to be greater than or equal to 240 psig.

b. At least once per 31 days and after each operation of the diesel where the period of operation was greater than or equal to 1 hour by checking for and removing accumulated water from the engine-mounted day fuel tanks.

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SURVEILLANCE REQUIREMENTS (Continued)

c. At least once per 92 days and from new fuel oil prior to addition to the storage tanks by verifying that a sample obtained in accordance with ASTM-D270-1975 has a water and sediment content of less than or equal to .05 volume percent and a kinematic viscosity @ 40°C of greater than or equal to 1.3 but less than or equal to 2.4 for 1D oil or ≥1.9 but ≤4.1 for 2D oil when tested in accordance with ASTM-D975-77, and an impurity level of less than 2 mg. of insolubles per 100 ml. when tested in accordance with ASTM-D2274-70.

d. At least once per 18 months, ~~during shutdown,~~ by:

1. Subjecting the diesel to an inspection in accordance with procedures prepared in conjunction with its manufacturer's recommendations for this class of standby service.

2. Verifying the diesel generator capability to reject a load of greater than or equal to 1425 kw while maintaining voltage at 4160 ± 400 volts and frequency at 60 ± 3.0 Hz.

3. Verifying the diesel generator capability to reject a load of 4000 kw without tripping. The generator voltage shall not exceed 4560 volts during and following the load rejection.

4. Simulating a loss of offsite power by itself, and:

   a) Verifying deenergization of the emergency busses and load shedding from the emergency busses.

   b) Verifying the diesel generator starts on the auto-start signal, energizes the emergency busses with permanently connected loads within 10 seconds and operates for greater than or equal to 5 minutes while its generator is loaded with the shutdown loads. After energization, the steady state voltage and frequency of the emergency busses shall be maintained at 4160 ± 400 volts and 60 ± 3.0 Hz during this test.

5. Verifying that on an ECCS actuation test signal, without loss of offsite power, the diesel generator starts on the auto-start signal and operates on standby for greater than or equal to 5 minutes. The generator voltage and frequency shall be 4160 ± 400 volts and 60 ± 3.0 Hz within 10 seconds after the auto-start signal; the steady state generator voltage and frequency shall be maintained within these limits during this test.

6. Verifying that on a simulated loss of the diesel generator, with offsite power not available, the loads are shed from the emergency busses and that subsequent loading of the diesel generator is in accordance with design requirements.

(8)

PBAPS ATTACHMENT B

LIMITING CONDITIONS FOR OPERATION	SURVEILLANCE REQUIREMENTS
3.9.B (Cont'd)	4.9.B

3. From and after the date that one of the diesel generators or associated emergency bus is made or found to be inoperable for any reasons, continued reactor operation is permissible in accordance with Specification 3.5.F if Specification 3.9.A.1 is satisfied.

4. From and after the date that one of the diesel generators or associated emergency buses and either the emergency or startup transformer power source are made or found to be inoperable for any reason, continued reactor operation is permissible in accordance with Specification 3.5.F, provided the other off-site source, startup transformer and emergency transformer are available and capable of automatically supplying power to the 4KV emergency buses.

5. From and after the date that one of the 125 volt battery systems is made or found to be inoperable for any reason, continued reactor operation is permissible during the succeeding three days within electrical safety considerations, provided repair work is initiated in the most expeditious manner to return the failed component to an operable state, and Specification 3.5.F is satisfied.

Amendment No. 69/68
May 16, 1980

3.9.A

4.9.A (Cont'd.)

b. Once per operating cycle the condition under which the diesel generator is required will be simulated and a test conducted to demonstrate that it will start and accept the emergency load within the specified time sequence. The results shall be logged.

c. Once a month the quantity of diesel fuel available shall be logged.

d. Once a month a sample of diesel fuel shall be checked for quality. The quality shall be within the acceptable limits specified in Table 1 of ASTM D975-68 and logged.

e. Each diesel generator shall be given an annual inspection in accordance with instructions based on the manufacturer's recommendations.

2. Unit Batteries

a. Every week the specific gravity, the voltage and temperature of the pilot cell and overall battery voltage shall be measured and logged.

b. Every three months the measurements shall be made of voltage of each cell to nearest 0.1 Volt, specific gravity of each cell, and temperature of every fifth cell. These measurements shall be logged.

c. Once each operating cycle, the stated batteries shall be subjected to a rated load discharge test. The specific gravity and voltage of each cell shall be determined after the discharge and logged.

LIMITING CONDITIONS FOR OPERATION	SURVEILLANCE REQUIREMENTS
3.5.F Minimum Low Pressure Cooling and Diesel Generator Availability	4.5.F Minimum Low Pressure Cooling and Diesel Generator Availability
1. During any period when one diesel generator is inoperable, continued reactor operation is permissible only during the succeeding seven days unless such diesel generator is sooner made operable, provided that all of the low pressure core and containment cooling subsystems and the remaining diesel generators shall be operable. If this requirement cannot be met, an orderly shutdown shall be initiated and the reactor shall be placed in the Cold Shutdown Condition within 24 hours.	1. When it is determined that one diesel generator is inoperable, all low pressure core cooling and containment cooling subsystems shall be demonstrated to be operable immediately and daily thereafter. In addition, the operable diesel generators shall be demonstrated to be operable immediately and daily thereafter.
2. Any combination of inoperable components in the core and containment cooling systems shall not defeat the capability of the remaining operable components to fulfill the cooling functions.	
3. When irradiated fuel is in the reactor vessel and the reactor is in the Cold Shutdown Condition, both core spray systems, the LPCI and containment cooling subsystems may be inoperable, provided no work is being done which has the potential for draining the reactor vessel.	
4. During a refueling outage, fuel and LPRM removal and replacement may be performed provided at least one of the following conditions below is satisfied:	

A.4 SYSTEM UNAVAILABILITY DUE TO MAINTENANCE DURING REACTOR OPERATION

One of the principal contributors to safety system unavailability may be the outage time associated with maintenance operations.* The reason for this unavailability is that while maintenance is occurring on one component in a system (or one leg of a two-leg system) that system may be incapacitated.** One available source of maintenance frequencies and durations based upon operating experience at nuclear power plants is WASH-1400. However, WASH-1400 does not state whether or not simultaneous maintenance activities are included and does not differentiate between on-line and off-line maintenance. The WASH-1400 data also include several startup problems in early BWRs which have been subsequently corrected. General Electric does not believe the data to be representative of present-day conditions. General Electric has performed a search of their Component Information Retrieval system and completed an analysis of the data. In addition, Philadelphia Electric has provided detailed maintenance information on each of the Peach Bottom 2 and 3 safety systems, based upon operating experience. Both of these sources confirm that maintenance unavailabilities are substantially less than assumed in WASH-1400. In addition, Philadelphia Electric Nuclear Plant operating philosophy dictates that all normal maintenance of safety systems be performed during outages when there will be no demand for the safety system. General Electric maintenance availability values were used in this analysis.

A.4.1 Calculated Maintenance Unavailabilities

For comparison purposes, maintenance information from WASH-1400 is provided. WASH-1400 assessed the mean time between component failures to be 4.55 months (.22 failures/month), while the mean time to repair (MTTR) is a function of both:

---

*WASH-1400 found on-line maintenance to be a major contributor to individual system unavailability; however, operating experience and maintenance philosophy of the operating PECo BWRs support a significantly lower estimate.

**Note that there may be some maintenance acts from which the operator can recover the system for use as a safety system; however, this is not considered in this model.

XII-A

C, p. 1

1. The component, and

2. The upper bound on the allowed system outage time (e.g., for HPCI it is 7 days with RCIC operational). The technical specifications define these combinations of system unavailabilities. The Limiting Conditions of Operation from the technical specifications for Peach Bottom* are reproduced in Table A.4.1.

The WASH-1400 evaluation of MTTR for components which are anticipated to lead to maintenance outages is summarized in Table A.4.2.

Table A.4.2

SUMMARY OF MEAN TIME TO REPAIR (HOURS) BY COMPONENT TYPE ASSUMING A LOG NORMAL DISTRIBUTION OF REPAIR TIMES AND A MAXIMUM ALLOWED OUTAGE TIME OF 7 DAYS (WASH-1400 ANALYSES)

Component Type	MTTR (hours)
Pumps	19
Valves	19
Diesels	21
Instrumentation (I&C)	7

The following brief summaries of each system provide the number of components by type, the evaluated mean time to repair (MTTR) for each component, and the calculated unavailability of safety systems due to maintenance while the plant is operating.

*As noted in the groundrules for this study, the Limerick technical specifications are not written or approved and therefore Peach Bottom technical specifications are used as typical.

C, p.2

A.5 DATA ASSESSMENT FOR DIESEL AVAILABILITY MODELING

Emergency electric power buses (4160 AC) are a vital and necessary function for successful long term core cooling and containment heat removal. Power to these buses can be supplied via any of the offsite power sources (see Section A.6) or the emergency diesels. The emergency diesels can be treated in at least two ways for the quantification of accident sequences. These methods are:

1. Draw a fault tree for the entire diesel generator system, including the auxiliaries. All common links between the diesels, including operator interaction, would need to be modeled.
2. Use operating experience field data on diesel generator performance to characterize the diesels.

Past analyses and data evaluations of diesels have concluded that the diesel failure rate can be relatively high and that potential common-cause events could be the most significant contributor to multiple diesel failures. These conclusions, plus the availability of recent diesel performance data, including PECo-specific data, has led to the choice of method (2) above. In addition to the use of data to characterize individual diesel failures, the model used in the Limerick quantification makes use of the available data on single and multiple diesels plus a Boolean model* for relating the probability of multiple diesel failures.

This section includes the following specific data as used in the quantification of the probability of diesel availability:

1. Characterization of the probability of a single diesel failing to start and run using Philadelphia Electric Company nuclear plant experience (Section A.5.1)

*This dependency model (see Appendix B) is quite general, but the data used to quantify it must be assumed to come from a population of diesels similar to those at Limerick.

C, p.3

2. Compilations of other sources of data to estimate the probability of a single diesel failure, plus the conditional probability of multiple diesel failures (Section A.5.2 and A.5.3).

3. Data on the length of time required to restore a diesel to operation is also important in the Limerick analysis, since the Limerick plant is designed to maintain a safe configuration even during the loss of all emergency AC power for a certain amount of time, i.e., at least two hours (Section A.5.4).

4. Summary of data used to characterize the LGS DGs (see A.5.5).

A.5.1 Diesel Performance Data from Philadelphia Electric Company Experience

An analysis of data on diesels from Peach Bottom 2 and 3 has been performed. This analysis is an attempt to provide a PECo-specific estimate of the failure probability of a single diesel and additional confirmation of other estimates of the probability of multiple diesel failure. Table A.5.1 summarizes Philadelphia Electric's experience with the Peach Bottom Units 2 and 3 diesels as reported in Licensee Event Reports (LERs). This includes the test experience and gives point failure estimates of 0.0078/demand for failure to start and 0.0099/demand for failure to sustain operations (or other failures not associated with starting), or a total of 1.8×10^{-2}/demand. The test experience used here is based on single unit testing; however, there have been at least 9 integrated tests (LOCA signal and loss of two off-site power sources to test the automatic startup of all four diesels at the same time). Two failures occurred which may be interpreted as common-mode: the presence of weld beads in the blower drive gears (6/15/74) and the loss of starting air (6/13/77). Accepting these as common-mode failures, the point estimate for their occurrence is 2/1409 = 0.0014/D. This may be conservative because the situations that resulted in the failures have changed.

In addition to the failure probability of a single diesel, the Peach Bottom data can be used to estimate the probability of restoring one diesel generator (DG). Table A.5.2 provides the Peach Bottom restoration times.

C, p.4

Table A.5.1

PEACH BOTTOM ATOMIC POWER STATION - DIESEL TEST DATA 1973-1980

Year	Tests by Diesel Number				Total Tests(a)	Failures to Start(b)	Failures to Sustain(c)	Failure to Start Frequency b/a	Failure to Sustain Frequency [illegible]
	1	2	3	4					
1973	7	9	6	9	31	2	0	.064	0
1974	30	30	30	41	131	1	2	.0078	.015
1975	54	55	53	53	215	1	2	.0047	.0093
1976	52	54	52	53	211	3	1	.014	.0047
1977	54	53	53	53	213	3	6	.014	.028
1978	55	55	55	53	218	1	2	.0046	.0092
1979	67	68	72	65	272	0	1	0	.0037
1980*	30	31	29	28	118	0	0	0	0
TOTAL					1409	11	14	.0078	.0099

*Through 9/15/80

Table A.5.2

HISTOGRAM DATA OF DIFFERENTIAL AND CUMULATIVE DG RESTORATION TIMES

Restoration Time (Hrs.)*	Number of Events in the Interval	Cumulative Events to Upper Time
0.0 - 0.5	1	1
0.5 - 1.0	5	6
1.0 - 2.0	3	9
2.0 - 4.0	2	11
4.0 - 10.0	8	19
10.0 - 50.0	6	25
50.0 - 100.0	2	27

*Events specified as exactly the upper limit are taken in that interval.

C, p.5

	Number of Trials	Number of Failure Combinations
Singles	660	32
Doubles	638	5
Triples	339	1
Quadruples	67	0

Using this information, upper bound estimates can be obtained. These upper bound estimates assume a failure occurs on the next trial. Therefore, the probability of failure on demand becomes:

$$P(s) = P(\text{Single}) = \frac{33}{661} = 4.99 \times 10^{-2}$$ 5%

$$P(d) = P(\text{Double}) = \frac{6}{639} = 9.39 \times 10^{-3}$$ 1%

$$P(t) = P(\text{Triple}) = \frac{2}{340} = 5.88 \times 10^{-3}$$

$$P(q) = P(\text{Quadruple}) = \frac{1}{68} = 1.47 \times 10^{-2}$$

Note that these assumptions have resulted in an impossible result for quadruple failures. That is, quadruple failures cannot be more likely than lesser combinations. Therefore, another estimate must be obtained. This other estimate can be obtained by recognizing that there was one triple failure where a quadruple failure did not occur. Thus, there was one chance for a fourth failure given three failures. Again, using an upper bound approximation, gives:

$$P(\text{fourth given three failures}) = \tfrac{1}{2} = .5$$

Other conditional failures can be found as

$$P(\text{second given one failure}) = \frac{P(d)}{P(s)} = .188$$

$$P(\text{third given two failures}) = \frac{P(t)}{P(d)} = .626$$

$$P(\text{fourth given three failures}) = .5 \text{ (from above)}$$

C, p.6

Probabilities for multiple diesel failures were then taken as the averages of the $\lambda(i|.)$ calculations for i = 2, 3, and 4. Results are given below:

$$P(1)_{avg} = \frac{432 \text{ Failures}}{(330.9 \text{ diesel years})(65.4 \text{ demands/diesel year})}$$

$$P(1)_{avg} = 2.0 \times 10^{-2} \text{ failure/demand}$$

$$P(2)_{avg} = .0083 \text{ /demand}$$

$$P(3)_{avg} = .0014 \text{ /demand}$$

$$P(4) = .0012 \text{ /demand}$$

This evaluation of multiple diesel failures is conservative in nature; however, the lack of data precludes a more realistic calculation.

A.5.3.3 Composite Diesel Assessment

Table A.5.9 presents a summary of the diesel data presented above. The observations which can be made from this data are the following:

1. The failure rate of a single diesel as determined from the various sources is quite similarly varying from 1.89×10^{-2} to 3×10^{-2}.

2. The cumulative effect of the conditional failure probabilities is that the probability of the three remaining diesels failing given that one diesel has failed, varies from .03 to .06.

C, p.7

Table A.5.9

COMPARISON OF DIESEL GENERATOR FAILURE RATE DATA (PER DEMAND)

PLANT X		ZION/COOK	WASH-1400	36 LWR's	Average Value[c]	Trimmed Value[d]
P(1)	4.99×10^{-2}	$(1.89-2.84)\times10^{-2}$	3×10^{-2}	$(2.0)\times10^{-2}$	2.94×10^{-2}	2.61×10^{-2}
P(2)	9.39×10^{-3}	$(1.58-7.07)\times10^{-3}$	$10^{-3}-10^{-2}$[b]	$(8.3)10^{-3}$	6.22×10^{-3}	6.55×10^{-3}
P(3)	5.28×10^{-3}	$(9.2-9.43)\times10^{-4}$	10^{-2}	$(1.4)10^{-3}$	3.8×10^{-3}	3.37×10^{-3}
P(4)	2.94×10^{-3}[a]		10^{-2}	$(1.2)10^{-3}$	3.00×10^{-3}	2.29×10^{-3}
P(2/1)	1.88×10^{-1}	$(.84-3.35)\times10^{-1}$	$(.33-3.3)10^{-1}$	$(4.2)10^{-1}$	2.32×10^{-1}	2.34×10^{-1}
P(3/2)	6.26×10^{-1}	$(4.47-5.82)\times10^{-1}$	1.0	$(1.7)10^{-1}$ *	5.6×10^{-1}	5.52×10^{-1}
P(4/3)	5×10^{-1}[a]		1.0	$(8.6)10^{-1}$	7.86×10^{-1}	8.50×10^{-1}

[a] Estimate

[b] 10^{-3} is the probability for 2 independent failures; 10^{-2} is the probability for common mode

[c] Average of all values - NOTE: P(2), P(3), P(4) averages were calculated from the average conditionals

[d] Mean value after deletion of largest and smallest values

** Appears to be an error. use 6×10^{-1} as conservative approximation from other two columns.*

A.5.4 Diesel Repair Rate

In the LGS analysis it is important to know the availability of onsite 4160V AC power during the course of an accident. If AC power is unavailable at the beginning of an accident sequence, it may be restored at a later time. Therefore, it was necessary to determine the diesel repair time (Table A.5.10). Specifically of interest in the LGS evaluation is the probability of recovering the diesels after two hours and four hours following the loss of AC emergency power buses:

Probability Description	Probability Value Estimate
1 diesel recovered within 2 hours	.33
1 diesel recovered within 4 hours.	.53

C, p.8

Table A.5.10

SUMMARY OF DIESEL REPAIR TIME FOLLOWING FAILURES OF INDIVIDUAL DIESELS

From EG&G (normalizing to 100%)

25% of time 1 diesel is repaired within 0-1 hr
28% of time 1 diesel is repaired within 1-4 hr
24% of time 1 diesel is repaired within 4-8 hr
11% of time 1 diesel is repaired within 8-24 hr
12% of time 1 diesel is repaired within >24 hr

Cumulative percentages become:

25% of time 1 diesel is available by 1 hr
53% of time 1 diesel is available by 4 hr
77% of time 1 diesel is available by 8 hr
88% of time 1 diesel is available by 24 hr
12% of time 1 diesel is unavailable after 24 hr

Estimation between 1-8 hr is:
75% of time 1 diesel is unavailable after 1 hr
66% of time 1 diesel is unavailable after 2 hr
57% of time 1 diesel is unavailable after 3 hr
47% of time 1 diesel is unavailable after 4 hr
41% of time 1 diesel is unavailable after 5 hr
35% of time 1 diesel is unavailable after 6 hr
29% of time 1 diesel is unavailable after 7 hr
23% of time 1 diesel is unavailable after 8 hr

C, p.9

A.5.5 Summary of Data Used in the LGS Evaluation

Combining the information from the various sources discussed in this section, the following data are used to characterize the unavailability of the diesel units for the LGS analysis:

1. The failure to "start and run" probability for a single diesel is taken from the Philadelphia Electric Company experience at the Peach Bottom Station. This is 1.7×10^{-2}/demand.

2. The conditional probability that multiple diesels may fail given that a single diesel fails is taken from the data source with the most information, the evaluated data from 36 LWRs. The values arrived at for the conditional failure probability are:

   - P(2/1) - Conditional Probability of a second diesel failing given that one has failed ≡ 4.2×10^{-1}

   - P(3/2) - Conditional Probability of a third diesel failing given that two diesels have failed ≡ ~~1.7×10^{-1}.~~ Use 6.0×10^{-1} see page A-98

   - P(4/3) - Conditional Probability of a fourth diesel failing given that three diesels have failed ≡ 8.6×10^{-1}.
     P(5/4) = ~1.0 conservatively

3. The probability of recovery of a diesel can be very important in many accident scenarios where the plant can be maintained in a safe condition for two to four hours without 4160V AC emergency power. The available data from Peach Bottom and the NRC evaluated diesel data both agree quite well as to the conditional probability of recovering diesel within 2 hours and within 4 hours. The data used in the Limerick evaluation is the NRC data, which is:

   Probability of Recovering
   1 diesel within 2 hours = .33

   Probability of Recovering
   1 diesel within 4 hours = .53

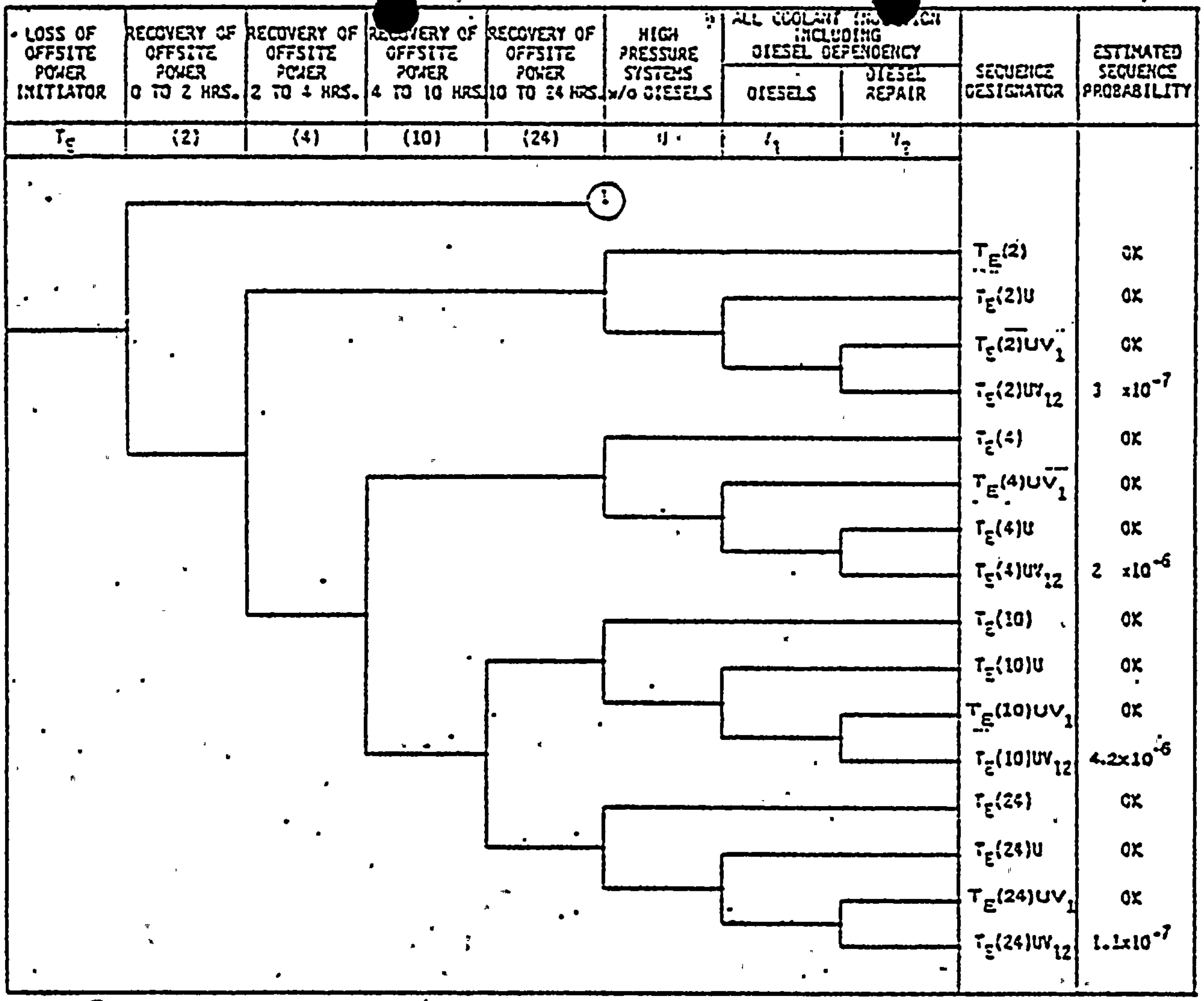
LGS-FR... C, p. 10

In addition to the need for adequate room cooling, another need arises after four hours without AC power. The station batteries will be expended after four hours without recharging. Therefore, after four hours, HPCI and RCIC are no longer reliable sources of coolant injection, due to the loss of all automatic control and operator indication. Despite this loss of all power, there is a possible mode of local, manual RCIC operation which could be used in this case. However, because of the adverse environment, a very low probability of success is given to this path.

In order to better define the contributors to potential degraded core conditions resulting from a loss of offsite power initiator, a time-phased event tree is presented in Figure 3.4.4b. The terminology used in the time phased event tree is slightly different than used in other event trees in order to emphasize the dependency of the coolant injection function on AC power. The time periods of most interest for the loss of offsite power initiator are:

TIME	QUALITATIVE DESCRIPTION
0 - 2 hours	The high pressure injection systems, HPCI and RCIC, can be operated using the on-site DC power sources. No offsite or emergency AC power sources are required during this time.
2 - 4 hours	An AC power dependence may arise if the HPCI or RCIC rooms cannot be adequately cooled.
>4 hours	DC battery sources are anticipated to last for 4 hours. Past this time offsite power or emergency power must be restored to assure coolant injection.

C, p. 11



(1) This branch transfers to MSIV closure initiators since it effectively is an MSIV Closure when offsite AC power is restored.

Figure 3.4.4b Loss of Offsite Power Transient Event Tree (Time-Phased Coolant Injection)

As seen in the time-phased event tree and Table 3.4.1, the time periods of highest probability of inadequate coolant injection are the periods 2 - 4 hours and 4 - 10 hours.

C, p.12

Table 3.4.1

QUANTITATIVE EVALUATION OF THE TIME PHASES OF THE LOSS OF OFFSITE POWER ACCIDENT SEQUENCE

PHASE	TIME PHASE OF ACCIDENT SEQUENCE	ACCIDENT INITIATOR T_E	FAILURE TO RECOVER OFFSITE POWER*†	FAILURE OF HIGH PRESSURE SYSTEMS U	FAILURE OF LOW PRESSURE SYSTEMS VT	COMMON-MODE DIESEL GENERATOR FAILURE PROBABILITY	FAILURE OF DIESEL GENERATOR REPAIR	TOTAL FREQUENCY (per reactor year)
I	0 - 2 hours	5.3×10^{-2}	.56	5×10^{-3}††	†	1.08×10^{-3}	1.0	3×10^{-7}
II	2 - 4 hours	5.3×10^{-2}	.35	.15*	†	1.08×10^{-3}	.56	2.0×10^{-6}
III	4 - 10 hours	5.3×10^{-2}	.158	1.0**	†	1.08×10^{-3}	.47	4.2×10^{-6}
IV	10 - 72 hours	5.3×10^{-2}	.01	1.0**	†	1.08×10^{-3}	.2	1.1×10^{-7}

*Probability of failure of ventilation of HPCI rooms coupled with the probability of failure of operators to establish a natural circulation ventilation path for these rooms.

**Conditional probability of failure of RCIC using manual control with no power (DC or AC) for times greater than 4 hours.

†Because of the redundancy of the available low pressure pumps the dominant contributor to the loss of the low pressure systems during a loss of offsite power is the common-mode failure of all the emergency diesels.

††No AC power required for HPCI/RCIC operation during the initial 2 hours following the loss of offsite power.

*†Probability of recovery of offsite power is derived from the data analysis performed in Appendix A for 30 minutes, 2 hours, 4 hours, and 10 hours.

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X -- Timely ADS Actuation. This is similar to the event appearing in Section 3.4.1.1, with an increase in failure probability due to potential reluctance of operators to depend on the diesel-powered low-pressure system pumps, or the inability of some portion of the diesels to start and run on full load and therefore prevent some low pressure pumps from starting, thus inhibiting ADS.

V -- LPECCS. Similar to the event appearing in Section 3.4.1.1 with AC power dependency.

W -- RHR and RHRSW or PCS or RCIC Steam Condensing Mode. The RHR and RHRSW systems have a dependency on the diesel generators when offsite power is unavailable. The PCS is unavailable when offsite power is lost. The reasons for dividing the sequences in a time phased diagram (Figure 3.4.4c) for a loss of offsite power are the following: