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SUBJECT: Forwards worse case loading profile for DGs following forced shutdown or loss of coolant accident/loss of offsite power event in support of 910821 proposed TS amends to Spec 3/4.8.1 re ac. sources.

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161-04623-WFC/DAF
February 19, 1992

U. S. Nuclear Regulatory Commission
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Reference: Letter 161-04124-WFC/DAF, dated August 21, 1991, from W. F. Conway, APS, to U. S. Nuclear Regulatory Commission (NRC), "Proposed Technical Specification Amendments to Specification 3/4.8.1, A. C. Sources"

Dear Sirs:

Subject: Palo Verde Nuclear Generating Station (PVNGS)
Units 1, 2, and 3
Docket Nos. STN 50-528/529/530
Additional Information in Support of Proposed Revision to
PVNGS Diesel Generator Surveillance Testing
File: 92-F-005-419.05; 92-056-026

During the NRC's review of the referenced Arizona Public Service Company (APS) Technical Specification amendment request, APS was requested to provide additional information. The amendment request, in part, would allow APS to conduct overload testing of the PVNGS diesel generators during the last two hours of a 24-hour surveillance test (performed every 18 months). Specifically, the NRC requested a copy of the PVNGS diesel generator kilowatt (KW) loading profile in order to continue their review of the referenced Technical Specification amendments.

Accordingly, APS has calculated the worst case (i.e., maximum) loading profile (starting and steady state loads) for PVNGS diesel generators following a forced shutdown or loss of coolant accident/loss of offsite power (LOCA/LOP) event.

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The worst case diesel generator loading as a function of time is shown numerically in Table 1 and graphically in Figure 1 (see Attachments 1 and 2, respectively). These calculations (based on Diesel Generator Loading Calculation¹) provide the KW and kilovolt amperes reactive (KVAR) loads for both Train A and Train B of the diesel. Of the two loading conditions, a LOCA/LOP on Train B results in the maximum transient loading and thus presents the highest KW values, which are provided in Table 1.

Figure 1 shows diesel generator KW and KVAR loadings as a function of time. The plot with "■" symbols represents the KW loading, while "+" represents the KVAR loading and "♦" represents the maximum rated capacity of the diesel (5500 KW). At time $t = 0$, a motor load of 1147 KW is switched on. This produces a 1274 KW and 6245 KVAR load on the generator which remains constant for 5 seconds at which time the motors reach their final speed and the starting load changes to a running load (1147 KW and 555 KVAR). At 5 seconds, a step 2 load of 654 KW is added on as a motor start load, etc. Therefore, the KW plot is seen essentially as a stair step loading which reaches its final value of 5218 KW at $t = 40$ seconds. The KW load drop at 40 seconds is due to the load connected at 35 seconds changing from a starting to a running load. The KVAR loading is initially high due to the starting of a large motor load which then drops to 2642 KVAR producing a net steady state 5849 kilovolt amperes (KVA) load on the diesel generator.

The curves in Figure 1 are based on the values in Table 1. Column 1 of Table 1 marked "Time (sec)" shows one second increments from 0 to 45 seconds. Column 2 marked "Step (KW)" shows the values from the calculation² for the LOCA/LOP event (Train B load). The column marked "Starting Load" shows the starting KW and KVAR loads for the step load of column 2. Starting KVA is assumed to be 5 times the running KVA with a power factor of 0.2 lagging. The column marked "Running Load" shows the total load at the steady state condition. The 1147 KW load which was switched on at $t = 0$ seconds does not reach its steady state value for 5 seconds. A power factor of 0.9 lagging is used to calculate the running load. The column marked "Starting + Running" shows the sum of starting and running loads and represents the total load on the diesel generator with the exception of the KW and KVAR losses which have not been included.

¹Diesel Generator Loading Calculation, Calculation No. 13-EC-DG-200, Rev. 7.

²Diesel Generator Loading Calculation, Calculation No. 13-EC-DG-200, Rev. 7, pages 27-33.

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The next column shows the losses which are proportional to the square of the total KVA loading. The final column marked "Net Diesel Gen Loading" shows the net KW, KVAR, and KVA loading on the diesel including losses. The following assumptions have been made in calculating the diesel loading profile:

1. The starting KVA is 5 times the running KVA.³
2. The starting power factor is 0.2.³
3. The running power factor is 0.9.³
4. The starting KVA and power factor remain unchanged for about 4 seconds, then change to the running KVA and power factor between 4 and 5 seconds.⁴
5. All loads are induction motor loads.
6. Losses are proportional to the square of the total KVA loading of the diesel generator.

Table 1 represents the maximum transient loading profile for the PVNGS diesel generators. As can be seen from the results of this calculation, the maximum KW rating is not exceeded during the transient period. The maximum calculated KVA loading (7014 KVA) is shown to exceed the maximum KVA rating (6875 KVA) by 2% during the 35 through 39 second interval, however, this assumes the entire 383 KW manual load is added to the diesel simultaneously. This assumption, while conservative, is unrealistic as operators place these loads on as needed, typically one at a time where no overloading would occur.

The loading profile calculation will be incorporated into the Diesel Generator Loading Calculation¹ for additional information.

³Transient Voltage Response of the Diesel Generator Units Trains A and B to Postulated Emergency Loading, NEI Peebles-Electrical Products, Inc., Report No. M018-551-1, Table 4-6.

⁴Paul C. Krause, Analysis of Electrical Machinery (New York: McGraw Hill Book Company, 1986), page 194.

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If you have any questions, please call Michael E. Powell of my staff at (602) 340-4981.

Sincerely,

James M. Levine for WFC

WFC/DAF/daf

Attachments

cc: J. B. Martin
D. H. Coe
A. C. Gehr
A. H. Gutterman

PALO VERDE DIESEL GENERATOR LOADING FOR LOCA/LOP TRAIN B LOAD

(Revised 12-23-91 To Include KVAR Losses)

Time (sec)	STEP (KW)	Starting Load		Running Load		Starting+Running		Losses		Net Diesel Gen Loading		
		KW	KVAR	KW	KVAR	KW	KVAR	KW	KVAR	KW	KVAR	KVA
0.00	1147	1274	6245	0	0	1274	6245	91	188	1366	6434	6577
1.00	0	1274	6245	0	0	1274	6245	91	188	1366	6434	6577
2.00	0	1274	6245	0	0	1274	6245	91	188	1366	6434	6577
3.00	0	1274	6245	0	0	1274	6245	91	188	1366	6434	6577
4.00	0	1274	6245	0	0	1274	6245	91	188	1366	6434	6577
5.00	654	727	3561	1147	555	1874	4116	46	95	1920	4211	4628
6.00	0	727	3561	1147	555	1874	4116	46	95	1920	4211	4628
7.00	0	727	3561	1147	555	1874	4116	46	95	1920	4211	4628
8.00	0	727	3561	1147	555	1874	4116	46	95	1920	4211	4628
9.00	0	727	3561	1147	555	1874	4116	46	95	1920	4211	4628
10.00	903	1003	4916	1801	872	2804	5788	93	192	2897	5980	6645
11.00	0	1003	4916	1801	872	2804	5788	93	192	2897	5980	6645
12.00	0	1003	4916	1801	872	2804	5788	93	192	2897	5980	6645
13.00	0	1003	4916	1801	872	2804	5788	93	192	2897	5980	6645
14.00	0	1003	4916	1801	872	2804	5788	93	192	2897	5980	6645
15.00	549	610	2989	2704	1309	3314	4298	66	136	3380	4435	5576
16.00	0	610	2989	2704	1309	3314	4298	66	136	3380	4435	5576
17.00	0	610	2989	2704	1309	3314	4298	66	136	3380	4435	5576
18.00	0	610	2989	2704	1309	3314	4298	66	136	3380	4435	5576
19.00	0	610	2989	2704	1309	3314	4298	66	136	3380	4435	5576
20.00	544	604	2962	3253	1574	3857	4536	80	164	3937	4701	6132
21.00	0	604	2962	3253	1574	3857	4536	80	164	3937	4701	6132
22.00	0	604	2962	3253	1574	3857	4536	80	164	3937	4701	6132
23.00	0	604	2962	3253	1574	3857	4536	80	164	3937	4701	6132
24.00	0	604	2962	3253	1574	3857	4536	80	164	3937	4701	6132
25.00	551	612	3000	3797	1838	4409	4838	96	199	4505	5037	6758
26.00	0	612	3000	3797	1838	4409	4838	96	199	4505	5037	6758
27.00	0	612	3000	3797	1838	4409	4838	96	199	4505	5037	6758
28.00	0	612	3000	3797	1838	4409	4838	96	199	4505	5037	6758
29.00	0	612	3000	3797	1838	4409	4838	96	199	4505	5037	6758
30.00	414	460	2254	4348	2104	4808	4358	95	195	4903	4554	6692
31.00	0	460	2254	4348	2104	4808	4358	95	195	4903	4554	6692
32.00	0	460	2254	4348	2104	4808	4358	95	195	4903	4554	6692
33.00	0	460	2254	4348	2104	4808	4358	95	195	4903	4554	6692
34.00	0	460	2254	4348	2104	4808	4358	95	195	4903	4554	6692
35.00	383	426	2085	4762	2305	5188	4390	104	214	5291	4605	7014
36.00	0	426	2085	4762	2305	5188	4390	104	214	5291	4605	7014
37.00	0	426	2085	4762	2305	5188	4390	104	214	5291	4605	7014
38.00	0	426	2085	4762	2305	5188	4390	104	214	5291	4605	7014
39.00	0	426	2085	4762	2305	5188	4390	104	214	5291	4605	7014
40.00	0	0	0	5145	2490	5145	2490	73	151	5218	2642	5849
41.00	0	0	0	5145	2490	5145	2490	73	151	5218	2642	5849
42.00	0	0	0	5145	2490	5145	2490	73	151	5218	2642	5849
43.00	0	0	0	5145	2490	5145	2490	73	151	5218	2642	5849
44.00	0	0	0	5145	2490	5145	2490	73	151	5218	2642	5849
45.00	0	0	0	5145	2490	5145	2490	73	151	5218	2642	5849

ASSUMPTIONS:

1. Starting KVA & PF remain unchanged for 4 seconds and change between 4 & 5 sec to running values.
2. Starting KVA=5*Rated KVA
3. Starting PF=0.2 & Running PF=0.9
4. Losses are proportional to KVA squared

TPE/PVDG.WK1

PVDG Loading For LOCA/LOP Train-B Load

Revised 12-23-91 To Include Losses



