CONTAINMENT SYSTEMS

CONTAINMENT STRUCTURAL INTEGRITY

LIMITING CONDITIONS FOR OPERATION

3.6.1.6 The structural integrity of the containment shall be maintained at a level consistent with the acceptance criteria in Specification 4.6.1.6.

APPLICABILITY: MODES 1, 2, 3 and 4.

ACTION:

a. With the structural integrity of the containment not conforming to the requirements of Specification 4.6.1.6.1.b, perform an engineering evaluation of the containment to demonstrate the acceptability of containment tendons within 72 hours; otherwise, be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours.

b. With the structural integrity of the containment otherwise not conforming to the requirements of Specification 4.6.1.6, in lieu of any other report required by Specification 6.9.1, prepare and submit a Special Report to the Commission pursuant to Specification 6.9.2 within 30 days after completion of the inspection describing the tendon condition, the condition of the concrete (especially at tendon anchorages), the inspection procedures, the tolerances on cracking, and the corrective actions taken.

SURVEILLANCE REQUIREMENTS

4.6.1.6.1 The structural integrity of the containment tendons shall be demonstrated at the end of one, three and five years following the initial containment structural integrity test and at five year intervals thereafter. The structural integrity of the tendons shall be demonstrated by:

a. Determining that for a representative sample* of at least 15 tendons (4 dome, 5 vertical and 6 hoop) each has a lift off force greater than or equal to 95% of its Base Value indicated in Table 4.6-1a. If the lift off force of a selected tendon in a group lies between the 95% Base Value and 90% of the Base Value, one tendon on each side of this tendon shall be checked for its lift off force. If the lift off forces of the adjacent tendons are greater than or equal to 95% of their Base Values in Table 4.6-1b, the single deficiency shall be considered unique and acceptable. For tendon(s) not conforming to 2

* For each inspection, the tendons shall be selected on a random but representative basis so that the sample group will change somewhat for each inspection; however, to develop a history of tendon performance and to correlate the observed data, one tendon from each group (dome, vertical, and hoop) may be kept unchanged after the initial selection.

these requirements, a determination shall be made as to the cause of the occurrence and the tendon(s) shall be restored to the required level of integrity.

If the lift-off force of the selected tendon lies below 90% of its Base Value, the tendon shall be completely detensioned and a determination made as to the cause of the occurrence. | 2

b. Determining that the average of the Normalized Lift Off Forces for each tendon group (vertical, dome and hoop) is greater than or equal to the minimum required average tendon force for the group. The minimum required average tendon force is 1195 kips for vertical tendons, 1115 kips for dome tendons, and 1181 kips for hoop tendons. The Normalized Lift Off Force for a tendon is obtained by adding the Normalizing Factor appearing in Table 4.6-2 to the lift off force. Failure to comply with this requirement may be evidence of abnormal degradation of the containment structure. | 1

If the Normalized Lift-Off Force of any tendon is less than the applicable minimum required average tendon force, an investigation shall be conducted to determine the cause and extent of occurrence. This investigation shall include as a minimum the measurement of lift-off forces of tendons adjacent to the deficient tendon to determine if the average of the tendon lift-off forces in this region of the containment is equal to or greater than the minimum required average tendon force. Failure to comply with this requirement may be evidence of abnormal degradation of the containment structure. | 1

c. Detensioning one tendon in each group (dome, vertical and hoop) from the representative sample. One wire shall be removed from each detensioned tendon and examined to determine:

1. That over the entire length of the tendon wire, the wire has not undergone corrosion, cracks or damage to the extent that an abnormal condition is indicated.

2. A minimum tensile strength value of 240,000 psi (guaranteed ulitmate strength of the tendon material) for at least three wire samples (one from each end and one at mid-length) cut from each removed wire.

d. Determining for each tendon in the above representative tendon sample, that an analysis of a sample of the sheathing filler grease is within the following limits:

1. Grease Voids	$\leq$ 5% of net duct volume
2. Chlorides	$\leq$ 10 PPM
3. Sulphides	$\leq$ 10 PPM
4. Nitrates	$\leq$ 10 PPM
5. Water Content	$\leq$ 10% by weight

SURVEILLANCE REQUIREMENTS (Continued)

If the inspections performed at 1, 3, and 5 years indicate no abnormal degradation of the tendon system, the number of sample tendons may be reduced to 3 dome, 3 vertical, and 3 hoop for subsequent inspections. Upon the completion of the five year inspection, the results of the first three inspections shall be evaluated to determine if an abnormal condition is evident for the tendon system. Based on the conclusions of this evaluation, the sample tendons with their Base Values and Normalizing Factors will be specified for all subsequent inspections. 1 2

4.6.1.6.2 At the same inspection frequency as the tendons, the structural integrity of the end anchorages of all tendons inspected pursuant to Specification 4.6.1.6.1 and the adjacent concrete surfaces shall be determined by a visual inspection and verifying that no abnormal material or structural behavior is evident.

4.6.1.6.3 At the same inspection frequency as the Type A containment leakage rate test, the structural integrity of the exposed accessible interior and exterior surfaces of the containment shall be determined prior to each Type A containment leakage rate test (Specification 4.6.1.2) by a visual inspection of these surfaces and verifying that no abnormal material or structural behavior is evident.

TABLE 4.6-1a

BASE VALUE OF TENDON FORCE

SURVEILLANCE TENDONS					
INSPECTION PERIOD					
1		2		3	
Tendon	Base Value (kips)	Tendon	Base Value (kips)	Tendon	Base Value (kips)
D-104	1275	D-125	1230	D-108	1287
D-129	1245	D-219	1258	D-121	1225
D-219	1265	D-228	1275	D-219	1254
D-328	1287	D-324	1273	D-312	1271
V-23	1328	V-23	1319	V-23	1313
V-46	1309	V-30	1287	V-37	1299
V-67	1332	V-53	1316	V-60	1294
V-92	1299	V-76	1315	V-83	1314
V-115	1322	V-99	1309	V-106	1296
3AC	1324	3AC	1313	3AC	1307
8BA	1272	13BA	1283	8CB	1254
13CB	1284	18CB	1264	18BA	1254
28CB	1263	28BA	1264	28AC	1261
38AC	1256	33CB	1282	33BA	1277
38BA	1253	36AC	1278	38CB	1230

TABLE 4.6-1b

BASE VALUE OF TENDON FORCE

ADJACENT TENDONS					
INSPECTION PERIOD					
1		2		3	
Tendon	Base Value (kips)	Tendon	Base Value (kips)	Tendon	Base Value (kips)
D-103	1245	D-124	1284	D-107	1241
D-105	1250	D-126	1262	D-109	1222
D-128	1296	D-218	1288	D-120	1284
D-130	1267	D-220	1291	D-122	1264
D-218	1296	D-227	1270	D-218	1281
D-220	1299	D-229	1235	D-220	1286
D-327	1244	D-323	1256	D-311	1266
D-329	1237	D-325	1227	D-313	1237
V-22	1306	V-22	1300	V-22	1295
V-24	1320	V-24	1317	V-24	1313
V-45	1308	V-29	1301	V-36	1284
V-47	1322	V-31	1327	V-38	1293
V-66	1309	V-52	1316	V-59	1308
V-68	1309	V-54	1298	V-61	1309
V-91	1309	V-75	1304	V-82	1297
V-93	1327	V-77	1313	V-84	1311
V-114	1313	V-98	1280	V-105	1297
V-1	1320	V-100	1300	V-107	1307
2AC	1277	2AC	1270	2AC	1264
4AC	1264	4AC	1252	4AC	1245
7BA	1324	12BA	1267	7CB	1303
9BA	1292	14BA	1263	9CB	1284
12CB	1285	17CB	1271	17BA	1261
14CB	1272	19CB	1287	19BA	1289
27CB	1277	27BA	1289	27AC	1297
29CB	1280	29BA	1272	29AC	1254
37AC	1283	32CB	1262	32BA	1259
39AC	1294	34CB	1232	34BA	1253
37BA	1294	35AC	1297	37CB	1276
39BA	1273	37AC	1275	39CB	1291

TABLE 4.6-2

NORMALIZING FACTORS (N.F.)

INSPECTION PERIOD					
1		2		3	
Tendon	N.F. (kips)	Tendon	N.F. (kips)	Tendon	N.F. (kips)
D-104	-24	D-125	36	D-108	-42
D-129	33	D-219	10	D-121	40
D-219	10	D-228	-28	D-219	10
D-328	-21	D-324	-12	D-312	-20
V-23	-15	V-23	-15	V-23	-15
V-46	11	V-30	31	V-37	- 5
V-67	-21	V-53	-24	V-60	11
V-92	25	V-76	-11	V-83	-15
V-115	-10	V-99	5	V-106	7
3AC	-56	3AC	-56	3AC	-56
8BA	18	13BA	-26	8CB	26
13CB	-23	18CB	29	18BA	34
28CB	26	28BA	17	28AC	10
38AC	40	33CB	-17	33BA	-16
38BA	40	36AC	0	38CB	54

3/4.6.1.6 REACTOR BUILDING STRUCTURAL INTEGRITY

This limitation ensures that the structural integrity of the containment will be maintained comparable to the original design standards for the life of the facility. Structural integrity is required to ensure that the containment will withstand the maximum pressure of 47.1 psig in the event of a steam line break accident. The measurement of containment tendon lift off force, the tensile tests of the tendon wires, the visual examination of tendons, anchorages and exposed interior and exterior surfaces of the containment, and the Type A leakage test are sufficient to demonstrate this capability.

The tendon lift off forces are evaluated to ensure that 1) the rate of tendon force loss is within predicted limits, and 2) a minimum required prestress level exists in the containment. In order to assess the rate of force loss, the lift off force for a tendon is compared with the force predicted for the tendon times a reduction factor of 0.95. This resulting force is referred to as the 95% Base Value. The predicted tendon force is equal to the original stressing force minus losses due to elastic shortening of the tendon, stress relaxation of the tendon wires, and creep and shrinkage of the concrete. The 5% reduction on the predicted force is intended to compensate for both uncertainties in the prediction techniques for the losses and for inaccuracies in the lift-off force measurements. 2

In order for the tendon lift off force to be indicative of the level of prestress force in the containment, each measured force must be adjusted for the known differences which exist among the tendons due to original stressing force and elastic shortening loss. This adjustment is accomplished through the use of a Normalizing Factor ($NF_i(t)$). This factor is added to the lift off force, which results in the Normalized Lift Off Force. The Normalizing Factor is given by:

$$NF_i(t) = \{F_{ave}(o) - F_i(o)\}\{1 - \frac{SR(t)}{100}\} + \Delta F_{es}^{T}\{\frac{N - 2n + 1}{2N}\}$$

$\{F_{ave}(o) - F_i(o)\}$ is the group average lock-off force at original stressing, minus the original stressing force for the specific tendon.

SR(t) is stress relaxation (percent) which occurs at time t after original stressing.

ΔF_{es}^{T} is the total elastic shortening tendon force loss.

n is the stressing sequence comprising the specific tendon.

N is the total number of stressing sequences for the group of tendons which comprise the specific tendons.

i refers to the specific tendon.

t refers to the time after original stressing of the current inspection period.

The surveillance requirements for demonstrating the containment's structural integrity are in compliance with the recommendations of Proposed Revision 3 to Regulatory Guide 1.35, "Inservice Inspection of Ungrouted Tendons in Prestressed

Concrete Containments, "April 1979, except that in place of the Lower Limit and 90% Lower Limit defined by these Regulatory Guides, the 95% Base Value and 90% Base Value, respectively, are used. 2

1.35 INSERVICE INSPECTION OF UNGROUTED TENDONS IN PRESTRESSED CONCRETE CONTAINMENT STRUCTURES (Revision 3; 4/79) 17

The surveillance program for the Virgil C. Summer Nuclear Station containment prestressing system is in compliance with the recommendations of Regulatory Guide 1.35 with the following exceptions and clarifications:

In place of the Lower Limit and 90% Lower Limit defined in this Guide, the 95% Base Value and 90% Base Value, respectively, are used. The Base Value is the force predicted for a tendon at the time of the surveillance. The Base Value is equal to the original stressing force minus the losses described in Proposed Regulatory Guide 1.35.1, "Determining Prestressing Forces for Inspection of Prestressed Concrete Containments," April 1979. In the calculation of the Base Value, zero tolerance has been applied to the losses. The losses are combined by considering a fraction of the tendon stress relaxation and concrete creep using the procedure described in "A Method for Predicting Prestress Losses in a Prestressed Concrete Structure" which appeared in the Prestressed Concrete Institute Journal, March/April 1972. 32

The Surveillance program is discussed in Section 3.8.1 and 16.4.