

CONTAINMENT SYSTEMS

CONTAINMENT STRUCTURAL INTEGRITY

LIMITING CONDITIONS FOR OPERATION

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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 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

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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 its Lower Limit indicated in Table 4.6-1a. If the lift off force of a selected tendon in a group lies between the prescribed Lower Limit and 90% of the Lower Limit, 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 their Lower Limits in Table 4.6-1b, the single deficiency shall be considered

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\* 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.

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### SURVEILLANCE REQUIREMENTS (Continued)

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unique and acceptable. For tendon(s) not conforming to 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 the prescribed Lower Limit, the tendon shall be completely detensioned and a determination made as to the cause of the occurrence.

- 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.

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.

- 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 ultimate 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

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### SURVEILLANCE REQUIREMENTS (Continued)

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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 and their Lower Limit Values will be specified for all subsequent inspections.

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

TENDON FORCE ACCEPTANCE CRITERIA

SURVEILLANCE TENDONS					
INSPECTION PERIOD					
1		2		3	
Tendon	Lower Limit (kips)	Tendon	Lower Limit (kips)	Tendon	Lower Limit (kips)
D-104	1251	D-125	1208	D-108	1260
D-129	1222	D-219	1233	D-121	1202
D-219	1241	D-228	1250	D-219	1228
D-328	1262	D-324	1249	D-312	1245
V-23	1303	V-23	1294	V-23	1288
V-46	1282	V-30	1262	V-37	1275
V-67	1307	V-53	1289	V-60	1269
V-92	1273	V-76	1288	V-83	1287
V-115	1296	V-99	1280	V-106	1273
3AC	1295	3AC	1287	3AC	1280
8BA	1250	13BA	1258	8CB	1230
13CB	1260	18CB	1240	18BA	1230
28CB	1242	28BA	1239	28AC	1238
38AC	1232	33CB	1257	33BA	1252
38BA	1230	36AC	1251	38CB	1211

TABLE 4.6-1b

TENDON FORCE ACCEPTANCE CRITERIA

ADJACENT TENDONS					
INSPECTION PERIOD					
1		2		3	
Tendon	Lower Limit (kips)	Tendon	Lower Limit (kips)	Tendon	Lower Limit (kips)
D-103	1225	D-124	1259	D-107	1217
D-105	1229	D-126	1238	D-109	1198
D-128	1271	D-218	1260	D-120	1256
D-130	1242	D-220	1262	D-122	1237
D-218	1272	D-227	1247	D-218	1253
D-220	1273	D-229	1211	D-220	1257
D-327	1222	D-323	1230	D-311	1240
D-329	1214	D-325	1204	D-313	1212
V-22	1281	V-22	1275	V-22	1270
V-24	1292	V-24	1284	V-24	1280
V-45	1285	V-29	1278	V-36	1262
V-47	1300	V-31	1300	V-38	1269
V-66	1283	V-52	1288	V-59	1282
V-68	1284	V-54	1273	V-61	1282
V-91	1286	V-75	1280	V-82	1273
V-93	1302	V-77	1289	V-84	1278
V-114	1289	V-98	1256	V-105	1271
V-1	1290	V-100	1273	V-107	1281
2AC	1257	2AC	1248	2AC	1242
4AC	1239	4AC	1230	4AC	1223
7BA	1296	12BA	1243	7CB	1272
9BA	1267	14BA	1239	9CB	1257
12CB	1260	17CB	1249	17BA	1233
14CB	1250	19CB	1262	19BA	1262
27CB	1254	27BA	1264	27AC	1268
29CB	1257	29BA	1248	29AC	1231
37AC	1260	32CB	1237	32BA	1230
39AC	1272	34CB	1211	34BA	1229
37BA	1273	35AC	1270	37CB	1252
39BA	1250	37AC	1250	39CB	1262

TABLE 4.1-2

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	40	38CB	54

## CONTAINMENT SYSTEMS

### BASES

#### 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 force is compared with the force predicted for the tendon. This predicted force includes a tolerance on force losses which are: +20% for concrete shrinkage, +25% for concrete creep, and +15% for stress relaxation. The resulting force is referred to as the Lower Limit force.

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:

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

$[F_{ave}(o) - F_i(o)]$  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.

$\Delta F_{es}^T$  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

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BASES (Continued)

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Concrete Containments," April 1979; and Proposed Regulatory Guide 1.35.1, "Inservice Surveillance of UngROUTED Tendons in Prestressed Concrete Containment Structures," April 1979.

## ARTICLE IWX-3000

## ACCEPTANCE STANDARDS

IWX-3100 GENERAL

The acceptance standards for various items (concrete, prestressing tendon components, liner deformations, etc.) of concrete containments shall be in accordance with IWX-3200, IWX-3300, IWX-3400, and IWX-3500.

IWX-3200 PRESTRESSED CONCRETE CONTAINMENT WITH UNGROUTED TENDONSIWX-3210 TENDON FORCE ACCEPTANCE CRITERIA

The containment shall be considered to have satisfied the prestressing system examination if the following tendon force (average of forces measured at both ends, if applicable) requirements are met:

- a. The average of all measured tendon forces for each type of tendon is equal to or greater than the minimum required prestress level at the anchorage for that type.
- b. The force measured in any individual tendon is equal to or greater than 95% of its predicted prestress force at the time of the test.
- c. The tendon force measured in any individual tendon divided by the total area of the effective prestressing elements which comprise the tendon, as defined in the Construction Specifications, shall not exceed 70% of the minimum specified ultimate strength of the prestressing elements.

In calculating the average force in part (a), each measured tendon force shall be corrected for initial installation conditions (actual anchorage force and elastic shortening loss during initial post-tensioning, and any other significant effects) so that the measured force is indicative of the average level of prestress.

The predicted prestress force at the time of the test in (b) may be determined by the method recommended in USNRC Regulatory Guide 1.35.1 or by an equivalent method.

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If the criterion of part (a) is not met, an investigation of the tendon system and structural integrity of the containment shall be conducted. The investigation shall include consideration of the design margins available in the containment design.

If the measured force in an individual tendon does not meet the criteria of part (b), but is equal to or greater than 90% of its predicted force, the force in adjacent tendons on each side of the individual tendon shall be measured. If the forces in these two tendons are equal to or greater than 95% of their respective predicted forces, the inspection program shall proceed considering the event unique and acceptable. The measured forces in adjacent tendons shall be included in the calculation of the average tendon force of part (a) of this section.

If the measured force in either of the adjacent tendons or in more than one of the original sample tendons is less than 95% of its predicted force, but is not less than 90% of its predicted force, the deficient adjacent tendon (a) and the inspection tendon shall be evaluated. If the reason for the deficiency cannot be determined, these tendons shall have their forces measured as additional tendons in the next scheduled inspection period in order to determine if the rate of force loss is significantly greater than predicted.

If the measured force in any tendon is less than 90% of its predicted force, the tendon shall be completely detensioned and a determination shall be made as to the cause of such an occurrence and corrective action shall be taken. In addition, all such tendons shall have their forces measured as additional tendons in the next scheduled inspection period.