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November 29, 1995
C311-95-2502

U. S. Nuclear Regulatory Commission
Att: Document Control Desk
Washington, DC 20555

Dear Sir:

Subject: Three Mile Island Nuclear Station, Unit 1 (TMI-1)
Operating License No. DPR 50
Docket No. 50-289
GPU Nuclear Response to NRC Request for Additional Information Regarding the TMI-1 20th Year Reactor Building Tendon Surveillance Test

Attached is the GPU Nuclear response to the NRC's August 31, 1995 request for additional information regarding Topical Report (TR) No. 093, entitled "Three Mile Island Unit 1 Reactor Building Twenty Year Tendon Surveillance (Inspection Period 6)." Our letter dated September 26, 1995 provided the GPU Nuclear schedule for responding.

Sincerely,

J. Knubel
Vice President and Director, TMI

MRK
Attachment

cc: Region I Administrator
TMI-1 Senior Project Manager
TMI Senior Resident Inspector

GPU NUCLEAR CORPORATION
THREE MILE ISLAND UNIT 1
TENDON SURVEILLANCE PROGRAM
RESOLUTION OF NRC QUESTIONS

PURPOSE

The purpose of this report is to address eight specific questions originated by the NRC concerning the results of the 6th tendon surveillance representing the 20th year of operation for the Three Mile Island Nuclear Station, Unit 1 Reactor Building.

REFERENCES

1. TMI Unit 1 Reactor Building, 20th year Tendon Surveillance, Inspection Period Number 6, Topical Report 093, Rev. 0, 3/95.

2. PSC Report #463 (2 Volumes), 20th Year Physical Surveillance of the Three Mile Island Unit 1 Containment Building.

3. Vendor Manual for Inland Ryerson, GPU Nuclear Manual No. VM-TM-2485, Rev. 3, 9/94.

4. Tendon Force Curves Calculation - Surveillances 6 through 10, DC-5390-225.01-SE, 4/94.

5. TMI Unit 1 Technical Specifications, Section 4.4.1.1, Amendment #167 and Section 4.4.2.1, Amendment #187.

6. FSAR Sections 5.2, 5.7, and Appendix 5B.

7. Force Curves Calculation, DC-5390-225.01-SE.

8. "Tendon Surveillance Requirements - Average Tendon Force," by J. F. Fulton, Nuclear Engineering and Design, October 1982, Page 303.

9. PSC Vendor Report for the fifth surveillance, 15th Year Physical Surveillance of the Three Mile Island Unit 1 Reactor Building, Revision 1, 3/90. (2 Volumes)

10. PSC Vendor Report for the fourth surveillance, 10th Year Surveillance of the Three Mile Island Unit 1 Reactor Building, Revision 1, 3/90. (2 Volumes)

11. First Period Surveillance Report, 1 year after SIT, GAI Report 1880.

12. NRC letter from Mr. Ronald W. Hernan, NRC Senior Project Manager to Mr. James Knubel, GPU Nuclear, dated August 31, 1995, a request for additional information listing 8 questions.

13. Regulatory Guide 1.35.1, Rev. 0, Determining Prestressing Forces For Inspection Of Prestressed Concrete Containments.

14. Regulatory Guide 1.35, Rev. 3, Inservice Inspection Of Ungrouted Tendons In Prestressed Concrete Containments.

NRC QUESTION NO. 1

Table VIII of the Reference 2 Surveillance Report refers to the tendon force base values from VM-TM-2485. Explain how the base values are established.

GPU NUCLEAR RESPONSE TO QUESTION NO. 1

The base values shown on the referenced tendon force curves are the result of individual tendon loss calculations specifically prepared for the TMI-1 Reactor Building surveillance periods. The base curve is equivalent to the prescribed lower limit as referred to in Regulatory Guide 1.35 and represents the summation of time dependent prestress losses as referred to in Regulatory Guide 1.35.1. The losses addressed in the TMI-1 calculations are the same as referred to in the Regulatory Guide and include:

1. Initial loss due to elastic shortening
2. Concrete shrinkage losses
3. Concrete creep losses
4. Steel wire relaxation losses

The force loss due to elastic shortening was calculated specifically for individual tendons in each of the three tendon groups. Individual tendon values were calculated based on a ratio of the total elastic shortening as determined for the entire group of tendons. The elastic shortening is dependent on the total number of tendon stressing sequences and the actual stressing sequence number used for the specific tendon.

Concrete shrinkage losses were calculated based on the time since average concrete placement, the E_S of the steel and the tendon area involved.

Concrete creep losses were calculated based on the time since average concrete placement, the E_S of the steel, the average stress on the transformed area, the tendon area involved, and Poisson's ratio.

Steel wire relaxation losses were calculated based on stress relaxation curves available from the wire vendor at the time of installation of the wire. A wire factor was also used to account for the effects of missing and ineffective wires on an individual tendon basis.

The above losses are calculated individually and summed to determine a total prestress loss for each individual tendon. These total losses are then deducted from the original force for the individual tendon at the time of installation. The resulting force-time curve is the base predicted tendon force curve for the life of the tendon. 95% and 90% base curves are then plotted on the same graph for evaluation of actual lift-off data against the acceptance criteria within Regulatory Guide 1.35, Revision 3. This allows for immediate action to be taken during the surveillance on adjacent tendons as required by the Regulatory Guide, based on the individual tendon lift-off results.

The curves contained in VM-TM-2485 include "lower limit" and "90% lower limit" values which are based on terminology in an earlier version of the Regulatory Guides. Recent calculations (Reference 4) were prepared to develop the force curves to be used for surveillances 6 through 10. These curves show the base curve, the 95% curve and the 90% curve plotted on the same graph.

This is consistent with the terminology used in Revision 3 of Regulatory Guide 1.35 and replaces those presented in the VM-TM-2485 document. The base curve values are the same in both documents, unless there has been a change in the number of effective wires within the tendon. The current criteria, methodology and design bases for the preparation of the individual tendon force curves has been maintained since their original preparation, with periodic reviews during prior surveillances. The intent of Regulatory Guide 1.35 has been maintained as it evolved from it's proposed revision issued in 1979. However, the tendon surveillance program and specifically, the calculation of the individual force curves may vary from the positions taken in Regulatory Guide 1.35.1, Revision 0, as formally issued in July, 1990. While GPU Nuclear has not committed to Regulatory Guide 1.35.1, Revision 0, the TMI-1 tendon program has a solid basis which meets the intent of Regulatory Guide 1.35, Revision 3.

NRC QUESTION NO. 2

Provide the lower bound tendon force curve or the tendon force as shown in Regulatory Guide 1.35.1, Revision 0, for each of the Figures (Attachments B, C, and D) in Topical Report 093.

GPU NUCLEAR RESPONSE TO QUESTION NO. 2

GPU Nuclear is not committed to Regulatory Guide 1.35.1, Rev. 0, and has not backfitted existing tendon calculations to determine tolerance bands for groups and subgroups of tendons.
The trending curves presented in the Topical Report as Attachments A, B and C were newly prepared for this surveillance period as a method of addressing Section 7.1.6 of Regulatory Guide 1.35, Revision 3, formally issued in 1990. The plotted data represents a trending line based on actual measured data results from the five prior surveillances, as well as the 20th year surveillance. The bases for these trend curves are further discussed in the response provided to NRC Question No. 3.

The request for a plot of the lower bound tendon force to be added to the existing Attachment B, C and D curves is not fully comparable with the existing plotted data making up the current trending curves. The primary reasons for this are:

- The Attachment trending curves were prepared as a method of addressing Section 7.1.6 of Regulatory Guide 1.35, Revision 3, and were not specifically set up to address the requirements of Section 4 and/or Figure 2 of Revision 0 of Regulatory Guide 1.35.1.

- Regulatory Guide 1.35.1 states that tolerance bands for groups and subgroups of tendons should be constructed and used for comparison of measured forces with predicted forces. The TMI force curves are set up so that each tendon has its own unique force curve representing the summation of individual prestress losses as discussed and reviewed in response to NRC Question No. 1. The base curve and the calculations for the individual prestress losses are based on a method and approach which has been in place for essentially the life of the plant.

- Regulatory Guide 1.35.1 presents a method for the easy construction of tolerance bands. However, the methods used in the preparation of the TMI-1 base curves involve decisions and assumptions made at the time of original design, which contain varying degrees of conservatism used for most of the variables that make up the predicted prestress force line, i.e., the established base curve. To provide the requested lower bound plot, GPU Nuclear would have to perform an in-depth review to understand how these same variations were considered in the original design and in the preparation of the base curves, and with what degree of conservatism. Otherwise, the construction and use of the tolerance bands as noted in Regulatory Guide 1.35.1, may provide for inappropriate results.

- While significant efforts have been made over the last 20 years to keep the TMI-1 tendon surveillance program up to the evolving Regulatory Guide criteria, the tendon force curves as originally prepared for TMI-1 have not been reviewed in depth for comparison with Regulatory Guide 1.35.1, issued in July, 1990. As such, there has been no formal commitment by GPU Nuclear for full compliance with Revision 0 of Regulatory Guide 1.35.1 for the TMI-1 tendon surveillance program. It would require additional work to evaluate the costs and benefits of backfitting for compliance, as well as any changes necessary to the tendon surveillance program.

NRC QUESTION NO. 3

For the Attachment B and other similar Figures within the Topical Report, explain how the lift-off force is represented by one value. Explain how this representative force is established and how the trend line was obtained. All the tendon lift-off forces for all surveillances should be used without any normalization and linear regression analysis should be performed to obtain the trend.

GPU NUCLEAR RESPONSE TO QUESTION NO. 3

The trending data and curves as presented in the Topical Report Attachments B, C and D were prepared new for this surveillance as a formal method of addressing Regulatory Guide 1.35, Revision 3, Section 7.1.6, formally issued in 1990. Liftoff data was tabulated on the following Tables attached herein.

Table 3.1	Dome Tendons Surveillance Data
Table 3.2	Vertical Tendons Surveillance Data
Table 3.3	Hoop Tendons Surveillance Data

The average lift-off force for each individual tendon, as measured (not normalized), is plotted on the individual force curve where it can be readily compared with the predetermined values of base, 95% base, and 90% base as required per the Regulatory Guide. If any measured, not normalized, lift-off force falls below the base value, the requirements of Regulatory Guide 1.35 are followed. The lift-off forces used to construct the trending curves shown in Attachments B, C and D in the Topical Report are normalized averages calculated from the average tendon lift-off forces measured for each tendon group during that surveillance.

The NRC request to use all lift-off forces and not use the normalization factor has been reviewed in depth. It is believed that it is more conservative to review the normalized data than the measured averages. To illustrate, suppose that the small sample of tendons as selected in a random but representative manner all had very high negative normalization factors, and the normalization factors were ignored in the trending plot. Then the plot of measured lift-off values would show a non-conservative trend line plotted higher in the vertical scale than that of the normalized data. By using the normalization factors, this small sample bias is eliminated and the average value obtained is representative of the average force condition for the inspected group. In addition, the normalization factor accounts for the effects on an individual tendon's initial lock-off force value resulting from tensioning adjacent tendons (see response to Question No. 4 for additional detail). If the normalization factors are not considered, the total losses experienced by the tendons cannot be appropriately determined.

The question of normalization of the input data has been recently addressed by Parsons Power (formerly Gilbert/Commonwealth) for the Crystal River plant where it was determined that it is more appropriate to use normalized lift-off data. Also, the use of averages vs. the use of all tendon data points was previously studied and discussed with the NRC for Crystal River. Through comparative analyses, it was determined that this variable did not have a significant effect on the resulting regression analysis at Crystal River. Similar comparative analyses of the TMI-1 data has been completed in response to this question with the following results.

Based on a comparison of individual data points vs. the averages for TMI-1, it has been determined that using all data points results in the steepest, and therefore the most conservative, slope curve. With respect to a comparison of normalized data vs. not normalized data, the results are mixed.

For the dome tendons, using the not-normalized data results in a steeper slope. However, for the hoop and vertical tendons, the normalized data provides the steepest slope. None of the above comparisons show any significant difference from one presentation of the data to the other. Therefore, since the NRC requested method is usually slightly less conservative, the curves selected for any data presentation herein use all lift-off data points without being normalized.

With respect to the linear regression, GPU Nuclear reviewed the tendon lift-off data points from all prior surveillances and concluded that the prestress loss was indeed larger in the early life of the plant, and that these losses now have leveled off significantly. A pure linear regression of the data points is therefore not appropriate and is not used. The curve selected is a best fit among all the data points considering a steeper slope in the initial years, and leveling out as losses are shown to have stabilized. The curve for the hoop tendons was prepared using engineering judgment as a best fit for the data points and is shown as Attachment B in the Topical Report.

Utilizing the data from Topical Report Attachment B, the hoop tendon curve has been duplicated herein using a mathematical regression best fit curve as shown in the attached Figure 3.1. This curve utilizes all lift-off points without being normalized. The results of this curve show that the regression line may fall below the minimum required prestress force for the hoop group in about 6 years. While this curve differs slightly from the curve contained in the Topical Report, it still shows that the tendon force values are expected to be above the minimum required value at the next surveillance. A similar curve will be generated after the next surveillance period to determine if forces remain at acceptable levels. If the results obtained in the 25th year surveillance indicate that forces would be expected to drop below the minimum required value, GPU Nuclear would take appropriate action.

TABLE 3.1
DOME TENDON SURVEILLANCE DATA

TENDON	PERIOD	DATE	AVG FORCE KIPS	AVG FORCE KIPS	NORMALIZED FACTOR KIPS	NORMALIZED FORCE KIPS	AVG NORM FORCE KIPS
D101	1	May-75	1252.0		40	1292.0	
D201	1st year	to	1278.0		-27	1251.0	
D301	after SIT	Jun-75	1269.0		37	1306.0	
D220			1253.0		9	1262.0	
D316			1259.0		-20	1239.0	
D116			1259.0		-19	1240.0	
				1261.7			1265.0
D130	2	Aug-77	1252.0		-7	1245.0	
D148	3rd year	to	1226.0		10	1236.0	
D202	after SIT	Oct-77	1273.0		-44	1229.0	
D219			1226.0		-42	1184.0	
D334			1247.0		-10	1237.0	
D348			1226.0		21	1247.0	
				1241.7			1229.7
D131	3	Mar-80	1180.0		-44	1136.0	
D147	5th year	to	1180.0		-19	1161.0	
D218	after SIT	Aug-80	1137.0		20	1157.0	
D203			1159.0		-40	1199.0	
D346			1169.0		19	1188.0	
D336			1221.0		-15	1206.0	
				1174.3			1174.5
D133	4	May-85	1100.0		70	1170.0	
D225	10th year	to	1117.0		45	1162.0	
D314	after SIT	Jun-85	1286.0		-54	1232.0	
				1167.7			1188.0
D145	5	Oct-89	1220.0		-34	1186.0	
D218	15th year	to	1147.5		20	1167.5	
D347	after SIT	Nov-89	1180.5		-40	1140.5	
				1182.7			1164.7
D141	6	Sep-94	1161.0		47	1208.0	
D225	20th year	to	1113.5		45	1158.5	
D248	after SIT	Nov-94	1188.5		9	1197.5	
				1154.3			1188.0

Minimum required prestress for Dome Group = 1140 kips

TABLE 3.2
VERTICAL TENDON SURVEILLANCE DATA

TENDON	PERIOD	DATE	AVG FORCE KIPS	AVG FORCE KIPS	NORMALIZED FACTOR KIPS	NORMALIZED FORCE KIPS	AVG NORM FORCE KIPS
V16	1	May-75	1348.0		-11	1337.0	
V27	1st year	to	1285.0		-26	1259.0	
V61	after SIT	Jun-75	1306.0		-22	1284.0	
V86			1285.0		9	1294.0	
V158			1306.0		-38	1268.0	
				1306.0			1288.4
V24	2	Aug-77	1283.0		-25	1258.0	
V48	3rd year	to	1275.0		32	1307.0	
V72	after SIT	Oct-77	1258.0		9	1267.0	
V97			1258.0		4	1262.0	
V119			1209.0		15	1224.0	
				1256.6			1263.6
V18	3	Mar-80	1274.0		-20	1254.0	
V31	5th year	to	1147.0		0	1147.0	
V55	after SIT	Aug-80	1211.0		-7	1204.0	
V105			1253.0		-44	1209.0	
V138			1211.0		-40	1171.0	
				1219.2			1197.0
V14	4	May-85	1243.0		-28	1215.0	
V30	10th year	to	1193.0		-10	1183.0	
V32	after SIT	Jun-85	1196.0		-8	1188.0	
V84			1203.0		-22	1181.0	
V160			1192.0		-7	1185.0	
				1205.4			1190.4
V19	5	Oct-89	1186.0		-9	1177.0	
V21	15th year	to	1185.0		-40	1145.0	
V22	after SIT	Nov-89	1169.0		-7	1162.0	
V23			1175.0		17	1192.0	
V50			1209.0		-31	1178.0	
V83			1193.0		-11	1182.0	
V84			1169.0		-22	1147.0	
V85			1179.0		4	1183.0	
				1183.1			1170.8
V32	6	Sep-94	1204.0		-8	1196.0	
V78	20th year	to	1289.0		-35	1254.0	
V126	after SIT	Nov-94	1205.0		19	1224.0	
				1232.7			1224.7

Minimum requirec prestress for Vertical Group = 1010 kips

TABLE 3.3
HORIZONTAL TENDON SURVEILLANCE DATA

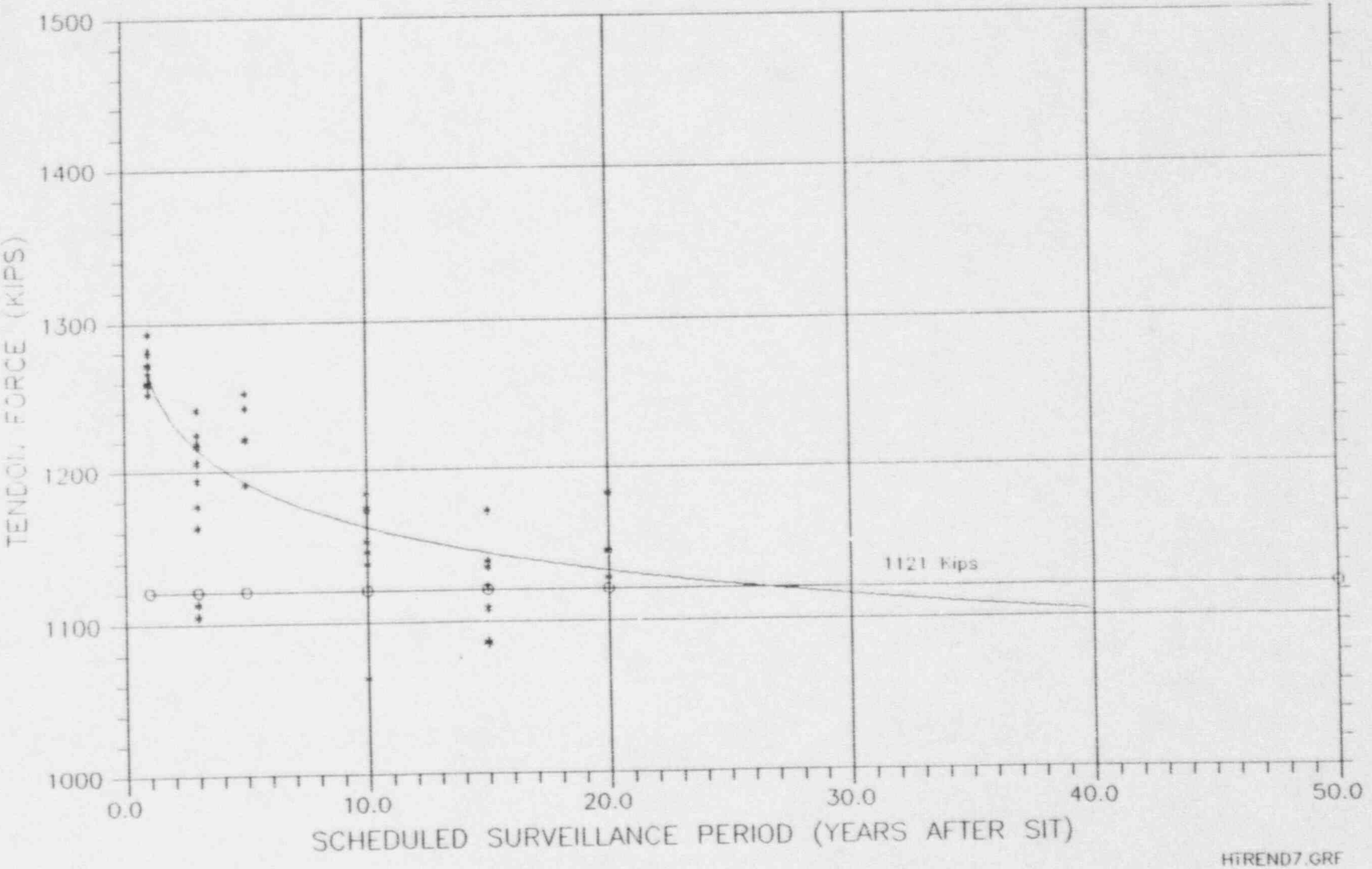
TENDON	PERIOD	DATE	AVG FORCE KIPS	AVG FORCE KIPS	NORMALIZED FACTOR KIPS	NORMALIZED FORCE KIPS	AVG NORM FORCE KIPS
H13-46	1	May-75	1260.0		50	1310.0	
H13-34	1st year	to	1273.0		31	1304.0	
H62-16	after SIT	Jun-75	1253.0		13	1266.0	
H62-10			1272.0		-30	1242.0	
H35-10			1259.0		8	1267.0	
H35-28			1282.0		-6	1276.0	
H13-28			1261.0		29	1290.0	
H51-12			1293.0		13	1306.0	
H24-21			1267.0		41	1308.0	
H24-47			1280.0		76	1356.0	
				1270.0			1292.5
H24-19	2	Aug-77	1105.0		19	1124.0	
H24-48	3rd year	to	1194.0		-22	1172.0	
H35-11	after SIT	Oct-77	1242.0		-52	1190.0	
H35-29			1219.0		43	1262.0	
H46-24			1225.0		-4	1221.0	
H46-28			1206.0		7	1213.0	
H51-13			1217.0		-46	1171.0	
H62-11			1163.0		62	1225.0	
H62-47			1113.0		84	1197.0	
H62-53			1177.0		64	1241.0	
				1186.1			1201.6
H62-57	3	Mar-80	1222.0		50	1272.0	
H24-49	5th year	to	1191.0		35	1226.0	
H46-32	after SIT	Aug-80	1253.0		-25	1228.0	
H46-30			1243.0		-13	1230.0	
H24-20			1253.0		-8	1245.0	
H24-28			1243.0		-20	1223.0	
H62-28			1243.0		-16	1227.0	
H35-16			1221.0		0	1221.0	
H62-10			1253.0		-30	1223.0	
H51-11			1243.0		-57	1186.0	
				1236.5			1228.1
H13-35	4	May-85	1184.0		-60	1124.0	
H13-36	10th year	to	1064.0		15	1079.0	
H13-37	after SIT	Jun-85	1175.0		-45	1130.0	
H24-26			1172.0		-24	1148.0	
H35-26			1153.0		17	1170.0	
H62-26			1138.0		2	1140.0	
H62-30			1146.0		4	1150.0	
				1147.4			1134.4
H24-29	5	Oct-89	1086.0		41	1127.0	
H24-30	15th year	to	1135.5		-36	1099.5	
H24-31	after SIT	Nov-89	1108.5		31	1139.5	
H24-51			1139.5		73	1212.5	
H46-34			1172.0		-27	1145.0	
H62-13			1087.0		59	1146.0	
H62-26			1122.5		2	1124.5	
				1121.6			1142.0
H24-40	6	Sep-94	1128.0		-5.0	1123.0	
H35-23	20th year	to	1184.0		-34.0	1150.0	
H35-47	after SIT	Nov-94	1182.0		-39.0	1143.0	
H62-26			1146.0		2.0	1148.0	
H62-49			1145.0		47.0	1192.0	
				1157.0			1151.2

Minimum required prestress for Hoop Group = 1121 kips

Three Mile Island Unit #1
Tendon Surveillance Program
Hoop Group Trend of Losses

Min. Required Avg. Liftoff Force
Tendon Forces – Not Normalized

FIGURE 3.1



NRC QUESTION NO. 4

In Table IX of the Reference 2 document, the normalizing factor and normalizing lift-off forces are shown. Explain how GPU Nuclear obtained the normalizing factors expressed in terms of forces.

GPU NUCLEAR RESPONSE TO QUESTION NO. 4

Table IX of the Reference 2 PSC Report shows the average lift-off values corrected with the normalization factor and then averaged for comparison with the minimum required prestress force for that group of tendons. This computation has been performed for all surveillances to date.

Normalization factors are a function of the original stressing sequence, the lock-off force at the original stressing, the average original tendon lock-off force, the wire stress relaxation percentage and the calculated elastic shortening loss, as well as other specific considerations for TMI-1. Normalization factors are calculated at the time the individual tendon force loss curves are generated and are documented in the Reference 4 calculation. The values are included within the current revision of the surveillance procedure and are shown on every individual tendon force curve. The expression for the basic normalization factor used for TMI-1 is as follows:

$$NF_i\,(t) = [\{F\,(0) - F_i\,(0)\} * \{1 - Sr\,(t)\} + ES * \{(N - 2n + 1) / 2N\}]$$

Where:

$NF_i\,(t)$ is the normalization force of a particular tendon (kips).

$F\,(0)$ is the Average Tendon Force for the Group (kips).

$F_i\,(0)$ is the Original Average Force for the Tendon (kips).

$Sr\,(t)$ is the stress relaxation (% /100) for the wire at time t, from test data.

ES is the Total Elastic Shortening Loss (kips) for that group of tendons.

N is the total number of stressing sequences for the tendon group.

n is the stressing sequence for the particular tendon.

The basis for this expression was derived and is documented in the paper, "Tendon Surveillance Requirements - Average Tendon Force," by J. F. Fulton, Nuclear Engineering and Design, October 1982, Page 303 (Reference 8). Mr. Fulton was actively involved with the subject of tendon surveillance and normalization factors for many years and contributed to the development of the current Regulatory Guides.

NRC QUESTION NO. 5

Provide force-elongation information in the requested format for each detensioned and retensioned tendon at the required 1/3 and 2/3 increments as required by Regulatory Guide 1.35. Prepare graphs showing the linear force-elongation relationship for each tendon. Explain and discuss the implications if not linear.

GPU NUCLEAR RESPONSE TO QUESTION NO. 5

Tables 5.1, 5.2 and 5.3 are attached and represent the force-elongation data collected in accordance with the requested NRC format for each of the detensioned and retensioned tendons. This includes data and graphs for three tendons; tendon D248, V-78, and H35-47 which were detensioned and retensioned in the surveillance. A legend and list of definitions used for the data gathered for these tables is provided as follows:

Legend:

PTF Force : The PTF force is used as the basis for the elongation measurement and is the pretensioned force necessary to bring the tendon into a lightly stressed condition to remove slack and seat the buttonheads. For TMI-1, a force equivalent to 1000 psi ram pressure was used as the basis for the PTF.

1/3 Increment: The 1/3 increment is the tendon force determined at a gauge pressure equivalent to 1/3 the overstress force pressure as required by Regulatory Guide 1.35, Subsection 4.2

2/3 Increment: The 2/3 increment is the tendon force determined at a gauge pressure equivalent to 2/3 the overstress force pressure as required by Regulatory Guide 1.35, Subsection 4.2.

LOF Force: The lock-off force is that force at which the tendon load is transferred to the shim stack from the ram, and is the force left in the tendon after retensioning.

OSF Force: The overstress force is that force where maximum elongation is determined, typically at a value of 80% of the Guaranteed Ultimate Tensile Strength (GUTS) for the tendon.

Figures 5.1, 5.2 and 5.3 were also prepared as requested and are attached. These figures represent the plotted force-elongation relationship for the three retensioned tendons.

The resulting force-elongation plots show very good linearity as the tendon is retensioned through the 1/3 and 2/3 increment points and up to the OSF. The graphs of all three tendons show excellent linear correlation between the measured incremental elongation and the force in the tendon during the retensioning process. For Hoop Tendon H35-47, the LOF is somewhat off the linear slope. This condition occurs because the shims have a finite thickness and can compress under load. This results in the LOF being a step function rather than a linear function. The LOF point is also taken after reversing the tensioning direction downward from the OSF, rather than during the retensioning process as all other points are established.

GPU Nuclear Corporation
Three Mile Island Unit 1
20th Year Tendon Surveillance

Force and Elongation Measurement Data
for Retensioned Tendon

Table 5.1

TENDON: D248

FORCE	KIPS (k)	REF.	PRESSURE (psi)	REF.	ELONGATION (in)	REF.
PTF	210	Ref. 1 Row 1	1130	Ref. 1 Row 6	4.10	Ref. 1 Row 7
Step 1 1/3 Increment	495	Ref. 1 Row 10	2625	Ref. 1 Row 10 Avg.	5.65	Ref. 1 Row 11
Step 2 2/3 Increment	989	Ref. 1 Row 12	5210	Ref. 1 Row 12	8.20	Ref. 1 Row 13
LOF	1225	Table X1 Page 26 Avg.	6448	Table X1 Page 26 Avg.	9.60	Data Sht. 3 Shim Thickness
OSF	1484	Ref. 1 Row 15	7805	Ref. 1 Row 9 Avg.	11.10	Ref. 1 Row 14

Total Elongation (actual) = (LOF - PTF) = 9.6 - 4.1 = 5.5"

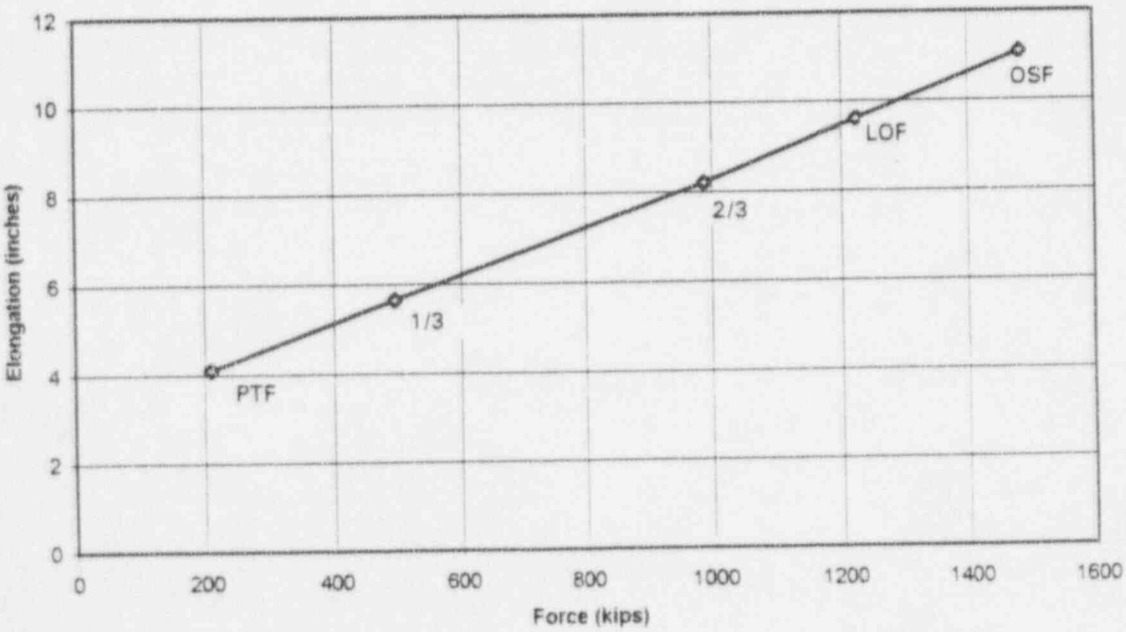


Figure 5.1
Tendon D248 : Force-Elongation relationship during retensioning

GPU Nuclear Corporation
Three Mile Island Unit 1
20th Year Tendon Surveillance

Force and Elongation Measurement Data
for Retensioned Tendon

Table 5.2

TENDON: V78

FORCE	KIPS (k)	REF.	PRESSURE (psi)	REF.	ELONGATION (in)	REF.
PTF	210	Ref. 1 Row 1	1000	Ref. 1 Row 6	4.50	Ref. 1 Row 7
Step 1 1/3 Increment	493	Ref. 1 Row 10	2340	Ref. 1 Row 10 Avg.	7.25	Ref. 1 Row 11
Step 2 2/3 Increment	739	Ref. 1 Row 12	3500	Ref. 1 Row 12 Avg.	9.40	Ref. 1 Row 13
LOF	1347	Table X1 Page 26	6383	Table X1 Page 26	15.00	Data Sht. 3 Shim Thickness
OSF	1478	Ref. 1 Row 15	7000	Ref. 1 Row 15	16.30	Ref. 1 Row 14

Total Elongation (actual) = (LOF - PTF) = 15.0 - 4.5 = 10.5"

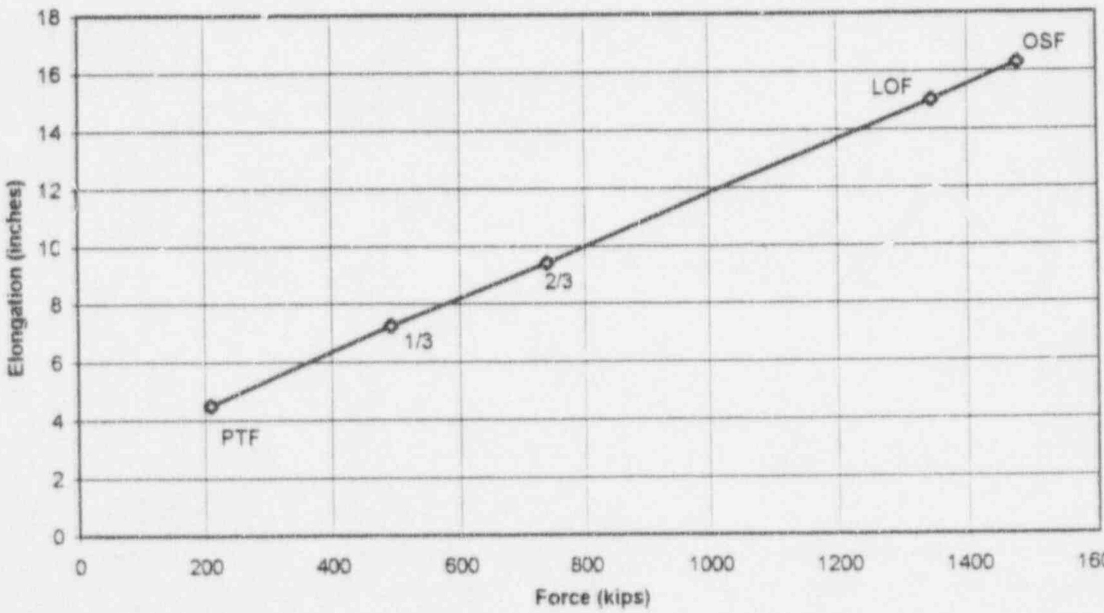


Figure 5.2
Tendon V78 : Force-Elongation relationship during retensioning

GPU Nuclear Corporation
Three Mile Island Unit 1
20th Year Tendon Surveillance

Force and Elongation Measurement Data
for Retensioned Tendon

Table 5.3

TENDON: H35-47

FORCE	KIPS (k)	REF.	PRESSURE (psi)	REF.	ELONGATION (in)	REF.
PTF	210	Ref. 1 Row 1	1130	Ref. 1 Row 6	7.30	Ref. 1 Row 7
Step 1 1/3 Increment	521	Ref. 1 Row 10	2755	Ref. 1 Row 10 Avg.	9.60	Ref. 1 Row 11
Step 2 2/3 Increment	1042	Ref. 1 Row 12	5490	Ref. 1 Row 12 Avg.	13.35	Ref. 1 Row 13
LOF	1219.5	Table X1 Page 26 Avg.	6419	Data Sht. 2 Page 25 Avg.	15.90	Data Sht. 3 Shim Thickness
OSF	1564	Ref. 1 Row 15	8225	Ref. 1 Row 9 Avg.	17.45	Ref. 1 Row 14

Total Elongation (actual) = (LOF - PTF) = 15.9 - 7.3 = 8.6"

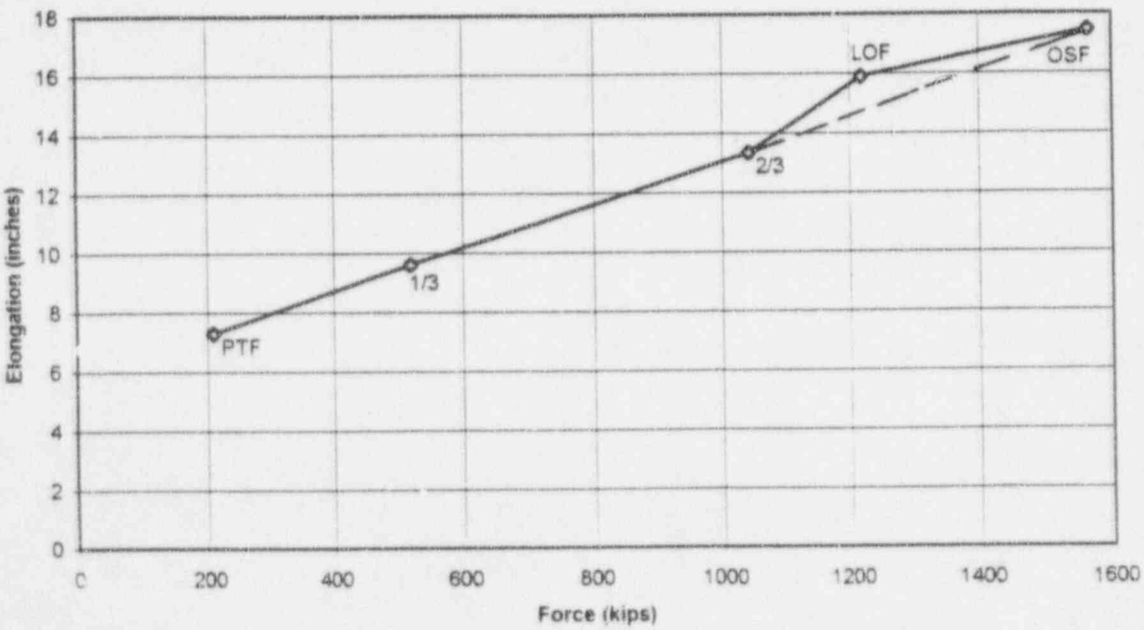


Figure 5.3
Tendon H35-47 : Force-Elongation relationship during retensioning

NRC QUESTION NO. 6

Based on the information in Table II, and in the Summary of Data Sheets SQ 6.1 contained in the PSC report, you inspected only the grease caps of the upper ends of the vertical tendons. Provide assurance and bases that there is no water in the lower grease caps of the vertical tendons.

GPU NUCLEAR RESPONSE TO QUESTION NO. 6

The referenced Table II (Reference 2) is a summary of numerous inspections made for the presence of water in the tendon conduit. The shop end of the vertical tendons is at the top of the tendon as designated in the Table. The field end is the bottom of the vertical tendons and the results of the inspection of the field end are also tabulated in the same Table. Thus, the lower grease caps of the vertical tendons were inspected. The results of the various inspections determined that none of the vertical tendons had any water present during this surveillance period.

The surveillance procedure requires that individual tendon data inspection sheets, 6.1, be completed for each tendon. These sheets were completed for each vertical tendon end and are presented in Appendix A, pages A3 to A8 of the PSC report. The inspection results indicate no water was detected at either the upper or lower ends of all vertical tendons inspected. In fact, examination of all data sheets from pages A3 to A24 indicates that no water was found in any tendon as a result of this surveillance inspection.

Similar results, data sheets and conclusions are presented for other tendons in Tables XV and XVI in the PSC Report (Reference 2). Note that Table I of the PSC Report also documents the results of laboratory analyses of the sheathing filler for chlorides, sulfides, nitrate and % water content. Results for the water content % indicate an insignificant amount of water (< 0.10 %) was found in all samples in the Table.

NRC QUESTION NO. 7

What significance does the anchorage thread measurement data, as presented in the Summary Report and Data Sheets, have on the results of the tendon lift-off.

GPU NUCLEAR RESPONSE TO QUESTION NO. 7

There is no significance of the measurement of anchorage thread diameters on the results of tendon lift-off testing. The purpose of PSC Procedure SQ 7.1, Data Sheet 8 is to assure that the anchorage and specific stressing adapter meet the minimum strength requirement of 110% of the minimum Guaranteed Ultimate Tensile Strength of a tendon. The results of this inspection as performed for this surveillance are presented in Table III of the PSC Report.

The procedures and related text within the surveillance procedure provide for the complete assurance of thread engagement during the lift-off, retensioning and detensioning process. The procedures and data sheets were further discussed with Mr. Ron Hough of PSC Corporation. Mr. Hough explained that he had first-hand knowledge of earlier problems with the Inryco system threads because the Military Specification bases for the threads was in error. As a result of a 1991 failure of internal threads on one of the tendon anchor heads at Oconee 1, the NRC issued Information Notice 91-80. Computer analyses have been performed and completed on thread designs. The PSC procedures, as presented in the GPU Nuclear procedure assure that this will not occur at TMI-1 during any surveillance. The only affect these procedures and data measurement activities have on the lift-off process is that it assures a safe working environment and prevents inadvertent damage to the tendon anchorage components.

NRC QUESTION NO. 8

Reference Table IV, Summary of Data Sheets 1, 2, 3 and 4. Corrosion conditions as presented for the shims indicate nearly all shims have visible oxidation. Explain why such conditions exist although the shims are enclosed in grease cans.

GPU NUCLEAR RESPONSE TO QUESTION NO. 8

The data presented on corrosion in the reference Table IV indicate that level 2 corrosion is commonly noted for the shims inspected in this surveillance. Specific data sheets which were used to record the inspection data are included on pages A45, A46 and A47 in the Reference 2 PSC report. Corrosion levels are defined in Table 2 of Enclosure 6 in Surveillance Procedure 1301-9.1. Corrosion level 1 is defined as "Bright metal, no visible oxidation, and corrosion level 2 is defined as "Metal reddish brown, no pitting".

To investigate this condition, previous surveillance reports were reviewed from the fifth, fourth and first surveillance periods. Data sheets 6, 7 and 8 of the Reference 9 and 10 Reports record the corrosion levels of shims and were reviewed. Data sheets 1, 2, and 3 of the Reference 11 Report record shim corrosion levels and were also reviewed. It was determined that these same corrosion levels existed for all the tendons listed in each of these past surveillance reports. Furthermore, it was determined that these same corrosion levels are commonly noted for other anchorage components inside the cap, such as the stressing washer and the buttonheads.

Based on the above findings and the knowledge of the field conditions and long duration it took to typically install the prestressing system, it is concluded that this level of corrosion has been present since the time of original installation. There have been no incidents in the past where prior surveillances have uncovered unusual conditions related to the components inside the tendon caps. Also, there has been no increase in corrosion levels or problem wire test results. Therefore, it is concluded that these low corrosion levels have existed for some time and have not propagated. The effects on the integrity of the anchorage or tendon as a whole are negligible.