April 16, 1982

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Docket No. 50-244
LS05-82-04-047

Mr. John E. Maier
Vice President
Electric and Steam Production
Rochester Gas & Electric Corp.
89 East Avenue
Rochester, New York 14649

Dear Mr. Maier:

SUBJECT: SEP TOPIC III-7.A, INSERVICE INSPECTION INCLUDING PRESTRESSED CONCRETE CONTAINMENTS WITH EITHER GROUTED OR UNGROUTED TENDONS R. E. GINNA NUCLEAR POWER PLANT

Reference: Letter dated February 12, 1982, from J. E. Maier to D. M. Crutchfield

In the above reference you supplied comments to the December 28, 1981 draft SER on theaabove topic. The staff has reviewed your comments.

The schedule for implementing the modifications of Topic III-7.A will be determined as part of the integrated assessment. The review of your tendon report concerning tendon relaxation will not be completed for approximately two months. The SER for III-7.A assumes resolution of the tendon relaxation problem. Should any restrictions be imposed as a result of reviewing your tendon report on relaxation which are more restrictive than the requirements of this topic, those requirements would govern.

We agree with visual inspection of the top anchorages only since the lower anchorages are inaccessible. We agree with submitting a report only if abnormal degradation is detected; however, due to the tendon relaxation problem experienced at Ginna, a peport describing the results of at least the next two tendon ISIs should be submitted after performing each ISI. The final safety evaluations for Topics VI-2.D "Mass and Energy Release for Possible Pipe Breaks Inside Containment" and VI-3 "Containment Pressure and Heat Removal Capability" confirmed that a 60 psig maximum containment internal pressure is the appropriate desgn value for the Ginna containment. This value was used in our enclosed final evaluation of SEP Topic III-7.A.

SE04 Add: Gary Staley
S/1 Allan Wang

Sincerely,

Original signed by

DSU USE EX(7)

Dennis M. Crutchfield, Chief
Operating Reactors Branch No. 5
Division of Licensing

AD:SA:DL
GLainas
4/16/82

Enclosure:
As Stated

*See previous Concurrence

OFFICE	cc: See next page	SEPB*	SEPB*	SEPB*	SEPB	ORB#5	ORB#5
SURNAME		DPersinko:bl	KHerring	RHermann	WRussell	JLyons	DCrutchfield
DATE		4/7/82	4/7/82	4/7/82	4/13/82	4/14/82	4/16/82

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We agree with visual inspection of the top anchorages only since the lower anchorages are inaccessible. We agree with submitting a report only if abnormal degradation is detected; however, due to the tendon relaxation problem experienced at Ginna, a report describing the results of at least the next two tendon ISIs should be submitted after performing each ISI.

This letter completes the review of SEP Topic III-7.A.

Sincerely,

Dennis M. Crutchfield, Chief
Operating Reactors Branch No. 5
Division of Licensing

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*See previous concurrence

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OFFICE	See next page	SEPB *	SEPB *	SEPB *	SEPB	ORB#	ORB#
SURNAME		DPersinko:bl	KHerring	RHermann	WRussell	JLyons	DCrutchfield
DATE		4/ 7/82	4/7/82	4/ 7/82	4/ /82	4/ /82	4/ /82

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The schedule for implementing the modifications of Topic III-7.A will be determined as part of the integrated assessment. The review of your tendon report concerning tendon relaxation will not be completed for approximately two months. The SER for III-7.A assumes resolution of the tendon relaxation problem. Should any restrictions be imposed as a result of reviewing your tendon report on relaxation which are more restrictive than the requirements of this topic, those requirements would govern.

We agree with visual inspection of the top anchorages only since the lower anchorages are inaccessible. In general, we agree with submitting a report only if Technical Specification limits are not met; however, due to the tendon relaxation problem experienced at Ginna, a report describing the results of at least two subsequent tendon ISIs should be submitted after performing each ISIS

This letter completes the review of SEP Topic III-7.A.

Sincerely,

Dennis M. Crutchfield, Chief
Operating Reactors Branch No. 5
Division of Licensing

SEPB
KHerring
4/7/82

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Mr. John E. Maier

R. E. Ginna
Docket No. 50-244
Revised 3/30/82

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SYSTEMATIC EVALUATION PROGRAM

TOPIC III-7.A

R. E. GINNA

TOPIC: III-7.A, Inservice Inspection Including Prestressed Concrete Containments With Either Grouted or Ungrouted Tendons

I. INTRODUCTION

This topic reviews the inservice inspection program of all Category I structures including steel, reinforced concrete and prestressed concrete containments. The objective is to assure that the licensees inspection program will detect any structurally significant deterioration of Category I structures in order that the structures will be capable of performing their necessary functions.

II. REVEIW CRITERIA

Review criteria for this topic is Regulatory Guide 1.35, Revision 2, "Inservice Inspection of Ungrouted Tendons in Prestressed Concrete Containment Structures," as interpreted in the Standard Technical Specifications dated August 15, 1979. Also, ISI requirements are described in CFR, Part 50, Appendix J, Part V.A.

III. RELATED SAFETY TOPICS

1. Topic III-7.C, "Delamination of Prestressed Concrete Containment Structures."

2. Topic III-7.D, "Containment Structural Integrity Test."

3. Topic VI-2.D, "Mass and Energy Release for Possible Pipe Break Inside Containment."

4. Topic VI-3, "Containment Pressure and Heat Removal Capability."

IV. REVIEW GUIDELINES

With the exception of containment, there currently exists no detailed inservice inspection (ISI) requirements for safety-related structures. CFR, Part 50, Appendix J, Section V.A., requires a general inspection of accessible interior and exterior surfaces of containment structures for any structural deterioration prior to performing Type A leak tests. No other guidelines are given. CFR, Part 50, Appendix J is currently being rewritten in TAP A-23 to clarify ISI requirements. ASME Section XI is currently considering ISI requirements for steel and concrete containments. The extent to which this section of the code will be implemented on existing nuclear power plants will be determined when the code is issued and receives NRC endorsement. Therefore, the only applicable portion of this topic is that part dealing with ISI requirements of tendons in prestressed concrete containments with current criteria defined in Regulatory Guide 1.35, Revision 2.

Since there has been much discussion and interpretation regarding Regulatory Guide 1.35, Revision 2 by licensees and architect-engineers, the NRC has recently contracted with Oak Ridge National Laboratory (ORNL) to conduct a study and make recommendations concerning ISI requirements for prestressed containments. The purpose is to use ORNLs results to assist the NRC in issuing a revised Regulatory Guide 1.35. The ORNL report is expected to be completed by the end of 1981 and the revised Regulatory Guide 1.35 is expected to be issued by mid to late 1982. Implementation of the revised Regulatory Guide 1.35 on existing plants will be determined after the revised guide is issued.

V. EVALUATION

A. Background

The containment at Ginna incorporates unique design features. It relies on prestressed, grouted rock anchors at the base to resist pressure and seismic loads. The grouted rock anchors are attached to vertical, ungrouted tendons in the walls. The containment only contains vertical prestressing tendons located in the sidewalls; a total of 160 tendons.

Only two of the rock anchor couplings are accessible and both are located in high radiation areas.

There is presently no NRC criteria governing the design and inspection of rock anchors; however, Regulatory Guide 1.90 describes ISI requirements for grouted tendons. Although Regulatory Guide 1.90 is not intended to govern the ISI of rock anchors, similarities between the grouted prestressed rock anchors and grouted tendons exist and it is presently the only criteria which could possibly be used as guidance to define ISI requirements for rock anchors. Regulatory Guide 1.35 describes ISI requirements for ungrouted tendons and governs the ISI of the wall tendons.

Regulatory Guide 1.90 states that the major concern in containments with grouted tendons is possible corrosion of the tendon steel and that this may remain undetected. Regulatory Guide 1.90 requires a) force monitoring of ungrouted test tendons, b) monitoring performance of grouted tendons, and c) visual examination of the structure. To monitor the performance of grouted tendons, two alternatives are given. One alternative is to monitor prestress loss by instrumenting the wires and sections of the structure. The other alternative is to monitor deformation of the structure during pressure testing.

At Ginna, the main function of the rock anchors is to act as an anchor point to maintain prestress in the ungrouted tendons. Regulatory Guide 1.35 requires lift-off testing of the tendons, visual inspection of

critical areas of the structure and wire mechanical tests and inspection. Should there be unusual relaxation in the rock anchors, this would be detected during lift-off testing since, when performing the lift-off tests, the entire tendon-rock anchor system is being tested.

The containment design is based on an average tendon prestress of 636^k, .6 x the guaranteed ultimate tensile strength (GUTS) of the tendons. During installation, the rock anchors were stressed to .8 GUTS and locked off at .7 GUTS, resulting in a 14% overstress. At a meeting held on February 19, 1981 attended by members of the NRC staff, licensee's staff and their consultants to discuss the tendon relaxation at Ginna, calculations were presented giving tendon force, and hence the applied load to the rock anchors, for the design loading combinations. These calculations were based on an initial tendon force of 636^k. The maximum calculated tendon force for the factored load combinations is 660^k/tendon. This results in the rock anchors having been proof-tested at time of installation to a load 28% greater than those obtained from the factored load combinations when the tendon force is 636^k. This factor is reduced to 11% immediately after lock-off when the tendon force is .7 GUTS (742^k). Also, the licensee has stated that in June 1980, 137 of the 160 tendons were retensioned to between .7 to .735 GUTS and were overstressed to 1.06 of this lock-off value. This results in the tendons being stressed to 19% greater than the loads calculated using factored load combinations based on an initial tendon force of 636^k. Doing the same calculations based on an initial tendon force of .7 GUTS (immediately after lock-off) results in the rock anchors having been proof tested during the 1980 retensioning to a load 3% greater than those calculated for the factored load equations.

In addition to actual rock anchor overstressing, three tests were performed on scaled-down rock anchors installed in the vicinity of the Ginna containment to demonstrate grout bond. Results of the bond tests indicated a minimum factor of safety against slip of 1.8.

After slip occurred, the rock anchor resisted additional load up to 2.6 x the design load in two of the three tests. In one of the tests, jacking was stopped at 2.08 x the design load to avoid damage to the jack due to excessive slippage. The minimum bond stresses at slippage in the tests were 250 psi at the rock-grout interface and 130 psi at the wire-grout interface. The maximum bond stresses experienced by the actual rock anchors in the field occurred shortly after initial tensioning (.8 GUTS), resulting in a 171 psi rock-grout stress and 45 psi wire-grout stress. Comparing these stresses to the minimum scale test slip stresses results in factors of safety against slip of 1.5 for the rock-grout and 2.9 for the wire-grout. At tendon forces corresponding to factored load conditions, these factors of safety become 1.6 and 3.0 when initial tendon force is .735 GUTS (maximum June 1980 retensioning value) and 1.9 and 3.7 when initial tendon force is .6 GUTS.

At tendon ultimate (GUTS), these factors of safety become 1.2 and 2.3.

The above indicates that the rock anchors have margin to resist load beyond those calculated using the factored load combinations. It also implies that the tendon will fail before the rock anchor.

The technical specifications at Ginna require a 6% overstress above lift-off to be performed on all 14 surveillance tendons. This would verify the ability of the tendons and rock anchors to resist the factored loads calculated to occur during an accident and/or seismic event since the 6% overstress would induce higher loads than those calculated. Therefore, Ginna's ISI will be governed by Regulatory Guide 1.35 since the lift-off tests would satisfy the intent of Regulatory Guide 1.90 for monitoring the performance of grouted tendons, in this case the rock anchors.

The results of the 1977 tests at Ginna indicated a relaxation substantially in excess of those predicted. Further testing was performed in 1979 indicating the same. As stated above, to obtain the required prestress, in June 1980, 137 of the 160 tendons were retensioned between .7 and .735 of the guaranteed ultimate tensile stress (GUTS) which is the original prestressing force.

This forms a new time zero and ISI was to be conducted at 1, 3, 5 years and every 5 year thereafter, as Regulatory Guide 1.35, Revision 2 requires. As a result of the unusual relaxation, RGE is currently performing tests on tendon wires at Lehigh University to better understand the cause of this abnormality. Results should be available in January 1982. Currently, there are continuous reading load cells on four tendons as part of the augmented ISI program at Ginna.

The following time frame is applicable to the containment at Ginna:

Prestressing of rock anchors	Fall 1966
Prestressing of Tendons	March-April 1969
Structural Integrity Test	April 1969
6 month ISI	October 1969
1 year ISI	May 1970
3 year ISI	May 1972
8 year ISI	June 1977
10 year ISI	October 1979
Retensioning of all tendons - New time zero	June 1980
New 1 year ISI	July 1981

B. Current Criteria

For the 1, 3, and 5 year inspections, current criteria requires the inspection and lift-off testing of 5 vertical tendons randomly and representatively distributed.

If these results indicate no problems in the tendons, sample size for the ten year and subsequent inspections is decreased to three vertical tendons. Visual inspection of tendon anchorage assembly hardware and surrounding concrete is required. The concrete around the anchorage should be checked during the integrated leak test while the containment is at maximum pressure. Lift-off testing requires measurement of jacking force and elongation and comparison of these to predetermined allowables. Tendon detensioning is required to identify broken or damaged wires.

One wire from one tendon should be removed for examination for corrosion and tensile testing. Three tensile tests are required for each wire. Sheathing filler grease must be inspected for grease coverage of the anchorage system, influence of temperature variations, voids in the trumpet, and requirements imposed by grease specifications.

Acceptance criteria are that the prestress force for each tendon should be "within the limits predicted for the time of the test." There should be no more than one tendon value outside of these limits. If a tendon is found outside these limits, one tendon on each side should be no more than one tendon value outside of these limits. If both of these are found acceptable, the low reading tendon is considered unique and not indicative of a problem; however, if either of these adjacent tendons also reads low or more than one tendon in the entire group of similar (dome, hoop, vertical) tendons reads below set limits, it is considered unacceptable. All tensile test values should be greater than or equal to the guaranteed ultimate strength of the material.

C. Testing Requirements at Ginna

According to Ginna's current technical specifications, 14 tendons are to be inspected for broken wires and lift-off tested. The inspection intervals are at six months, one year, three years, eight years, and every five years thereafter. Acceptance criteria are that no more than 38 wires are broken in 14 tendons nor more than six wires in any one tendon. Should more than 38 wires be broken, all tendons shall be inspected. If six broken wires are found in one tendon, four immediately adjacent tendons shall be inspected. There shall be no more than four broken wires in any of the four tendons. Acceptance criteria for the lift-off tests is that the average stress of the 14 tendons shall be greater than .60 of the ultimate stress.

D. Discussion

The tendon surveillance program now in effect at Ginna has deviations from Regulatory Guide 1.35, Revision 2, some of which are unacceptable and discussed below.

For all lift-off tests, acceptable lift-off test limits were the minimum effective design prestress (.6 GUTS) as the lower limit and no upper limit. An upper limit is required as it is an indication of abnormality if tendon prestress force is measure too high and also some concrete degradation may occur if tendon prestress is too high. The lower limit is the force relied on to resist design loads.

Regulatory Guide 1.35, Revision 3 and 1.35.1 were issued for comment to clarify the intent of the present Regulatory Guide 1.35. The intent of Regulatory Guide, Revision 2 is that the limits for each tendon vary with time so that one can identify trends in the rate of prestress loss. Measured tendon forces for each tendon should be within these limits and not average tendon force.

The objective is to track prestress loss with time so that rates of prestress loss can be determined and compared to those assumed in design, thus identifying potential problems before they actually occur.

For Ginna, the number of tendons to be tested for lift-off exceeds current criteria by two to three times. The test frequency at Ginna, although listed in the technical specifications as every 1, 3, 8 years and every 5 years thereafter, has been changed in subsequent correspondence to agree with current criteria. The retensioning establishes time zero and inspections will occur every 1, 3, 5 years and 5 years thereafter. The program at Ginna only addresses wire breakage and lift-off testing and does not address other aspects that are listed in Regulatory Guide 1.35, Revision 2. The acceptable lift-off requirement does not meet current criteria because the existing technical specifications at Ginna require that the average of the 14 tendon stresses be greater than a value which remains constant and does not vary with time. Current criteria requires that each tendon fall within acceptance limits that vary with time and that the average of all lower bound acceptance limits falls above the minimum effective design prestress at 40 years, after correcting for initial losses.

VI. CONCLUSIONS

There are some deviations in the technical specifications which govern the tendon surveillance program in effect at Ginna. The following conclusions are applicable to Ginna upon the completion of any augmented ISI programs in effect because of the accelerated stress relaxation problem.

At Ginna, two to three times as many tendons are tested than required by Regulatory Guide 1.35, Revision 2; however, Regulatory Guide 1.35 does not address rock anchors and one of the items being tested during a lift-off test is the ability of the rock anchor to resist pullout. Criteria governing the number of rock anchors to be tested does not exist, although Regulatory Guide 1.90 requires, as one alternative, prestress monitoring of three vertical tendons. Since a substantially greater number of tendons are tested than required by either Regulatory Guide 1.35 or 1.90, it is judged that testing 14 tendons at Ginna will be adequate to detect any defects in the rock anchors.

By testing two to three times as many tendons as required by Regulatory Guide 1.35, more credence is given to the use of an average value. However, in addition to requiring the average to be above the minimum average design prestress level, acceptance limits which vary with time should be established for each tendon. To assure that each tendon is tracking with time as predicted, all tendon lift-off forces should be compared to the time dependent acceptance limits predicted for those tendons.

Because the tendons at Ginna have been retensioned and because the behavior of retensioned wires is unknown, it is not possible to establish these limits. The licensee has indicated that one of the results expected from the Lehigh tests currently being performed is the behavior of retensioned wires. Therefore, the acceptance bands for each tendon should be established after analyzing the Lehigh test results. Those tendons not meeting the acceptance criteria should be handled as described in Section 7 of Regulatory Guide 1.35, Revision 2. The results should be measured as tendon force not wire stress although, should wire breakage occur, wire stress must remain below acceptable limits during retensioning.

The technical specifications at Ginna do not include the additional considerations of Regulatory Guide 1.35, Revision 2 and these considerations as described below should be implemented during future tendon surveillances.

Although not in Ginna's technical specifications, visual inspection of tendon anchorage assembly hardware was conducted during this last inspection. It should be performed during all future inspections.

Concrete surrounding the top end anchorage of prestressing tendons lift-off tested during the previous tendon inspections should be visually inspected during the integrated leak rate tests while the containment is at maximum test pressure. The surrounding concrete should be viewed for any unusual cracking. Cracks larger than .01 inch as described in ASME Section III, Division 2, Subsection CC-6000 should be noted and evaluated. Any changes should be noted and evaluated during subsequent inspections. The bottom anchorages are the rock anchors and are inaccessible for visual inspection for visual inspection.

Since only two rock anchor-tendon couplings are accessible, it is only possible to detension and remove previously stressed wires from these two tendons to inspect for corrosion and perform mechanical tests. These two couplings are located in high radiation areas. However, the Ginna containment does contain 40 tendons with one surveillance wire per tendon that is not stressed, but is exposed to the same atmosphere as the other tendons. Inspections and mechanical tests should be performed on one of these wires per inspection as described in Regulatory Guide 1.35, Revision 2, Section 5 with the corresponding acceptance criteria described in Section 7. Although testing and inspecting these non-stressed wires would not exactly duplicate testing and inspecting stressed wires, it would give indications of possible deleterious effects of the stressed wires. Also, additional margin exists at Ginna regarding material acceptability because 14 tendons are being tested and because of the wire breakage requirement described below.

Regulatory Guide 1.35, Revision 2, does not give specific criteria regarding wire breakage; however, it states that identification of broken wires in a tendon is required. At Ginna, there has been no wire breakage and therefore, if wire breakage were to occur now, it may be indicative of an abnormality. In future tests, any wire breakage noted should be included in the inspection report with reasons for the occurrences. Inspection of the filler grease should be performed during future inspections as described in Section 6 of the same Regulatory Guide.

Normally, we would agree with submitting a report only if abnormal degradation is detected; however, due to the tendon relaxation problem experienced at Ginna, a report describing the results of at least the next two tendon ISIs should be submitted after performing each ISI. In the report, lift-off test results and their corresponding acceptance limits should be shown.

The Technical Specifications at Ginna should be changed to the current Standard Technical Specifications modified to agree with this SER where differences from the Standard Technical Specifications are relied upon.

The schedule for implementing the modifications of this topic will be determined as part of the integrated assessment. This topic evaluation assumes resolution of the tendon relaxation problem. Should any restrictions be imposed as a result of the review of your tendon report on relaxation which are more restrictive than the requirements of this topic evaluation, those requirements would govern.