Response to Public Comments on Draft Regulatory Guide (DG)-1197 "Inservice Inspection of Prestressed Concrete Containment Structures with Grouted Tendons"

Proposed Revision 2 of Regulatory Guide (RG) 1.90

A notice that Draft Regulatory Guide, DG-1197 (Proposed Revision 2 of RG 1.90) was available for public comment was published in the *Federal Register* on April 28, 2011 on page 76 FR 23845. The Public Comment period ended June 26, 2011. Comments were received from the organizations and individuals listed below. The U.S. Nuclear Regulatory Commission (NRC) has combined the comments and NRC staff disposition in the following table.

Comments were received from the following:

James H. Riley
Nuclear Energy Institute
1776 I Street NW, Suite 400
Washington, DC 20006-3708
Phone: 202-7398137
Fax: 202.533 0193
jhr@nei.org
ADAMS Accession No.
ML11173A065

Etienne GALLITRE
Chef de Groupe Génie Civil
Electricity de France
EDF - DIN
SEPTEN/GS
12-14 avenue Dutrievoz
69628 Vileurbanne cedex
etienne.gallitre@edf.fr
Tél. : 04 72 82 71 60
ADAMS Accession No.
ML12178A428

Gayle Elliott
Gayle.elliott@areva.com
ADAMS Accession No. ML11188A068

Item	Comments	By	NRC Response
1	Discussion of corrosion should be removed from this document or clearly linked solely to visual examination as it is misleading in the current context.	NEI-1	The NRC staff does not agree with the comment requesting the removal of the discussion of corrosion on page 4. Wide-spread corrosion will cause distress to a containment structure. In Regulatory Position C.2 visual examination is listed as one element of a recommended ISI program. However, the availability of visual examination is limited for grouted tendons. Also, with the advancement of the technology, detection of corrosion is now possible through non-destructive examination (NDE). The intent of the Regulatory Guide (RG) is to use both visual and instrumented monitoring as part of a containment ISI program as opposed to solely relying on visual examinations.

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2	Page 4, item "c": The effect of differential thermal expansion or contraction on the internal stress state of the containment would be very minor within operational temperature limits.	NEI-2	The staff agrees that the change is "very minor within operational temperature limits." However, the existing language is correct because licensees need to consider that the factors discussed may be cumulative.
3	The term "elastic shortening" is used throughout. Does this refer to curing shrinkage? If so, it is misleading. Please use a more descriptive term.	NEI-3	The staff agrees that the usage of the term "elastic shortening" without further explanation may be misleading and, therefore, has added a definition for "elastic shortening" in the glossary section of the RG.
4	Page 5, item "c": The use of fiber optic Bragg grating strain sensors can be very simply temperature compensated and have been used in geological applications in recent years. I would strongly advocate their usage for this application.	NEI-4	The staff disagrees with this comment. The staff believes that the item is acceptable as written and the agency cannot recommend one particular brand name because there are other brands that are acceptable for purposes of the RG.
5	Page 5, last paragraph states "Any significant decrease in the stiffness of the structure because of loss of prestress would result in cracking of the structure under pressure." Stiffness is a function of Young's modulus of the steel and would be constant. This should probably be worded differently. In addition, local cracking suggests a local tensile field had been reached. It is not necessarily indicative of general internal stress state of the structure.	NEI-5	The staff does not agree with the comment "stiffness is a function of Young's modulus of the steel and would be constant." Stiffness is also a function of the effective cross sectional area of steel and concrete; not only the steel. Under a pressure load, prestress steel is designed and used to control the extent and width of the cracks. Therefore, a significant loss of prestress generally results in cracking of the concrete structure. The staff guidance is retained as written.
6	Page 6, second paragraph mentions deformation in millimeters. Giving a strain value would be much more useful because it is normalized by gauge length.	NEI-6	The staff does not agree with the comment. The paragraph is discussing deformation monitoring for Alternative B. The intent is to monitor deformations at locations where these deformations are measurable (hence the minimum value specified). The staff does not believe that specifying strains is appropriate because deformations would not necessarily be measured using strain gauges. This is also consistent with American Society of Mechanical Engineers (ASME) CC-6410(c) for initial structural integrity testing (ISIT).
7	Page 6, last paragraph: Concrete having a pulse velocity < 4000m/s being indicative of poor quality is a somewhat dubious statement	NEI-7	The staff agrees with the comment, and modified the paragraph to more clearly state that concrete pulse velocity below 4,000 meters per second could indicate concrete of questionable quality, and that visual

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	and should be mechanically tested. Pulse velocity alone is not sufficient to characterize mechanical properties.		examination may need to be supplemented by other methods, (e.g. impact hammer or pullout test) to characterize the mechanical properties of the concrete.
8	Page 7, Figure 1: Linearity of the bound lines assumes Young's modulus of the concrete is constant with time, hence the estimate may be somewhat conservative. The NRC may consider allowing utilities exceptions if they can demonstrate that a change in Young's modulus in the plant concrete over time merits a recomputation of bound lines.	NEI-8	The staff agrees with the comment. Compliance with the regulatory guide is not required. Also, in paragraph 2 of page 5 the NRC recommends that "an applicant establish a band of acceptable prestress levels <u>similar</u> to that illustrated in Figure 1."
9	Page 8, last item a. 1-3: Suggest adding some language as to placement of surveillance tendons, e.g., at 120 deg spacing for vertical tendons.	NEI-9	The staff agrees with the comment because recommendation for placement of surveillance tendon is important. See Figure 3 for changes. Figure 3 "Containment diagram showing typical locations of test tendons and instrumentation" shows the placement of surveillance tendons, e.g., at 120 deg spacing for vertical tendons and dome tendons. No change has been made for the 120 deg (in other words 60 deg) family. The staff has added a diagram for dome tendons at 90 deg.
10	Page 10, 3.1.1.b: Recommend changing the language of these three items to denote "Parallel to tendons." Using "along" suggests the tendons themselves are instrumented.	NEI-10	The staff agrees with the comment and has used the suggested wording in C.2.2.1.1.b. (2), (3) and (4) to improve the clarity of the RG.
11	Page 10, 3.1.2.a.(3) and page 12, 3.1.2.c: Strain values would be more useful here. Calculation would be based on lower bound of Young's modulus and Poisson's ratio for concrete within spec.	NEI-11	The staff does not agree with the comment. The identified paragraph is discussing prestress level monitoring for Alternative A. The intent is for the instruments to withstand cyclic compression loading during the life of the nuclear power plant. The staff does not believe specifying strains is appropriate because cyclic compression loading is more naturally specified in terms of stress. Stresses can be converted to strains as needed (depends on site-specific Young's modulus and Poisson's ratio).
12	Page 14, 5.1.a: Consider removing "tendon" and replacing with "post tensioning direction."	NEI-12	The staff agrees in part with this comment because the proposed change will add clarification. Staff replaced the word "tendon" with "post-tensioning direction." The sentence in 5.1.a has been revised to read "in the direction of the tendon (post-tensioning direction)."
13	Page 2, Section B, Discussion, Background, 3rd. paragraph, line 2: Change the ultimate strength value for the grouted tendon from 1,625 tons to 1,725 tons. The EPR tendon	AREVA-1	The staff agrees with the comment. According to Section 3.8.1.6.3, of the U.S. Evolutionary Power Reactor (U.S. EPR) Final Safety Analysis Review Tier 2, Revision 2, there are 55 seven-wire strands in each tendon. The ultimate strength is 270 ksi and the tendon cross section is

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	ultimate design strength is nominally 1,725 tons. There are no known impacts to the ISI objectives in the guide by making this change.		12.76 in^2. This results in an ultimate strength of 3445.2 kips or 1722.6 tons, close to the nominal value provided. The statement has been revised to say 1725 tons.
14	Page 5, Section B, Discussion, Monitoring Alternatives for Grouted Tendons, Monitoring the Prestress Level and Pressure Testing (Alternative A), last paragraph, line 5: The pressure testing interval in the first 10 years should be consistent with the Integrated Leakrate Testing frequency in 10 CFR 50, Appendix J, Type A testing. Both the ILRT and Pressure Testing requires the unit to be shutdown and the containment pressurized. This is a significant impact on the plant availability. The test frequency must be consistent.	AREVA-2	The staff agrees with the comment in part. The staff recognizes the cost-effectiveness aspect of the comment. However, monitoring the prestress level and pressure testing is part of "Examination of Concrete Containments" which is mandated by 10 CFR 50.55a(b)(2)(viii), which incorporates ASME Section XI, IWL. The ASME ISI at 5 year intervals was established by industry data and research and judged to be a sufficient time period to detect trending in degradation. Therefore, the inspection interval of 5 years in the RG is required by the ASME code. ILRT is mandated by 10 CFR 50.54(o) which is subject to the requirements set forth in Appendix J to 10 CFR Part 50 Industry may be able to develop operational experience data to support a change to either of these rules. However, since these rules are currently in effect, the staff's recommendation for pressure testing must remain as stated. Licensees may schedule integrated leak rate testing (ILRT) and pressure testing at the same time if appropriate to optimize plant shutdown.
15	Page 8, Section C. Regulatory Position, paragraph 1.d: Same comment as item 2. Test interval should be consistent with the ILRT for both Alternative A and Alternative B.	AREVA-3	See staff's response to AREVA-2.
16	Page 8, Section C. Regulatory Position, paragraph 2.a, item (3): Add gamma tendons, the representative manner for testing a gamma tendon is "two gamma tendons for the design using two 90 degree families of tendons." The US EPR design utilizes a gamma tendon for dome prestressing. The gamma tendon is anchored at the base of the containment in the tendon gallery and extends vertically up and over the dome and is anchored at the dome ring girder.	AREVA-4	The staff agrees and has revised the RG as follows because the comment is to add the tendon type that is used for new design of US EPR: 1. The staff added the following statement to the background discussion in Section B at the end of paragraph 6: "The gamma tendon is anchored at the base of the containment in the tendon gallery and extends vertically up and over the dome and is anchored at the dome ring girder." 2. The staff also added the following item (4) to Regulatory Position C.2.a: "two gamma tendons for the design using two 90-degree families of tendons."
17	For completeness, the requirements for the	AREVA-5	The staff agrees that referencing the requirements for the inspection of

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	inspection of greased tendons in RG 1.35 should be included in DG-1197. RG 1.35 is applicable to nongrouted containments. The requirements for inspection of the greased tendons in ungrouted test tendons in the grouted containment should be added to DG-1197.		greased tendons in RG 1.35 would contribute to the completeness of the RG and therefore has added a sentence to Regulatory position C.2.1.c to refer to Regulatory Guide 1.35.
18	Page 9, Figure 2: Same comment as item 2. Test interval should be consistent with the ILRT. Also the test interval shown after 10 years should reflect once every 10 years for Alternative B.	AREVA-6	The staff disagrees with this comment and will retain the test frequency for Alternative B at 5-year intervals. The test frequency is based on ASME code, section XI, IWL-2400 which is required by 10 CFR 50.55a. See also the staff response to AREVA-2.
19	Page 10, paragraph 3.1.1.b.(3): same comment as item 4. Add gamma tendons.	AREVA-7	The staff agrees and has added instrument locations parallel to gamma tendons to Regulatory Position -C.2.2.1.1.b.(4). See also the staff response to AREVA-4.
20	Page 11, Figure 3: Add figure for dome tendons that are at 90 degrees. Indicate two typical locations for test tendons and instrumentation across the center of the dome at 90 degrees.	AREVA-8	The staff agrees with this comment because it will add more clarity. The staff has revised Figure 3 to show dome tendons. Figure 3 also indicates typical locations for test tendons and instrumentation across the center of the dome at 90 degrees.
21	Page 12, paragraph 3.1.4.a: Same comment as item 2. Test interval should be consistent with the ILRT. Note that the relaxed test frequency is recognized in this paragraph for Alternative B, whereas, it is only recognized for Alternative A in Regulatory Position 1.d.	AREVA-9	The staff disagrees with this comment. Alternative A allows for a relaxation in the pressure testing frequency because additional monitoring of the containment structure is performed by instrumentation. See also the staff response to AVERA-2.
22	Page 14, paragraph 4.2.a.(1), "Inspection of Anchorage Assemblies": Add gamma tendons. "A minimum of 4 gamma tendons, two of which are located in each 90 degree group (two families of tendons), randomly distributed to provide random sampling.	AREVA-10	The staff agrees with this comment and has added a fourth item to Regulatory Position C.2.3.3.a.(4). According to Section 3.8.1.1.2 of U.S. EPR FSAR Tier 2, Revision 2, a total of 104 gamma tendons divided into two groups are placed 90 degrees apart in the reactor containment building dome. See also the staff response to AREVA-4.
	Background: Just before "Force Monitoring of		The staff reviewed the comment and determined that the final version of RG 1.90 is clear abourt frequency. Refer section B.2, C.2.2, and Figure

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23	Ungrouted Tendons" we could add "Periodic pressure tests are more frequent for alternative B than for Alternative A" (which is the case in the figure of the RG). We think this point as a background element is also important.	EDF-1	2,
24	In France we instrument current zones of dome and cylinder wall; with a high redundancy level - these gauges can effectively be interpreted. We have some doubt about our capacity to interpret gauge distributed "in the concrete" near tendons—-it is possible but as the stress diffuse in the structure, the connection between measurement and cable is not obvious.	EDF-2	The staff agrees with this comment because the minimum requirement is for pressure testing. For monitoring by instrumentation, high redundancy level is recommended which is also covered in the RG. The staff has deleted the last sentence in Regulatory Position C.2.2.1.1.b which stated "Figure 3 delineates the typical planes and tendons." The staff added the following sentence to Regulatory PositionC.2.2.1.1.c. "Figure 3 delineates the minimum requirements of the typical planes and tendons for pressure testing." Redundancy level of instruments is stated in section B and C2.2.1.1.c.
25	The NEA report about August 1997 in Civaux says that stress cells in the concrete were deficient (Belgium article). It is possible to measure directly stress in concrete, but it is difficult task we perform only in special occasions, not for containment periodic measurements.	EDF-3	The staff agrees with the comment on the deficiency of "stress cells." However, the RG recommends the use of several types of instrumentation in addition to the use of "stress meters" and provides a statement that the complete understanding of instrumentation readings is required. Therefore, the RG is sufficient as written.
26	Alternative A is very well described in Section a. Section b could explain which zones have to be monitored (presenting this one as a minimum which has to be measured during the all life time-—that is to say which need redundancy and replaced if needed). Our minimum locations are for EdF is: Dome (center/two directions); Cylinder wall (two locations/two directions); Gouset (two location/two directions). This minimum locations need a very large redundancy to confirm measurement error, to detect any structural abnormal behavior if suspected and to manage gauges lifetime. These local instruments are completed by other devices such as invar wire located near the "minimum areas" for validation.	EDF-4	The staff agrees that these minimum locations need a very large redundancy in order to establish measurement error, to detect any structural abnormal behavior, and to manage gauges over their lifetime. Also, the staff agrees that the local instruments at these minimum locations are complemented by other devices such as invar wire located near the "minimum areas" for validation. Therefore, the staff has added text to Regulatory Position C.2.2.1.c to this effect. See also the staff response to comment EDF-2.

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27	Section C could be modified, only by writing "…shall…to measured strain, temperature in concrete. This minimum device can be completed by other instruments to measure stress and other parameters in concrete, bars and tendons." Effectively the total number of gauges may be 250 to 300 (at the beginning).	EDF-5	The staff disagrees with this comment. The commenter suggests that the staff specify the total number of gauges to be used (at the beginning). The guide, as written, provides a reference to current industry practice for the total number of gauges at existing plants. However, the total number of instruments may vary from plant to plant. Also specifying the number of instruments at the beginning only may be misinterpreted to mean that licensees do not need to maintain the instruments throughout the life of the structure. The NRC expects an appropriate number of instruments to be retained operable for the whole service life of the structure.
28	Section 3.1.3.a: There is a little ambiguity about the word "interpretation." Does it mean that the licensee has to produce a report every 2 months? Or has to produce a report where data corresponding to a 2-month period are interpreted?	EDF-6	The staff agrees that the use of the word "interpret" alone is ambiguous and has added the phrase "(review recorded data to determine prestress level)" after the word "interpret" in the second sentence of C.2.2.1, subsection "Monitoring Instrumentation Functionality," bullet a. to improve clarity.
29	General comment on Alternative B: Several containments in France without any loss of rigidity during pressure test have shown a loss of pre-stress in concrete due to concrete creep, it is the reason why we explain to US/EPR staff that it would be better not to have "zero" permanent instrument (minimum with very few redundancy).	EDF-7	The staff acknowledges the commenter's statement. The staff is investigating the general comment that "several containments in France without any loss of rigidity during pressure test have shown a loss of pre-stress in concrete due to concrete creep." NRC guidance may be revised if this research indicates that the current recommendation is not sufficient. This is noted as a future action.