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NL-10-120

December 16, 2010

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

SUBJECT: Entergy Nuclear Operations Inc.
Clarification of Previously Submitted Information
Use of Air Entrainment Admixture in Structural Concrete
Indian Point Nuclear Generating Unit Nos. 2 & 3
Docket Nos. 50-247 and 50-286
License Nos. DPR-26 and DPR-64

REFERENCE:
1. Entergy Nuclear Operations Inc. Letter NL-08-169, "Additional Information Regarding License Renewal Application-Operating Experience Clarification," dated November 6, 2008
2. Entergy Nuclear Operations Inc. Letter NL-09-056, "Reply to Request for Additional Information (RAI)-Open Items Items," dated May 1, 2009

Dear Sir or Madam:

Entergy Nuclear Operations, Inc is providing, in Attachment 1, a clarification to the referenced letters (Reference 1 and 2) and related sections of the LRA regarding use of air entrainment admixture for Unit 2 and 3 structural concrete. The clarification is a result of recently completed additional reviews of concrete test reports for Indian Point Units 2 and 3 structural concrete including further reviews of the original concrete design specifications.

If you have any questions, or require additional information, please contact Mr. Robert Walpole at 914-734-6710.

A128
NRR

I declare under penalty of perjury that the foregoing is true and correct. Executed on 12/6/10.

Sincerely,

FRD/cbr

Attachment: 1. License Renewal Application Structural Concrete Clarification

cc: Mr. William Dean, Regional Administrator, NRC Region I
Mr. Sherwin E. Turk, NRC Office of General Counsel, Special Counsel
Mr. Kenneth Chang, NRC Branch Chief, Engineering Review Branch I
Mr. John Boska, NRR Senior Project Manager
Mr. Paul Eddy, New York State Department of Public Service
NRC Resident Inspector's Office
Mr. Robert Callender, Vice President NYSERDA

ATTACHMENT 1 TO NL-10-120

LICENSE RENEWAL APPLICATION LICENSE RENEWAL APPLICATION STRUCTURAL CONCRETE CLARIFICATION

ENTERGY NUCLEAR OPERATIONS, INC.
INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 & 3
DOCKET NOS. 50-247 AND 50-286

INDIAN POINT NUCLEAR GENERATING UNIT NOS. 2 AND 3
LICENSE RENEWAL APPLICATION
STRUCTURAL CONCRETE CLARIFICATION

Clarification Regarding Use of Air-entrainment Admixture for IP2 and IP3 Structural Concrete.

Entergy recently completed additional review of concrete test reports for IP2 and IP3 structural concrete as well as further review of the original concrete design specifications for both units. Based on these reviews, Entergy has confirmed that the IPEC containment concrete was designed and constructed in accordance with the 1963 or later version of ACI 318, "Building Code for Reinforced Concrete" and meets the specified minimum compressive strength of 3,000 psi at 28 days.

As a result of these reviews, Entergy is providing a clarification to letters NL-08-169, NL-09-056 and related sections of the LRA. This clarification relates to the use of air entrainment in IPEC structural concrete. In particular, NL-08-169 states that the "specification .... requires air-entrained concrete." This statement was based on site specification CE-PS 70-70, "All Stations - Reinforced Concrete", dated 9/2/1970 (applicable to both units), which specified the use of air entrainment from 4% to 6%. However, review of the earlier specifications which were in effect during initial IP2 and IP3 containment construction, 9321-01-69-1, "Batch Plant, Ready-Mixed Concrete", dated February 14, 1966 (for Unit 2) and 9321-05-69-1, "Batch Plant, Ready-Mixed Concrete", dated May 17, 1968 (for Unit 3), indicates that those specifications allowed, but did not require, use of air entrainment admixtures. These earlier specifications were consistent with ACI 318, the code of record for the construction of IP2 and IP3. See ACI 318, Section 406(a) ("Air-entraining admixtures, *if used*, shall conform to "Specifications for Air-Entraining Admixtures for Concrete" (ASTM C 260)."). In September of 1970, Specification CE-PS 70-70 required use of air entrainment, which was used for the remainder of IP2 and IP3 containment concrete.

Review of the concrete test reports for IP2 indicates that most of the Unit 2 concrete was placed without using an air entrainment admixture. Specifically, for IP2 concrete pours that occurred from 1967 through 1969, the associated concrete test reports do not include an entry for percentage of air content and the only admixture identified is Placewell, which is a water-reducing admixture. In contrast, the IP3 concrete test reports for pours occurring in 1971 and 1972 document specific percentage air contents indicating that the majority of IP3 containment concrete was placed using an air-entrainment admixture (Airecon). The use of Airecon appears to coincide with approval of specification CE-PS 70-70.

The limited use of air entrainment admixture in IP2 containment concrete (air entrainment admixture was used in some of the final IP2 containment concrete pours) does not alter Entergy's conclusions concerning the quality of IP2 containment concrete. As explained in NL-09-056, the strength and durability of concrete depend largely on its permeability; i.e., the pore structure of the concrete, including the tortuosity of any flow paths. Concrete permeability is a function of multiple factors, including the water-cement ratio; cementitious material content; the hardness of aggregates; the gradation of aggregates; the use of admixtures; and curing, drying, and compaction processes.

As discussed in ACI codes (e.g., 318, 363 and 201.2R), air entrainment is intended to increase the resistance of concrete to the potential adverse effects of de-icing agents (salts or other chemicals) and cyclic freezing (i.e., freeze-thaw conditions). Although air-entraining admixture was not used for most of IP2 concrete containment and some of IP3 containment, IP2 and IP3 concrete were designed in accordance with ACI-318, which specified requirements for mixing, placing, and curing the concrete to assure the required strength and

durability of the concrete for each application. Importantly, IP2 and IP3 concrete structures are not exposed to salt or other de-icing agents that could be detrimental to these structures. The concrete most exposed to possible freeze-thaw conditions is the concrete on the exterior surfaces of structures, which is readily visible for periodic inspection. Extensive inspection history has shown no degradation of IP2 or IP3 concrete resulting from freeze-thaw conditions. Finally, IP2 and IP3 aging management programs, credited in Appendix B of the LRA, will continue to inspect and monitor the condition of IP2 and IP3 concrete structures to confirm the absence of significant aging effects during the period of extended operation.

Due to the results of Entergy's review, the following changes are made to a) letter NL-08-169, b) letter NL-09-056, and c) associated sections of the LRA. Deletions are shown by strikethrough and additions are underlined.

a) Entergy letter NL-08-169, dated November 6, 2008, clarification to LRA section 3.5.2.2 (part 2), first paragraph is revised to read as follows.

"IPEC containment structure concrete was designed and constructed in accordance with the requirements of ACI 318, "Building Code for Reinforced Concrete". The original construction specification for IPEC containment structure requires 3000 psi strength ~~air-entrained~~ concrete."

b) Entergy letter NL-09-056, dated May 1, 2009, clarification to Response for Follow-up RAI 4(a) is revised to read as follows.

"Concrete pour data from construction records show water-to-cement ratio of concrete used for IPEC containment ranged from a low of 0.455 (U3 equipment hatch area) to a high of 0.591 (U2 containment MAT) with an average ratio at the time of construction of 0.54 at Unit 2 and .51 at Unit 3. The method used to confirm the required concrete compressive strength of 3000 psi for the containment and other safety-related concrete structures, in accordance with ACI 318, Method 2 is testing of actual field samples taken during construction. ACI documents state that strength and durability are primarily governed by water-to-cement (w/c) ratio, and strength goes hand-in-hand with durability. The strength and durability are both based on the permeability of the concrete which is based on the distance between the cement particles, i.e. the closer the cement particles the stronger the concrete. Permeability is therefore a function of the w/c ratio, particle size distribution (PSD), type of cement, type of aggregate, compaction and quality control.

Relying on just one indicator for durability is not justified, which is why the ACI code uses it only as a first estimate based on the tables for determining strength and durability. The ACI documents recommend that the strength based on w/c ratio should be verified by trial batches to ensure the specified properties of the concrete are met. To confirm that the required compressive strength was achieved, ACI 214.3R-88, "Simplified Version of the Recommended Practice for Evaluation of Strength Test Results of Concrete" was used to develop a summary of the results of the original concrete strength tests. These results are based on raw strength values from the test samples to obtain the mean and the standard deviation.

IPEC containment and other safety-related structures were designed for a minimum compressive strength of 3000 psi. The design mix goal was to provide a design margin of 15% above the minimum compressive strength proven by the average of three tests of the design mix.

~~Approximately 200~~ Entergy has reviewed concrete test reports for concrete used in the IPEC containment, refueling cavity and spent fuel pool structures. Air entrainment admixture, when used, ~~values~~ resulted in air entrainment percentages ranging from 3.2 to 6.5%. Only a few of the test reports

indicated air entrainment higher than 6.0%. Those higher values are still acceptable based on the ACI 211.1-77, section 5.3.3, which shows that higher entrainment values up to 7% are acceptable for extreme exposure conditions, and that higher air entrainment is generally better for durability under extreme exposure conditions. A primary concern for high air entrainment, however, is an accompanying reduction in concrete strength. As discussed in the following paragraph, the concrete used for IP containment, refueling cavity and spent fuel pool still exceeded the concrete design strength requirements in accordance with ACI 318, producing durable, low-permeability concrete.

The Concrete test reports for each site were reported slightly different. For Unit 3, Containment concrete test reports involved an average of 3 sample concrete cylinders for strength testing. No test cylinder strength under 3000 psi 28-day strength was observed. The Unit 3 averaged compressive strength from these samples ranged from a low of 3317 psi to a high of 6430 psi. The standard deviation obtained from the samples reviewed was determined to be approximately 595 psi with an average or mean concrete compressive strength of approximately 4880 psi. For Unit 2, the individual compressive strength for each report ranged from 3321 psi to 6650 psi with an average of 4052 psi and a standard deviation of 862 psi.

All concrete for IP2 and IP 3 was batched and poured under the same controlled conditions regardless of location. All available concrete test reports were reviewed for the Fuel Storage Building and safety related concrete associated with the reactor and fuel transfer system in containment. It has been verified that concrete met the requirements for a 28 day test and no test data was found out of specification. *Therefore, based on review of the specifications and actual concrete test data, the required concrete compressive strength for the containment and other safety-related concrete structures, in accordance with ACI 318-63, Method 2 was achieved. Although this identifies that IPEC concrete is of good quality, the credited programs in Appendix B of the application will confirm the absence of significant concrete aging effects.*

c) Citation to air-entrainment in LRA section 3.5.2.2.1.1, Aging of Inaccessible Concrete Areas", is revised to read as follows.

The below-grade environment is not aggressive (pH > 5.5, chlorides < 500 ppm, and sulfates < 1,500 ppm). IPEC concrete was designed in accordance with ACI-318, Method 2, which relies on proportioning a concrete mixture by using trial batches of varying water-cement ratios to establish a mixture that provides the required concrete strength and quality. In addition, most of the IP3 concrete was designed using an air entrainment admixture that resulted in ~~at least the minimum required~~ air contents ranging from ~~4% and 6%~~ 3.2% to 6.5%. ~~and a low water/cement ratio~~. Importantly, IP2 and IP3 concrete structures are not exposed to salt or any other de-icing agent that could be detrimental to those structures. Furthermore, extensive inspections have shown no degradation of IP2 or IP3 concrete structures resulting specifically from freeze-thaw conditions. Finally, IP2 and IP3 aging management programs, credited in Appendix B of the LRA, will continue to monitor the condition of IP2 and IP3 concrete structures to confirm the absence of significant aging effects during the period of extended operation.

d) Citation to air-entrainment in LRA section 3.5.2.2.2.1.1, "Cracking, Loss of Bond, and Loss of Material (Spalling, Scaling) Due to Corrosion of Embedded Steel for Groups 1-5, 7, 9 Structures" is revised to read as follows.

The aging mechanisms associated with cracking, loss of bond, and loss of material (spalling, scaling) due to corrosion of embedded steel are applicable only to below-grade concrete/grout structures. The below-grade environment for IPEC is not aggressive and concrete is designed in accordance with specification ACI 318, Building Code Requirements for Reinforced Concrete, which results in low permeability and resistance to aggressive chemical solutions by providing a high cement, low water/cement ratio, proper curing and adequate air content ~~(between 4% and 6%)~~ between 3.2% and 6.5% (for most of IP3) and no air entrainment (for most of IP2). Neither IP2 nor IP3 concrete structures are exposed to salt or other de-icing agents that would be detrimental to these structures. Operating experience has not shown cracking, loss of bond, or loss of material due to corrosion of embedded steel for IP2 or IP3 concrete structures. IP2 and IP3 aging management programs, credited in Appendix B of the LRA, will continue to monitor the condition of IP2 and IP3 concrete structures to confirm the absence of significant aging effects during the period of extended operation.

e) Citation to air-entrainment in LRA section 3.5.2.2.2.1.4, 3.5.2.2.2.1.5, 3.5.2.2.2.4.2, and 3.5.2.2.2.4.3 are revised to read as follows.

"...and air entrainment percentages are between 3.2% and 6.5% (for most of IP3) and no air entrainment (for most of IP2). Neither IP2 nor IP3 concrete structures are exposed to salt or other de-icing agents that would be detrimental to these structures. Operating experience has not shown loss of material or cracking due to freeze – thaw, or cracking due to expansion and reaction with aggregates or loss of strength due to leaching of calcium hydroxide for IP2 or IP3 concrete structures. However, IP2 and IP3 aging management programs, credited in the appendix B of the LRA, will continue to monitor condition of IP2 and IP3 concrete structures to confirm the absence of significant aging effects during the period of extended operation.

f) Citation to air-entrainment in LRA Table 3.5.1, "Structures and Component Supports, NUREG-1801 Vol. 1", line item, 3.5.1-35, "discussion" is revised to read as follows.

"Aging effects are not applicable for accessible and inaccessible areas. These concrete structures are exposed to saturated water conditions near the ground surface; however, the concrete used at IPEC is designed with entrained air content of between ~~4% and 5%~~ 3.2% and 6.5% (for most of IP3) and no air entrainment (for most of IP2) in conformance with ACI-318, and plant experience has not identified any degradation related to freeze-thaw. Nonetheless, the Structures Monitoring Program will confirm the absence of aging effects requiring management for IPEC Group 6 concrete components. See Section 3.5.2.2.2.4 for additional discussion."