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DESCRIPTION:

Ltr furn info ref change in concrete Specifications of the Susquehanna Steam Electric Station.....

Dist Per W. Paulson

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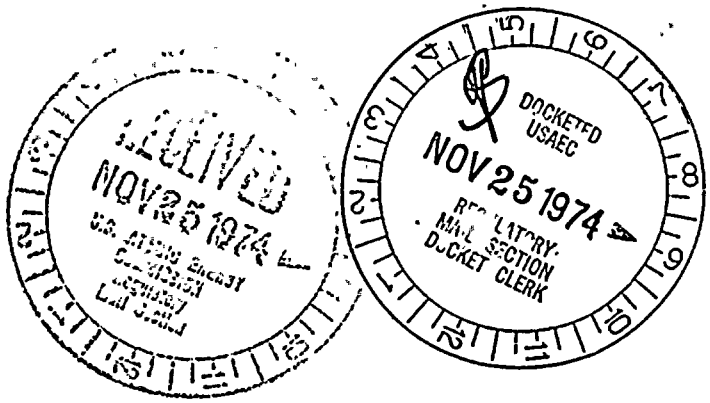
Mr. A. Giambusso
Deputy Director for Reactor Projects
U. S. Atomic Energy Commission
Directorate of Licensing
Washington, D.C. 20545



SUSQUEHANNA STEAM ELECTRIC STATION
CHANGE IN CONCRETE SPECIFICATIONS
ER 100450 FILE 840-2, 150-1
PLA-40
DOCKET NOs. 50-387 & 50-388

Dear Mr. Giambusso:

One year has now passed since the start of construction of the Susquehanna Steam Electric Station. Recent construction work has included several large volume, heavily reinforced, massive concrete placements. Notable among these are the Unit #1 Reactor Containment concrete base slab, the Reactor Building #1 base slab, and the base slab for Turbine Pedestal #1.

Prior to these placements, reports by your inspectors pointed out several provisions in the project specifications which did not appear to conform to their strict interpretation of the industry codes and standards referenced in the PSAR, although these PSAR references were included to be used as a "source of guidance for design" (PSAR Section 5.2.4.1 - ACI318-71) and as a "basis for construction" (PSAR Section 5.2.5.2.1 - ACI301-72). Due to the necessity to maintain our tight construction schedule, we elected to modify our project specifications to conform to your inspector's strict interpretations of the codes and standards.

Experience on this project as well as previous experience on other similar projects has now caused us to review these recent modifications with the objective of improving concrete quality and production methods within the intent of the referenced codes and standards.

We are herewith submitting several proposals for improvement modifications to the project specifications which represent our interpretation of the intent of ACI301-72 although they may not conform to the exact wording of this Specification. That this is within the intent of ACI301-72, is acknowledged by the statement in the ACI301-72 INSTRUCTIONS TO THE ARCHITECT/ENGINEER: "Adjustments to the needs of a particular job can be made by means of a list of supplemental

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requirements, as described below...". This is also recognized in Paragraph 1.1.3: "The provisions of these specifications shall govern wherever applicable (i.e., to conditions and types of work that occur on the particular job) except as otherwise provided in the contract documents. In case of conflicting requirements, the contract documents shall govern."

These proposals were discussed on November 19, 1974, in a telephone conversation between your Messrs. Walter Paulsen and A. Gluckman and our Messrs. R. McNamara and C. T. Coddington.

Based upon these provisions we submit the following proposals:

PROPOSAL A: To increase the as placed concrete slump working limit for massive, reinforced members (i.e. those with a least dimension of 2½' or greater) from the 2" with an inadvertency margin of ±1" presently required by ACI301-72 for mass concrete (Para. 14.4.1) to 3" with an inadvertency margin of ±2".

BASIS: ACI slump requirements are a common method of controlling the water content in fresh concrete. Such water control is exercised to minimize the adverse effects of heat of hydration build-up during the curing process. To produce concrete with proper workability, to allow placement by pumping or other methods and with improved consolidation properties, to result in uniform quality concrete of required design strength and durability in massive members that contain dense reinforcing (as are common in nuclear power plant structures); and at the same time exercise proper control of heat of hydration, the Susquehanna project has taken the following actions and made the following considerations in arriving at concrete control methods which vary nominally from ACI requirements but represent sound engineering judgment.

1) ACI 301-72, Chapter 14 notes that the provisions of this chapter are "applicable whenever the mass of the concrete is large enough to produce cracks or other problems caused by excessive differential temperatures resulting from the heat of hydration."

   ACI 301-72, Chapter 14 further notes that "...the requirements of each project should be evaluated on their own merits." This document constitutes Susquehanna project's technical evaluation of concrete requirements as relates to heat of hydration effects.

The ACI 301-72, Chapter 14 slump requirement is not necessary for the Susquehanna project due to the following technical considerations relating to alternate methods of control of heat of hydration:

a) The ratio of the surface exposed during construction and initial curing to the total concrete volume is considered sufficiently large (especially) when compared to dam-type structures) to permit adequate, naturally controlled dissipation of the heat of hydration.

b) Measures are taken in paragraph 12.2.4 of Susquehanna Project Specification 8856-C-8 (Rev. 1) to minimize unacceptable effects of differential temperatures during the initial curing period.

c) The total heat of hydration is lowered by implementation of the following:

i) Use of Type II cement per ASTM C150.

ii) Use of 15% pozzolan (sintered flyash) per ASTM C618 as replacement for cement.

iii) Minimize cement content by establishing the design strength (f'c) at 90 days rather than 28 days for principal structural applications.

iv) Establishing 70F as the maximum concrete temperature at which massive concrete (i.e., members with a least dimension of 2½ feet or greater) may be placed. Although 70F is the specified maximum, Susquehanna Project Spec. 8856-C-7, Rev. 2, Section 11.2, requires the concrete temperature to be as near 50F as can be obtained.

v) Water reducing admixture in all mixes,

2) Generally, mass concrete has little or no reinforcing, and the code requirements have been established on this basis. However, the great majority of the structures and structural components of nuclear power plants are massive concrete that contains dense reinforcing. (Reinforcement steel in containment cylindrical walls averages 350#/C-Y. and far exceeds the relatively unreinforced mass concrete described in ACI 301-72, Chapter 14.) To allow proper deposition greater workability, and improved consolidation properties in such heavily reinforced concrete structures as are common to nuclear power plant structures, the concrete slump working limit should be 3 inches.

3) On October 24, 1974, a meeting was held in San Francisco between representatives of Bechtel, PL, and Mr. Lewis H. Tuthill, a nationally recognized authority in the area of concrete technology. Mr. Tuthill affirmed the soundness of Bechtel Power's corporate position and the Susquehanna Project's intention to utilize 3 inch slump in applications such as those presented by this project. He further pointed out that the use of the lower slump (i.e., 2 inch) concrete delays construction activities which leads to problems in furnishing proper quality concrete. The delays and potential problems can affect quality far more than an increase to a 3 inch slump.

As Dr. Gluckman suggested, a review of the proposed ACI standard, "Code for Concrete Reactor Vessels and Containments" reported by Joint ACI-ASME Committee 359 in the May, 1973 ACI Journal indicates that there are no conflicts therein, with the above proposals.

PROPOSAL B: To increase the permissible depth of individual layers within a mass concrete placement from approximately 18 inches as required by ACI 301-72, paragraph 14.4.3, to 24 inches as referenced in ACI 304-73.

BASIS: ACI 301-72, paragraph 14.4.3, indicates that mass concrete should be placed in layers approximately 18 inches thich. This paragraph also directs the engineer to ACI 309-72 for detailed recommendations on concrete consolidation. ACI 309 suggests 15-20 inch placements for mass concrete and 12-18 inch placements for general concrete.

Another reference document is ACI 304-73 which recommends layers not exceeding 2 feet for general concrete and 1½ to 2 feet for mass concrete.

Use of pozzolan and a slump of 3 inches contributes to a workable concrete. Further, the use of powerful vibrating equipment (currently vibrators with a 6-inch head and a frequency of approximately 7,000 cycles per minute) ensure sufficient workability of the as deposited concrete to make the project requirements for deposition reasonable and adequate.

PROPOSAL C: To interpret Section 12.2.4 of Susquehanna Project Project Specification 8856-C-8, Revision 1, as acceptable alternate control of curing during cold weather to the statements contained in ACI 301-72 paragraphs 14.5.2 and 14.5.4.

BASIS: Curing methods during cold weather for the Susquehanna project are in accordance with ACI 306-66 (1972) and as supplemented by Susquehanna Project Specification 8856-C-8. The following is a comparison of statements in the project specification and that in ACI 301-72:

a) ACI 301-72, paragraph 14.5.2, states that curing methods during cold weather are not to add heat to the concrete. Paragraph 12.2.4 of Susquehanna Project Specification 8856-C-8 which states the curing method shall not dry the concrete or heat the concrete surface to above 90F is considered an acceptable alternate control.

b) ACI 301-72, paragraph 14.5.4, states that air temperature adjacent to the concrete shall not fall more than 3F in 1 hour or more than 30F in any 24 hour period. Paragraph 12.2.4 of Specification 8856-C-8 is considered to cover this cold weather condition by stating that cold weather protection shall remain in place at least 24 hours after heating is discontinued. (In extremely cold weather the Field Engineer shall require that additional measures be taken to prevent excessively rapid cooling of the concrete by this method).

The specification requirements for the Susquehanna project are the same as those in Bechtel Power's corporate standard specification and have been successfully used in over ten nuclear power plant projects which are located in widely varying climatic conditions.

PROPOSAL D : To utilize starter mixes in lieu of grout mixes for horizontal construction joints as required by Section 8.5 of Susquehanna Project Specification 8856-C-8, Revision 1 and for the bottom of foundation slabs.

This proposal will be effected by the following specification changes:

a) Add the following mixes to the "Concrete Classification Table" (Section 9.1(b)) of Susquehanna Project Specification 8856-C-7, Revision 3.

Class	Design Strength (psi)	Slump Working Limit (in.)	Inadvertency Margin (in.)	Rejection Limit (in.)	Max. Aggregate Size (in.)
B-Start	3000	5	±1"	6"	3/4
C-Start	4000	5	±1"	6"	3/4
D-Start	5000	5	±1"	6"	3/4
E-Start	6000	5	±1"	6"	3/4

b) Add the following new Section 9.1(g):
"Starter mixes should be used at the bottom of foundation slabs and may be used in lieu of grout mixes, as defined in Section 9.1(d) above, at horizontal construction joints. Such mixes shall not be used in structures less than 2½ feet in depth. Starter mixes have the same proportions of ingredients as the 3/4 inch aggregate mix for each design strength except the water is increased to produce concrete with a slump "Working Limit" of 5 inches.

The slump of the starter mix shall not be included in calculating the average slump of the concrete placement."

c) Add the following paragraph to Section 8.5 of Susquehanna Project Specification 8856-C-8, Rev. 1:

"In lieu of using the grout mixes described above, starter mixes as defined in Specification 8856-C-7 may be used for horizontal construction joints after producing a saturated surface dry joint. Generally, such mix should be placed in a layer 4-6 inches deep; however, the layer depth shall not exceed 8 inches."

d) Revise the second paragraph of Section 10.5 of Susquehanna Project Specification 8856-C-8, Rev. 1 to read as follows:

"On the bottom of formed beams and slabs, where the congestion of steel near the forms makes placing difficult, a layer of grout, not to exceed one inch in depth with the same

compressive strength (f'c) as used in the concrete, or a layer of starter mix with the same compressive strength (f'c) as used in the concrete shall first be deposited. The starter mix should be placed in a layer 4-6 inches deep; however the layer depth shall not exceed 8 inches. The starter mix shall not be used in structures less than 2½ feet in depth."

BASIS: A need for this type of concrete mix arises due to the great majority of the structures and structural components of nuclear power plants having massive concrete that contains dense reinforcing where segregation of the concrete and rock pockets may become a problem. Further, a "wet" mix (as opposed to one that is too dry or stiff) should be used to start a placement to provide good concrete bond and ensure good workability.

On October 24, 1974 a meeting was held in San Francisco between representatives of Bechtel, PL and Mr. Lewis H. Tuthill, a nationally recognized authority in the area of concrete technology. Mr. Tuthill stated as follows:

"Elsewhere, concerning starter mixes, I have affirmed and here reaffirm that "a body of starter mix provides immediate plastic embedment for any coarse aggregate that may become separated from the first concrete deposited. It also provides something to work with any low slump first batches that may inadvertently be delivered despite the special effort that should be made to avoid "dry" ones at the start. The higher-slump starter mixes quickly average their water content with concrete placed above it, since water migrates upward as the solids settle downward to make stronger than average concrete at the bottom of all such placements."

This statement confirms Bechtel's judgment on the desirability of such starter mixes.

It is noted that such starter mixes have been successfully used in applications other than nuclear power plants as indicated by the article entitled:

"Cracking Controlled in Massive Reinforced Structural Concrete by Application of Mass Concrete practices." L. H. Tuthill and R.H.Adams, ACI Journal August 1972, pp. 481-491.

which is referenced by A.E.C. Regulatory Guide 1.55, "Concrete

Placement in Category I Structures."

Starter mixes are also recommended in SP-2 ACI Manual of Concrete Inspection (p. 147).

As previously mentioned above, these proposed modifications to our project specifications and the PSAR were discussed in a telephone conversation between your Mr. Paulsen and Dr. Gluckman and our Messrs. McNamara and Coddington. Messrs. Paulsen and Gluckman indicated tentative agreement with the changes defined above and requested that we submit this letter to speed up their approval. PSAR page changes will be submitted at a later date.

Our construction operations are presently at the point where we are ready to place concrete for our reactor pressure vessel support pedestal. We would greatly appreciate your early review and approval of these proposals so that we may implement them for this placement.

Very truly yours,

N W Curtis

Norman W. Curtis
Vice President - Engineering & Construction

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