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Norman W. Curtis

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PROP

INPUT FORM

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DESCRIPTION: Notorized 05-23-77...Proposing changes in construction project modifying sections of ACI Codes:

a) ACI 318 - Building Code Requirements for Reinforced Concrete

b) ACI 301 - Specifications for Structural Concrete for Buildings.....

6 pages

PLANT NAME: SUSQUEHANNA UNITS 1 & 2

jcm

ENCLOSURE

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NRC FORM 195 (2-76)

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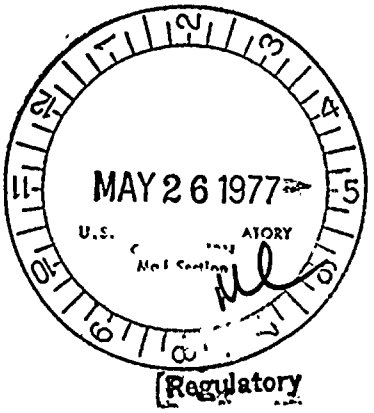
May 16, 1977



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Director of Nuclear Reactor Regulation
Attention: Olan D. Parr, Chief
Light Water Reactors Branch No. 3
U.S. Regulatory Commission
Washington, D.C. 20555

SUSQUEHANNA STEAM ELECTRIC STATION
MODIFICATIONS TO CONCRETE SPECIFICATION
ER 100450 FILE 840-2, 150-1
PLA-174

50-387/388

Dear Mr. Parr:

Due to continually rising construction costs we have instituted several productivity improvement changes in the Susquehanna Steam Electric Station construction project. These changes have generally been within scope of codes and standards which formed the basis for the Susquehanna SES construction permit issued in November, 1973. Occasionally, when we find it necessary to deviate from the codes we have submitted complete justification for the deviation. In all cases where a deviation is requested, it has been to improve productivity without reducing the quality of the work below acceptable levels. Accordingly we are again submitting several proposed changes in project specifications which may or may not be classified as deviations from the codes, but which are intended to improve field work productivity without reducing the quality of the final product.

We propose to modify sections of the following ACI Codes:

a). ACI 318 - Building Code Requirements for Reinforced Concrete

b) ACI 301 - Specifications for Structural Concrete for Buildings

The following are the proposed changes which we intend to implement on July 1, 1977.

PROPOSAL A:

Provisions of ACI 301 - Chapter 4 - "Formwork" shall be modified as follows:

"Table 4.3.1 - Tolerances for Formed Surfaces shall be replaced with the following:

"Table 4.3.1 - Tolerances for Formed Surfaces for Reinforced Concrete Work in Buildings:

1. Variations from Plumb:

   A. In the lines and surfaces of columns, piers, walls, and in arrises: 1/2 inch per 10 ft., but not more than 1-1/2 inch.

   B. For exposed corner columns, control-joint grooves, and other comspicuous lines:

      In any bay or 20 ft. maximum: 1/2 inch
      In 40 ft. or more: 1 inch.

2. Variation from the level or from the grades indicated on the drawings:

   A. In slab soffits, ceilings, beam soffits, and in arrises, measured before removal of supporting shores:

      In 10 ft: 1/2 inch
      In any bay or 20 ft. maximum: 5/8 inch
      In 40 ft. or more: 1 inch.

B. In exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines:

   In any bay or 20 ft. maximum: 3/8 inch
   In 40 ft. or more: 1 inch.

3. Variation of the linear building lines from established position in plan and related position or columns, wall, and partitions:

   In any bay or 20 ft. maximum: 1/2 inch
   In 40 ft. or more: 1 inch.

4. Variation in the sizes and locations of sleeves, floor openings, and wall openings:

   Variation in sizes: -1/4, +1/2 inch
   Deviation from established center line location: 1/2 inch

5. Variation in cross-sectional dimensions of columns and beams and in the thickness of the slabs and walls: -1/4, +1 inch.

6. Footings:

   A. Variations in dimensions in plan:

      Formed: -1/2, +2 inches
      Unformed: -1/2, +6 inches

   B. Misplacement or eccentricity: 2 percent of footing width in the direction of misplacement, but not more than 2 inches.

   C. Reduction in footing thickness: -5 percent of specified thickness.

7. Variation in steps:

   In a flight of stairs:

   A. Rise: ±1/4 inch

      Tread: -1/4, +1/2 inch

   B. In consecutive steps:

      Rise: ±1/8 inch

      Tread: ±1/4 inch.

Basis: See Proposal "B"

PROPOSAL B:

Replace Sections 5.4.2, 5.4.3 and 5.5.1 of ACI 301 Chapter 5 and Sections 7.3.2, 7.4.1, 7.4.3 and 7.14.1 of ACI 318 Chapter 7 with the following:

Unless otherwise specified on the design drawings, the reinforcing steel shall be placed within the tolerances specified in the following sections.

a. For longitudinal location of bends and ends of bars:

   ±3 inches, provided the minimum cover is maintained, except at discontinuous ends of members where the tolerances shall be ±1/2 inch.

b. The clear distance between parallel bars in a layer shall be not less than the nominal diameter of the bar, nor less than 1-1/3 times the nominal size of largest aggregate nor less than 1 inch. Where parallel reinforcement is placed in two or more layers, the bars in the upper layer shall be placed directly above those in the bottom layer with the clear distance between bars in adjacent layers not less than the nominal diameter of the bar, nor less than 1-1/3 times the nominal size of the largest aggregate, nor less than 1 inch.

c. Spacing of rebars in walls and slabs shall be as shown on drawings with a tolerance of ± 2 bar diameters provided that the total number of rebars as required by design, is kept and the maximum spacing between bars is not greater than three times the thickness of member nor more than 18 inches.

d. Minimum clear concrete cover for reinforcing steel shall be as follows:

1. For concrete deposited against the ground: 3 inches.

2. For formed surfaces exposed to earth, weather or water: 2 inches.

3. For formed surfaces not exposed to earth, weather or water: 3/4 inch for slabs and walls, except when such slabs and walls have bar sizes of No. 14 & 18, the cover shall be increased to 1-1/2 inches.

4. For beams, girders and columns: 1-1/2 inches for principal reinforcement, ties, stirrups and spirals.

e. Maximum clear concrete cover for reinforcing steel shall be as follows:

1. For concrete members where the thickness is less than 24 inches the maximum cover shall not exceed the minimum by 1 inch.

2. For concrete members where the thickness is 24 inches or greater the maximum cover shall not exceed the minimum by more than 2 inches.

f. Where interferences occur between bars and embedded items, such as electrical conduits, pipe sleeves, piping, and like items, positions of bars shall be modified as specified below unless shown otherwise. However, the specified clearance, cover, and minimum spacing requirements shall be maintained.

If the dimension of the embedded item that interferes with the bar is 12 inches or more, the bar arrangement shall be as shown. If the dimension of the embedded item that interferes with the bar is less than 12 inches the bar arrangement shall be as follows:

1. For bar size #8 and larger: move entire bar

2. For bar size #7 and smaller: bend bar to an offset of 1:6 maximum with radius of bends in accordance with ACI 315 Section 2.9, or move entire bar.

BASIS: (Applicable to Proposals A & B)

The ACI Code establishes minimum requirements for ordinary commercial reinforced concrete structures. ACI Committee 301 has stated that the tolerances specified in ACI 301-72 "represent the tightest limits within which reinforcing steel can consistently be placed." Section 1.1.3 of ACI 318-71 states that for special structures the provisions of the ACI Code shall govern where applicable. It is Bechtel's position that nuclear power plants qualify as special structures and are governed only by applicable provisions of the Code rather than the Code in its entirety. Therefore, Bechtel recommends rebar placing tolerances for concrete cover exceeding those specified in ACI-318-71 and ACI-301-72. These relaxed tolerances are justifiable and consistent with the design industry, and the size and complexity of reinforced concrete members in nuclear power plant structures. They are also within the fit-up requirements of various component parts of the work.

Susquehanna reinforced concrete design is based on the strength design method as outlined in ACI-318-71. This Code has extra margins of safety to provide for the possibility that small adverse variations in material strengths, workmanship, and dimensions, while individually within acceptable tolerances and limits of good practice, may combine to result in undercapacity. In addition, to assure adequate structural strength, the theoretical capacity of a member is reduced by the capacity reduction factor, ϕ.

Considering the high degree of control over adverse variations in material strength and workmanship which is characteristic of the nuclear construction industry, it is Bechtel's judgment that the proposed tolerances for Specification 8856-C-8, modifying those specified in ACI Codes, will result in an acceptable actual level of strength as compared with theoretical.

It should be noted that the nuclear power plant is characterized by mass concrete and heavy reinforcing bars, often congested in zones of high stress or discontinuity. In many areas the walls and slabs are extensively penetrated and embedded with conduit, pipe, and special hardware. Therefore, the tolerances required should reflect these conditions and not those befitting more conventional structures.

In an informal meeting attended by Bechtel's Chief Civil/Structural Engineer, NRC personnel indicated that they will favorably consider justified differences from ACI codes and recommendations.

Since the time of the original SSES design and PSAR statements, Bechtel has conducted studies directed toward the development of practical tolerances for concrete work in nuclear power plants. The resulting details and specifications have pointed toward improvements in field practice consistent with the requirements for functional performance and

structural adequacy. These studies involved observation of actual field problems and subsequent submittal of prospective solutions to engineering evaluation. Where deemed appropriate the advice of outside consultants were sought. In August 1976 Bechtel's concerns for the impact of more restrictive tolerances plus the recommendations for relaxation of unnecessarily restrictive code provisions were submitted to Mr. L. H. Tuthill, concrete consultant, for his review and comments. Mr. Tuthill, in his report, concurred with Bechtel's conclusions regarding a practical approach for selection and application of formwork and rebar tolerances. Some of his views are reproduced below.

> "Appropriate tolerances are often debated. Obviously the law of diminishing returns of refinements beyond a practical value or necessity."
>
> "Accordingly, tolerance values should be judged on their merit or necessity in each case. ACI 347 and ACI 301 are well considered guides but should not be mandatory if wider tolerances are adequate or narrower tolerances really worthwhile. It should be noted that ACI/ASME, Section III, Division 2, (ACI 359), CC4342, says, 'The tolerances for the placement of reinforcement shall be specified in the Construction Specifications.' Presumably ACI 359 leaves concrete tolerances up to the designer, as well."

Bechtel has reviewed the design methods, criteria and assumptions with respect to the effect of the increased tolerances on the strength of Susquehanna SES structural elements. On consideration of such factors as: The large size members involved; the increased redundancy in framing; the accommodation of higher stresses (between 3% - 5%) in local areas thru the influence of the capacity reduction factor, $\emptyset$; the higher actual rebar yield stresses compared to the minimum required; etc., it was concluded that no detrimental impact on member strength would prevail through application of the slightly wider tolerances.

PROPOSAL C:

The requirements of ACI-301 Chapter 6 - "Joints and Embedded Items" will be modified as follows:

"Modify Section 6.1.2 to read as follows:

> All reinforcement shall be continued across joints. Keys and inclined dowels shall be provided as indicated on the design drawings." (Delete: "Longitudinal keys at least 1-1/2 inches deep shall be provided in all joints in walls and between walls and slabs or footings.").

BASIS:

Based upon our evaluation regarding the requirement of keys at construction joints we have concluded that joint preparation by hydroblasting or sandblasting with specified wetting, without shear keys, will produce competent and structurally sound shear planes with shear resistance equivalent to that of concrete placed monolithically.

We also contacted numerous concrete specialists and consultants including L. H. Tuthill, R. Gaynor, B. Mather, F. Kramrisch and Bechtel's concrete specialists, D. E. Graham and S. B. Helms all of whom agree with our conclusion. Most of those interviewed referred us to technical literature to supplement their reasoning.

Blume/Newmark in their volume "Design of Multi-Storied Reinforced Concrete Buildings for Earthquake Motions" included the following statement in Section 6.7 "When the concreting procedures described in Section 8.3 are followed, the bond between old and new concrete can be good enough to provide tensile and shear resistance equivalent to that of concrete placed monolithically.

Mark Fintel in his volume "Handbook of Concrete Engineering" included the following statement in Section 4.9; "When proper concreting procedures are followed, the bond between the old and new concrete plus the doweling effect of the reinforcement can be made good enough to provide shear resistance equivalent to that of concrete placed monolithically."

Additionally, the method of joint preparation as described in Section 6.4.1 of ACI 349 and Section CC-4252 of ACI 359 also agrees with the method described above.

We would appreciate your comments and approval of these proposals prior to June 15, 1977, as we wish to implement these changes as early in the construction season as possible.

Very truly yours,

NW Curtis

Norman W. Curtis
Vice President-Engineering & Construction

Sworn to and subscribed before me
this 23rd of May, 1977

Notary Public Louise A. Earp

My Commission expires: July 17, 1978

RMY:deb