COMPARISON BETWEEN CMAA-70 AND EOCI-61

The draft Technical Evaluation Report for the North Anna plants asks for an evaluation of 14 issues regarding the recommendations of CMAA-70 and EOCI-61 which was the design basis for North Anna cranes. The 14 issues of comparison are addressed as follows:

1. Impact Allowance

   CMAA-70, Article 3.3.2.1.1.3 requires that crane design calculations include an impact allowance of 0.5 percent of the load per foot per minute of hoisting speed but not less than 15 percent. EOCI-61 specifies only a minimum allowance of 15 percent. Therefore, for cranes with hoist speeds in excess of 30 feet per minute, it is possible that the impact allowance applied under EOCI-61 will be less than that required by CMAA-70.

   The containment polar cranes hoist speeds are below 30 fpm, and thereby, comply with the above article.

2. Torsional Forces

   CMAA-70, Article 3.3.2.1.3 requires that twisting moments due to overhanging loads and lateral forces acting eccentric to the horizontal neutral axis of a girder be calculated on the basis of the distance between the center of gravity of the load or force center line, and the girder shear center measured normal to the force vector. EOCI-61 states that such moments are to be calculated with reference to the girder center of gravity. For girder sections symmetrical about each principal central axis, such as box sections or I-beam girders, used in these cranes, the shear center coincides with the centroid of the girder section and there is no difference between the two requirements.

   The containment polar cranes are constructed with symmetrical box section girders, thereby complying with the above article.

3. Longitudinal Stiffeners

   CMAA-70, Article 3.3.3.1 specifies (1) the maximum allowable web depth/thickness (h/t) ratio for box girders using longitudinal stiffeners and (2) requirements concerning the location and minimum moment of inertia for such stiffeners. EOCI-61 allows the use of longitudinal stiffeners but provides no similar guidance.

   There are two longitudinal stiffeners on the containment polar crane box girder. The web depth/thickness ratio h/t is calculated to be 219, which is within the allowable h/t specified in CMAA-70:

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$$\text{allowable } h/t = C(k+1)\sqrt{\frac{17.6}{f_c}} = 2C = 2 \times 243 = 486$$

or $h/t = M = 564$

where

C = 243 for 2 longitudinal stiffeners

$(k + 1)\sqrt{\frac{17.6}{f_c}}$ = 2 which is the smallest value based on the most conservative approach used for a symmetrical girder, where the maximum stresses are assumed to equal the basic allowable stresses.

M = 564 for 2 longitudinal stiffeners

Therefore the design complies with the CMAA-70 article.

4. Allowable Compressive Stress

CMAA-70, Article 3.3.3.1.3 identifies allowable compressive stresses to be approximately 50 percent of yield strength of the recommended structural material (A-36) for girders, where the ratio of the distance between web plates to the thickness of the top cover plate (b/c ratio) is less than or equal to 38. Allowable compressive stresses decrease linearly for b/c ratios in excess of 38. EOCI-61 provides a similar method for calculating allowable compressive stresses except that the allowable stress decreases from approximately 50 percent of yield only after the b/c ratio exceeds 41. Consequently, structural members with b/c ratios in the general range of 38 to 52 designed under EOCI-61 will allow a slightly higher compressive stress than those designed under CMAA-70.

The b/c ratio of the containment polar crane girder is calculated to be 25, therefore complying with the CMAA-70 article.

5. Fatigue Considerations

CMAA-70, Article, 3.3.3.1.3 provides substantial guidance with respect to fatigue failure by indicating allowable stress ranges for various structural members in joints under repeated loads. EOCI-61 does not address fatigue failure.

The requirements of CMAA-70 are not considered to be of consequence for the containment polar cranes because these cranes are not generally subjected to frequent loads at or near design conditions (CMAA-70 provides allowable stress ranges for loading cycles in excess of 20,000) and are not generally subjected to stress reversal (CMAA-70 allowable stress range is reduced to below the basic allowable stress for only a limited number of joint configurations). Therefore, fatigue failure is unlikely.

6. Hoist Rope Requirements

CMAA-70, Article 4.2.1 requires that the capacity load plus the bottom block divided by the number of parts of rope not exceed 20 percent of the published rope breaking strength. EOCI-61 requires that the rated capacity load divided by the number of parts of rope not exceed 20 percent of the published rope breaking strength. The effect on crane safety margins of this variation depends on the ratio of the weights of the load block and the rated load.

There are 12 parts of rope for the containment polar crane main hoists, therefore complying with the requirements of CMAA-70.

7. Drum Design

CMAA-70, Article 4.4.1 requires that the drum be designed to withstand combined crushing and bending loads. EOCI-61 requires only that the drum be designed to withstand maximum load bending and crushing loads with no stipulation that these loads be combined.

The containment polar crane drums are designed to withstand combined crushing and bending loads, therefore complying with the requirements of CMAA-70.

8. Drum Design

CMAA-70, Article 4.4.3 provides recommended drum groove depth and pitch. EOCI-61 provides no similar guidance.

The CMAA-70 article represents a codification of the same good engineering practice that would have been used in the cranes built to EOCI-61 specifications.

9. Gear Design

CMAA-70, Article 4.5 requires that gearing horsepower ratings be based on certain American Gear Manufacturers Association Standards and provides a method for determining allowable horsepower. EOCI-61 provides no similar guidance.

American Gear Manufacturers Association Standards were used in the design of containment polar crane, therefore complying with the requirements of CMAA-70.

10. Bridge Brake Design

CMAA-70, Article 4.7.2.2 requires that bridge brakes, for cranes with cab control and the cab on the trolley, be rated at least 75 percent of bridge motor torque. EOCI-61 requires a brake rating of 50 percent of bridge motor torque for similar configurations.

The containment polar cranes are controlled from cabs mounted on the bridges.

11. Hoist Brake Design

CMAA-70, Article 4.7.4.2 requires that hoist holding brakes, when used with a method of control braking other than mechanical, have torque ratings no less than 125 percent of the hoist motor torque. EOCI-61 requires a hoist holding brake torque rating of no less than 100 percent of the hoist motor torque without regard to the type of control brake employed.

The containment polar crane main and auxiliary hoist motors are equipped with two DC magnetic brakes, each rated at 150% of full motor torque. The bridge motors have an electric hydraulic foot brake rated at 150% of the full motor torque. The designs comply with the CMAA-70 article.

12. Bumpers and Stops

CMAA-70, Article 4.12 provides substantial guidance for the design and installation of bridge and trolley bumpers and stops for cranes which operate near the ends of bridge and trolley travel. No similar guidance is provided in EOCI-61.

The following bumpers are provided for the containment polar cranes.

	Bridge Bumpers	Trolley Bumpers
Polar Crane	None provided, crane operates on circular runway	Spring

13. Static Control Systems

CMAA-70, Article 5.4.6 provides substantial guidance for the use of static control systems. EOCI-61 provides guidance for magnetic control systems only.

The containment polar cranes are equipped with magnetic-type motor controls, so this article is not applicable.

14. Restart Protection

CMAA-70, Article 5.6.2 requires that cranes not equipped with spring-return controllers or momentary-contact push buttons be provided with a device that will disconnect all motors upon power failure and will not permit any motor to be restarted until the controller handle is brought to the OFF position. No similar guidance is provided in EOCI-61.

The containment polar cranes were designed with motor controllers of the "dead-man" type with spring returns to the "OFF" position. Therefore, this article is not applicable.