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TECHNICAL EVALUATION REPORT

CONTROL OF HEAVY LOADS

COMMONWEALTH EDISON COMPANY
QUAD CITIES STATION UNITS 1 AND 2

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FRC ASSIGNMENT 3

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1. INTRODUCTION

1.1 PURPOSE OF REVIEW

This technical evaluation report documents the Franklin Research Center (FRC) review of general load handling policy and procedures at Commonwealth Edison's Quad Cities Station Units 1 and 2. This evaluation was performed with the following objectives:

- o to assess conformance to the general load handling guidelines of NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants" [1], Section 5.1.1
- o to assess conformance to the interim protection measures of NUREG-0612, Section 5.3.

1.2 GENERIC BACKGROUND

Generic Technical Activity Task A-36 was established by the U.S. Nuclear Regulatory Commission (NRC) staff to systematically examine staff licensing criteria and the adequacy of measures in effect at operating nuclear power plants to assure the safe handling of heavy loads and to recommend necessary changes in these measures. This activity was initiated by a letter issued by the NRC staff on May 17, 1978 [2] to all power reactor licensees, requesting information concerning the control of heavy loads near spent fuel.

The results of Task A-36 were reported in NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants." The staff's conclusion from this evaluation was that existing measures to control the handling of heavy loads at operating plants, although providing protection from certain potential problems, do not adequately cover the major causes of load handling accidents and should be upgraded.

In order to upgrade measures for the control of heavy loads, the staff developed a series of guidelines designed to achieve a two-part objective using an accepted approach or protection philosophy. The first portion of the objective, achieved through a set of general guidelines identified in NUREG-0612, Article 5.1.1, is to ensure that all load handling systems at nuclear power plants are designed and operated so that their probability of failure is uniformly small and appropriate for the critical tasks in which

they are employed. The second portion of the staff's objective, achieved through guidelines identified in NUREG-0612, Articles 5.1.2 through 5.1.5 is to ensure that, for load handling systems in areas where their failure might result in significant consequences, either (1) features are provided, in addition to those required for all load-handling systems, to ensure that the potential for a load drop is extremely small (e.g., a single-failure-proof crane) or (2) conservative evaluations of load handling accidents indicate that the potential consequences of any load drop are acceptably small. Acceptability of accident consequences is quantified in NUREG-0612 into four accident analysis evaluation criteria.

The approach used to develop the staff guidelines for minimizing the potential for a load drop was based on defense-in-depth and is summarized as follows:

1. provide sufficient operator training, handling system design, load handling instructions, and equipment inspection to assure reliable operation of the handling system

2. define safe load travel paths through procedures and operator training so that, to the extent practical, heavy loads are not carried over or near irradiated fuel or safe shutdown equipment

3. provide mechanical stops or electrical interlocks to prevent movement of heavy loads over irradiated fuel or in proximity to equipment associated with redundant shutdown paths.

Staff guidelines resulting from the foregoing are tabulated in Section 5 of NUREG-0612. Section 6 of NUREG-0612 recommended that a program be initiated to ensure that these guidelines are implemented at operating plants.

1.3 PLANT-SPECIFIC BACKGROUND

On December 22, 1980, the NRC issued a letter [3] to Commonwealth Edison, the Licensee for Quad Cities, requesting that the Licensee review provisions for handling and control of heavy loads, evaluate these provisions with respect to the guidelines of NUREG-0612, and provide certain additional information to be used for an independent determination of conformance to these guidelines. On June 22, 1981, Commonwealth Edison provided the initial response [4] to this request.

2. EVALUATION AND RECOMMENDATIONS

FRC's evaluation of load handling at Quad Cities is divided into two categories. These categories deal separately with the general guidelines of Article 5.1.1 and the recommended interim protection measures of Article 5.3 of NUREG-0612. Applicable guidelines are referenced in each category. FRC's conclusion and recommendations are provided in the summary for each guideline.

2.1 GENERAL GUIDELINES

The NRC has established seven general guidelines which must be met in order to provide the defense-in-depth approach for the handling of heavy loads. These guidelines consist of the following criteria from Section 5.1.1 of NUREG-0612:

- Guideline 1 - Safe Load Paths
- Guideline 2 - Load Handling Procedures
- Guideline 3 - Crane Operator Training
- Guideline 4 - Special Lifting Devices
- Guideline 5 - Lifting Devices (Not Specially Designed)
- Guideline 6 - Cranes (Inspection, Testing, and Maintenance)
- Guideline 7 - Crane Design.

These seven guidelines should be satisfied for all overhead handling systems that handle heavy loads in the vicinity of the reactor vessel, near spent fuel in the spent fuel pool, or in other areas where a load drop may damage safe shutdown systems. The Licensee's verification of the extent to which these guidelines have been satisfied and FRC's evaluation of this verification are contained in the succeeding paragraphs.

2.1.1 Safe Load Paths [Guideline 1, NUREG-0612, Article 5.1.1(1)]

"Safe load paths should be defined for the movement of heavy loads to minimize the potential for heavy loads, if dropped, to impact irradiated fuel in the reactor vessel and in the spent fuel pool, or to impact safe shutdown equipment. The path should follow, to the extent practical, structural floor members, beams, etc., such that if the load is dropped, the structure is more likely to withstand the impact. These load paths

should be defined in procedures, shown on equipment layout drawings, and clearly marked on the floor in the area where the load is to be handled. Deviations from defined load paths should require written alternative procedures approved by the plant safety review committee."

a. Summary of Licensee Statements and Conclusions

An evaluation of Quad Cities Station Units 1 and 2 has been performed by the Licensee to evaluate safe load paths. While load paths are not defined for all loads, the Licensee states that load movements follow the safest and shortest routes with the load as close to the floor as practical. Due to the configuration and the number of load paths, the Licensee states that marking the paths on the floor is generally not feasible nor would it contribute to the health and safety of the plant personnel or the public.

Safe load paths for "other casks" have been addressed in a previous Licensee submittal to the NRC [5] in response to a request for additional information on the control of heavy loads.

b. FRC Evaluation

FRC's review of the Licensee's response and drawings indicates that Guideline 1 criteria have not been satisfied at Quad Cities Station, based upon the Licensee's response that load paths have not been developed for all heavy loads identified. FRC does not concur that movement of heavy loads along the "safest and shortest" route is an acceptable alternative to development of specific load paths for individual loads. The definition of "safest and shortest" load paths, in FRC's estimation, is subject to individual interpretation by both crane operators and supervisors; preferably, safe load paths should be determined by detailed analysis by engineers familiar with plant layout, structural strength members, and locations of safety-related plant equipment. In addition, a not-unreasonable probability exists that situations could occur in which the safest and shortest load path would not be available due to evolutions in progress or interference from equipment staged; in such cases, crane operators and supervisors unfamiliar with details of plant layout might use a load path of convenience, thus resulting in a potential violation of NUREG-0612 criteria. However, no

deviations would be noted by the responsible plant supervisory personnel since written alternative procedures, approved by the plant safety review committee, are not required at Quad Cities Station for deviations from established load paths.

Similarly, the Licensee's contention that floor markings are "generally not feasible" is not acceptable. Load path markings should be used by crane operators and their supervisors as means of monitoring the proper execution of load handling evolutions and clearly identifying those areas where movements of heavy loads will occur. Load path markings will alert personnel not involved in load handling to keep these pathways clear of non-related equipment in order to avoid interference when load handling is in progress. By consolidating various heavy load paths, the Licensee should be able to develop a system of heavy load paths that is not overly complex or confusing to operators and supervisors and which would contribute to the general safety of plant personnel by minimizing interference with load movements.

Review of the drawings submitted by the Licensee indicates that, for the most part, suitable load paths have been identified for the movement of major components in the reactor building, including the reactor vessel head, head insulation, drywell head, shield plugs, dryer/separator equipment, and pool plugs. These load paths are acceptable based upon FRC's review and should be defined in procedures following whatever consolidation and simplification the Licensee deems necessary. These load paths should be used as examples for developing pathways for the other handling systems identified, including the reactor building crane auxiliary hook, drywell first level monorail, second floor jib crane, and CRD repair floor jib crane. The Licensee has also identified at least one handling system (the 1/2-ton new fuel inspection stand jib crane) which handles loads less than that defined to be a heavy load by NUREG-0612. If the Licensee can verify that this system or any others do not carry heavy loads, FRC concurs that detailed load paths, procedures, physical markings, and drawings are not required, provided administrative measures are taken to ensure that those systems capable of handling heavy loads are prevented from carrying these loads.

In addition, no information has been provided by the Licensee to verify that deviations from established load paths will require written alternatives that must be approved by the plant safety review committee.

c. FRC Conclusions and Recommendations

Quad Cities Station does not comply with Guideline 1. In order to fulfill the criteria of this guideline, the Licensee should perform the following:

1. formally develop safe load paths for all heavy loads, similar to those identified for movement of major loads in the reactor building

2. incorporate these load paths into load handling procedures and equipment layout drawings

3. clearly mark safe load paths on the floor in areas where loads are handled

4. require that deviations from established load paths require written alternatives that are approved by the plant safety review committee.

2.1.2 Load Handling Procedures [Guideline 2, NUREG-0612, Article 5.1.1(2)]

"Procedures should be developed to cover load handling operations for heavy loads that are or could be handled over or in proximity to irradiated fuel or safe shutdown equipment. At a minimum, procedures should cover handling of those loads listed in Table 3-1 of NUREG-0612. These procedures should include: identification of required equipment; inspections and acceptance criteria required before movement of load; the steps and proper sequence to be followed in handling the load; defining the safe path; and other special precautions."

a. Summary of Licensee Statements and Conclusions

A detailed list of heavy loads and procedures governing the handling of each load has been supplied by the Licensee, who states that these procedures, either implemented or under development, meet the intent of Section 5.1.1(2) of NUREG-0612 and generally include sections such as equipment description, purpose, references, initial conditions, and appropriate precautions or limitations. Although most of the loads are governed by these procedures, the

Licensee notes that all loads will be handled under a generic rigging practices procedure that is currently being developed as a result of the review of NUREG-0612. This procedure will prohibit handling of loads over spent fuel in the fuel pools or over the open reactor cavity when fuel is in the reactor unless a specific procedure has been written directing or permitting such action.

b. FRC Evaluation

FRC concurs that the specific procedures identified by the Licensee for load handling at Quad Cities Station satisfy the criteria of Guideline 2 with one exception: safe load paths have not been defined for the movement of individual heavy loads.

As previously noted in FRC's evaluation of Guideline 1, FRC concurs that detailed procedures need not be developed for the 1/2-ton new fuel inspection stand jib crane since it does not lift loads in excess of those defined to be a heavy loads by NUREG-0612. As an alternative, the Licensee should consider marking the crane with the maximum load (less than the heavy load limit) or restricting the crane by other suitable means.

C. FRC Conclusions and Recommendations

Quad Cities Station complies with the criteria of Guideline 2. The Licensee should incorporate defined safe load paths into individual procedures, and, when completed, these procedures should be made readily available for review and inspection by the NRC staff.

2.1.3 Crane Operator Training [Guideline 3, NUREG-0612, Article 5.1.1(3)]

"Crane operators should be trained, qualified and conduct themselves in accordance with Chapter 2-3 of ANSI B30.2-1976 'Overhead and Gantry Cranes' [6]."

a. Summary of Licensee Statements and Conclusions

The Licensee states that Quad Cities Station does comply with ANSI B30.2-1976 with respect to operator training, qualification, and conduct.

b. FRC Evaluation

Quad Cities Station satisfies the criteria of Guideline 2 on the basis of the Licensee's verification that no exceptions are taken to the guidelines of ANSI B30.2-1976.

c. FRC Recommendations and Conclusions

Quad Cities Station complies with Guideline 3.

2.1.4 Special Lifting Devices [Guideline 4, NUREG-0612, Article 5.1.1(4)]

"Special lifting devices should satisfy the guidelines of ANSI N14.6-1978, 'Standard for Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More for Nuclear Materials' [7]. This standard should apply to all special lifting devices which carry heavy loads in areas as defined above. For operating plants certain inspections and load tests may be accepted in lieu of certain material requirements in the standard. In addition, the stress design factor stated in Section 3.2.1.1 of ANSI N14.6 should be based on the combined maximum static and dynamic loads that could be imparted on the handling device based on characteristics of the crane which will be used. This is in lieu of the guideline in Section 3.2.1.1 of ANSI N14.6 which bases the stress design factor on only the weight (static load) of the load and of the intervening components of the special handling device."

a. Summary of Licensee Statements and Conclusions

The Licensee states that the lifting devices were designed according to industrial standards using good engineering practices. Additionally, load tests have been performed on the following lifting devices to the weight specified:

1. reactor head strongback - 129 tons (129% of rated load)
2. moisture separator hook box - 129 tons (180%)
3. dryer separator lifting rig - 130 tons (205%).

b. FRC Evaluation

Quad Cities Station does not satisfy the criteria of this guideline on the basis that the Licensee has not verified that any of these special lifting devices have been evaluated with respect to the design, fabrication, testing,

and maintenance requirements specified in ANSI N14.6-1978 or with respect to the stress design factor identified in this guideline. The Licensee has documented that two of the three lifting devices identified (the moisture separator hook box and the dryer separator lifting rig) have been weight-tested to loads that meet or exceed the specified 150% load test; however, insufficient information has been provided to verify that periodic testing is being performed to maintain continuing compliance as specified in Section 5.2 of ANSI N14.6-1978. The load test of the reactor head strongback to 129% of rated load is not acceptable since it does not fulfill the requirement to test these lifting devices to 150% of rated load.

c. FRC Conclusions and Recommendations

Quad Cities Station does not comply with Guideline 4. In order to satisfactorily comply with the criteria, the Licensee should perform the following:

1. conduct a point-by point comparison of all special lifting devices against the criteria of ANSI N14.6-1978 and the stress design factor of this guideline and evaluate all differences

2. conduct a 150% load test of the reactor head strongback

3. verify that programs exist for special lifting devices which satisfy the requirements of ANSI N14.6-1978, Section 5 (Acceptance Testing, Maintenance, and Assurance of Continued Compliance).

2.1.5 Lifting Devices (Not Specially Designed) [Guideline 5, NUREG-0612, Article 5.1.1(5)]

"Lifting devices that are not specially designed should be installed and used in accordance with the guidelines of ANSI B30.9-1971, 'Slings' [8]. However, in selecting the proper sling, the load used should be the sum of the static and maximum dynamic load. The rating identified on the sling should be in terms of the 'static load' which produces the maximum static and dynamic load. Where this restricts slings to use on only certain cranes, the slings should be clearly marked as to the cranes with which they may be used."

a. Summary of Licensee Statements and Conclusions

The Licensee states that lifting devices were designed according to industrial standards using good engineering practices. Procedures for the use, maintenance, and storage of slings and cables at Quad Cities Station are being developed from the Dresden Station procedures, which. Are based on and do comply with ANSI B30.9-1971.

b. FRC Evaluation

Procedures being implemented for use and installation of slings at Quad Cities Station are acceptable based upon the Licensee's statement that these procedures comply with ANSI B30.9-1971.

Insufficient information has been provided, however, to ensure that the following requirements of Guideline 5 will be incorporated into plant procedures:

- o sling selection is based upon the sum of the static and maximum dynamic load
- o slings are marked with the static load in accordance with this guideline
- o slings restricted in use to only certain cranes are clearly marked to so indicate.

c. FRC Conclusions and Recommendations

Quad Cities Station will comply with Guideline 5 upon implementation of revised procedures assuring that all requirements of this guideline, whether or not specifically identified in the Licensee's response, are incorporated in these procedures. The Licensee should verify that Quad Cities procedures provide for the following:

1. selection of slings based upon the sum of the static and maximum dynamic load
2. marking of slings with the static load in accordance with this guideline
3. slings restricted in use to only certain cranes are clearly marked to so indicate.

These revised procedures should be readily available for review and inspection by the NRC staff.

2.1.6 Cranes (Inspection, Testing, and Maintenance) [Guideline 6, NUREG-0612, Article 5.1.1(6)]

"The crane should be inspected, tested, and maintained in accordance with Chapter 2-2 of ANSI B30.2-1976, 'Overhead and Gantry Cranes,' with the exception that tests and inspections should be performed prior to use where it is not practical to meet the frequencies of ANSI B30.2 for periodic inspection and test, or where frequency of crane use is less than the specified inspection and test frequency (e.g., the polar crane inside a PWR containment may only be used every 12 to 18 months during refueling operations, and is generally not accessible during power operation. ANSI B30.2, however, calls for certain inspections to be performed daily or monthly. For such cranes having limited usage, the inspections, test, and maintenance should be performed prior to their use)."

a. Summary of Licensee Statements and Conclusions

The Licensee states that the Quad Cities standard for the testing, inspection, and maintenance of overhead cranes, QMS 100-2, was based on and does comply with ANSI B30.2-1976.

b. FRC Evaluation

The Licensee satisfies the criteria of this guideline on the basis that crane inspection, testing, and maintenance programs at Quad Cities Station comply with ANSI B30.2-1976.

c. FRC Conclusions and Recommendations

Quad Cities Station complies with Guideline 6 on the basis of the Licensee's certification that they operate in accordance with internal procedures in full compliance with ANSI B30.2-1976.

2.1.7 Crane Design [Guideline 7, NUREG-0612, Article 5.1.1(7)]

"The crane should be designed to meet the applicable criteria and guidelines of Chapter 2-1 of ANSI B30.2-1976, 'Overhead and Gantry

Cranes,' and of CMAA-70, 'Specifications for Electric Overhead Traveling Cranes' [9]. An alternative to a specification in ANSI B30.2 or CMAA-70 may be accepted in lieu of specific compliance if the intent of the specification is satisfied."

a. Summary of Licensee Statements and Conclusions

Cranes in use at Quad Cities Station were purchased to Sargent and Lundy specifications including Electric Overhead Traveling Bridge Cranes (Form 280B), which was based upon the American Institute of Steel Construction Specifications, Electric Overhead Crane Institute (EOCI) Specifications, and USAS Safety Code B30.2.0-1967. A comparison of these requirements with the recommendations of CMAA-70 has been performed and, based upon this review, the Licensee states that these cranes meet the intent of CMAA-70.

Specific differences between the procurement specification and CMAA-70 have been identified by the Licensee. Specifically, regarding impact allowance, the Licensee states that the EOCI specification requires a design force equal to 15% of the rated capacity of the crane, while CMAA-70 specifies that the impact load be 0.5% of the load times the hoist speed in feet per minute and that the impact should be not less than 15% and not greater than 50% of the rated capacity. Cranes procured for Quad Cities Station conform to the requirements of CMAA-70 since hoist speeds are less than 30 feet per minute.

b. FRC Evaluation

Cranes at Quad Cities Station substantially satisfy the criteria of Guideline 7 on the basis that they were procured according to EOCI-61 and other industry standards of that period. However, in addition to those items addresed by the Licensee, several more restrictive design requirements were imposed by CMAA-70 which could affect the cranes' ability to safely handle heavy loads.

FRC has compared the recommendations of CMAA-70 against those of EOCI-61 [10] and identified several areas where revisions incorporated into CMAA-70 may affect crane safety. The Licensee should evaluate these areas to determine

whether the intent of NUREG-0612 is satisfied. In particular, the following issues should be addressed in the Licensee's review.

1. 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 girder center of gravity. For girder sections symmetrical about each principal central axis (e.g., box section or I-beam girders commonly used in cranes subject to this review), the shear center coincides with the centroid of the girder section and there is no difference between the two requirements. Such is not the case for nonsymmetrical girder sections (e.g., channels).

2. 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. The requirements of CMAA-70 represent a codification of girder design practice and they are expected to be equivalent to design standards employed in cranes built to EOCI-61 specifications.

3. Allowable compressive stress. CMAA-70, Article 3.3.3.1.3 identifies allowable compressive stresses of approximately 50% 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% 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. This variation is not

expected to be of consequence for cranes subject to this review since b/c ratios of structural members are expected to be less than 38.

4. 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 expected to be of consequence for cranes subject to this review since the 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).

5. 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% 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% of the published rope breaking strength. The effect of this variation on crane safety margins depends on the ratio of the weights of the load block and the rated load.

6. 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. This variation is not expected to be of consequence since the requirements of CMAA-70 represent the codification of the same good engineering practice that would have been incorporated in cranes built to EOCI-61 specifications although a specific requirement was not contained in EOCI-61.

7. Drum design. CMAA-70, Article 4.4.3 provides recommended drum groove depth and pitch. EOCI-61 provides no similar guidance. The recommendations in CMAA-70 constitute a codification of good engineering practice with regard to reeving stability and reduction of rope wear and are not expected to differ substantially from practices employed in the design of cranes subject to this review and built to EOCI-61 specifications.

8. Gear design. CMAA-70, Article 4.5 requires that gearing horsepower rating be based on certain American Gear Manufacturers Association Standards and provides a method for determining allowable horsepower. EOCI-61 provides no similar guidance. The recommendations in CMAA-70 constitute a codification of good engineering practice for gear design and are not expected to differ substantially from the practices employed in the design of cranes subject to this review and built to EOCI-61 specifications.

9. 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% of bridge motor torque. EOCI-61 requires a brake rating of 50% of bridge motor torque for similar configurations. A cab-on-trolley control arrangement is not expected for cranes subject to this rewiew.

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

This variation is not expected to be of consequence for cranes subject to this review since mechanical load brakes were typically specified for cranes built to EOCI-61 specifications. The addition of a holding brake safety margin in conjunction with electric control braking is a codification of good engineering practice. Some manufacturers provide holding brakes rated at up to 150% of hoist motor torque when used with electrical control braking systems.

11. 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 end of bridge and trolley travel. No similar guidance is provided in EOCI-61. This variation is not expected to be of significance for cranes subject to this review since these cranes are not expected to be operated under load at substantial bridge or trolley speed near the end of travel. Further, the guidance of CMAA-70 constitutes the codifica-

tion of the same good engineering practice that would have been used in the design of cranes built to EOCI-61 specifications.

12. 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. This variation is not expected to be of safety significance because magnetic control systems were generally employed in cranes designed when EOCI-61 was in effect and the static control requirements identified in CMAA-70 constitute a codification of the same good engineering practice that would have been used in the design of static control systems in cranes built to EOCI-61 specifications.

13. 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. This variation is not expected to be of consequence for cranes subject to this review since they are generally designed with spring return controllers or momentary contact push buttons.

c. FRC Conclusions and Recommendations

Quad Cities Station complies with Guideline 7, to a substantial degree, on the basis of compliance with EOCI-61 criteria. However, the Licensee should provide information to verify that the following CMAA-70 requirements have been satisfied for cranes subject to this review or provide suitable justification for concluding that the requirements of CMAA-70 have been satisfied by equivalent means:

1. nonsymmetrical girder sections were not used in construction of the cranes

2. any longitudinal stiffeners in use conform to the requirements of CMAA-70, and allowable h/t ratios in box girders using these stiffeners do not exceed ratios specified in CMAA-70

3. girders with b/c ratios in excess of 38 were not used

4. fatigue failure was considered in crane design and the number of design loading cycles at or near rated load was less than 20,000 cycles

5. maximum crane load weight, plus the weight of the bottom block, divided by the number of parts of rope does not exceed 20% of the manufacturer's published breaking strength

6. drum design calculations were based on the combination of crushing and bending loads

7. drum groove depth and pitch conform to the recommendations of CMAA-70

8. gear horsepower ratings were based on design allowables and calculation methodology equivalent to that incorporated into CMAA-70

9. cab-control, cab-on-trolley configurations were not used

10. mechanical load brakes or hoist holding brakes with torque ratings of approximately 125% of the hoist motor torque were used

11. crane operation under load near the end of the bridge or trolley travel is not allowed or is compensated for by bumpers and stops which satisfy the intent of CMAA-70

12. any static control systems in use conform to the requirements of CMAA-70

13. controllers used were of the spring-return or momentary-contact pushbutton type.

2.2 INTERIM PROTECTION MEASURES

The NRC has established six interim protection measures to be implemented at operating nuclear power plants to provide reasonable assurance that no heavy loads will be handled over the spent fuel pool and that measures exist to reduce the potential for accidental load drops to impact on fuel in the core or spent fuel pool. Four of the six interim measures of the report consist of general Guideline 1, Safe Load Paths; Guideline 2, Load Handling Procedures; Guideline 3, Crane Operator Training; and Guideline 6, Cranes (Inspection, Testing, and Maintenance). The two remaining interim measures cover the following criteria:

1. Heavy load technical specifications

2. Special review for heavy loads handled over the core.

The status of the Licensee's implementation and FRC's evaluation of these interim protection measures are summarized in the succeeding paragraphs of this section.

2.2.1 Technical Specifications [Interim Protection Measure 1, NUREG-0612, Article 5.3(1)]

"Licenses for all operating reactors not having a single-failure-proof overhead crane in the fuel storage pool area should be revised to include a specification comparable to Standard Technical Specification 3.9.7, 'Crane Travel - Spent Fuel Storage Pool Building,' for PWR's and Standard Technical Specification 3.9.6.2, 'Crane Travel,' for BWR's, to prohibit handling of heavy loads over fuel in the storage pool until implementation of measures which satisfy the guidelines of Section 5.1."

a. Summary of Licensee Statements and Conclusions

The Licensee made no statement of conclusions regarding this interim protection measure.

b. FRC Evaluation, Conclusions, and Recommendations

Quad Cities Station does not comply with Interim Protection Measure 1 and should implement the required technical specification.

2.2.2 Administrative Controls [Interim Protection Measures 2, 3, 4, and 5, NUREG-0612, Article 5.3(2)-5.3(5)]

"Procedural or administrative measures [including safe load paths, load handling procedures, crane operator training, and crane inspection]... can be accomplished in a short time period and need not be delayed for completion of evaluations and modifications to satisfy the guidelines of Section 5.1 of [NUREG-0612]."

a. Summary of Licensee Statements and Conclusions

Summaries of Licensee statements and conclusions are contained in discussions of the respective general guidelines in Sections 2.1.1, 2.1.2, 2.1.3, and 2.1.6.

b. FRC Evaluations, Conclusions, and Recommendations

FRC's evaluations, conclusions, and recommendations are contained in discussions of the respective general guidelines in Sections 2.1.1, 2.1.2, 2.1.3, and 2.1.6.

2.2.3 Special Reviews for Heavy Loads Over the Core [Interim Protection Measure 6, NUREG-0612, Article 5.3(1)]

"Special attention should be given to procedures, equipment, and personnel for the handling of heavy loads over the core, such as vessel internals or vessel inspection tools. This special review should include the following for these loads: (1) review of procedures for installation of rigging or lifting devices and movement of the load to assure that sufficient detail is provided and that instructions are clear and concise; (2) visual inspections of load bearing components of cranes, slings, and special lifting devices to identify flaws or deficiencies that could lead to failure of the component; (3) appropriate repair and replacement of defective components; and (4) verify that the crane operators have been properly trained and are familiar with specific procedures used in handling these loads, e.g., hand signals, conduct of operations, and content of procedures."

a. Summary of Licensee Statements and Conclusions

The Licensee made no statements or conclusions reqgarding this interim protection measure.

b. FRC Evaluation, Conclusions, and Recommendations

The Licensee does not comply with Interim Protection Measure 6 and should perform the special review specified in the interim measure.

3. CONCLUDING SUMMARY

This summary is provided to consolidate the conclusions and recommendations of Section 2 and to document FRC's overall evaluation of the handling of heavy loads at Quad Cities Station. It is divided into two sections dealing with general provisions for load handling at nuclear power plants (NUREG-0612, Article 5.1.1) and the staff recommendations for interim protection, pending complete implementation of the guidelines of NUREG-0612 (NUREG-0612, Article 5.3). In each case, recommendations for additional Licensee action, and additional NRC staff action where appropriate, are provided.

3.1 GENERAL PROVISIONS FOR LOAD HANDLING

The NRC staff has established seven guidelines concerning provisions for handling heavy loads in the area of the reactor vessel, near stored spent fuel, or in other areas where an accidental load drop could damage safe shutdown systems. Compliance with these guidelines is necessary to ensure that load handling system design, administrative controls, and operator training and qualification are such that the possibility of a load drop is very small for the critical functions performed by cranes at nuclear power plants. These guidelines are partially satisfied at Quad Cities Station. This conclusion is presented in tabular form as Table 3.1. Specific recommendations for achieving full compliance with these guidelines are provided as follows:

Guideline	Recommendation
1	a. Formally develop safe load paths for all heavy loads, similar to those identified for major loads in the reactor building.
	b. Incorporate safe load paths into all load handling procedures and equipment layout drawings.
	c. Clearly mark safe load paths on the floors in areas where loads are handled.
	d. Develop means for requiring that deviations from established load paths require written alternatives which are approved by the plant safety review committee.

Table 3.1. Quad Cities Units 1 and 2/NUREG-0612 Compliance Matrix

Heavy Loads	Weight or Capacity (tons)	Guideline 1 Safe Load Paths	Guideline 2 Procedures	Guideline 3 Crane Operator Training	Guideline 4 Special Lifting Devices	Guideline 5 Slings	Guideline 6 Crane - Test and Inspection	Guideline 7 Crane Design	Interim Measure 1 Technical Specifications	Interim Measure 6 Special Attention
1. Units 1/2 Reactor Bldg Cranes	125/9	--	--	C	--	--	C	I	--	--
Reactor Cavity Shield Plugs	110	NC	R	--	--	R	--	--	--	NC
Drywell Head	65	NC	C	--	NC	--	--	--	--	NC
Dryer Separator Blocks	46	NC	R	--	NC	--	--	--	--	NC
Reactor Vessel Head	96	NC	C	--	NC	--	--	--	--	NC
Steam Dryer	32	NC	C	--	NC	--	--	--	--	NC
Steam Separator	63.5	NC	C	--	NC	--	--	--	--	NC
Refueling "Cattle Chute"	11	NC	C	--	--	R	--	--	--	NC
TN-9 Cask	100	NC	R	--	NC	--	--	--	NC	NC
Misc. Equipment	--	NC	R	--	--	R	--	--	--	NC
Fuel Pool Gates	0.7	NC	C	--	--	R	--	--	NC	NC
Refuel Pool Slot Plugs	6.5	NC	R	--	--	R	--	--	NC	--
Vessel Service Platform	5	NC	R	--	--	R	--	--	--	--

C = Licensee action complies with NUREG-0612 Guideline.
NC = Licensee action does not comply with NUREG-0612 Guideline.
R = Licensee has proposed revisions/modifications designed to comply with NUREG-0612 Guideline.
I = Insufficient information provided by the Licensee.

Table 3.1 (Cont.)

Heavy Loads	Weight or Capacity (tons)	Guideline 1 Safe Load Paths	Guideline 2 Procedures	Guideline 3 Crane Operator Training	Guideline 4 Special Lifting Devices	Guideline 5 Slings	Guideline 6 Crane - Test and Inspection	Guideline 7 Crane Design	Interim Measure 1 Technical Specifications	Interim Measure 6 Special Attention
RV Head Insulation	6	NC	R	--	NC	--	--	--	--	NC
In-Vessel Work Skiff	7	NC	R	--	--	R	--	--	--	NC
New Fuel/ Metal Shipping Container	1.5	NC	C	--	--	R	--	--	NC	NC
Test Weights- Refuel Bridge	0.9	NC	R	--	--	R	--	--	--	NC
2. Units 1/2 Drywell First Level Monorail	20	--	--	C	--	--	C	I	--	--
Misc. PWR Plant Equipment	--		R	--	--	R	--	--	--	--
3. 2nd Floor Jib Crane	2	--	--	C	--	--	C	I	--	--
CRD Jib Crane	0.5	--	--	C	--	--	C	I	--	--
Misc. PWR Plant Equipment	--		R	--	--	R	--	--	--	--

Table 3.1 (Cont.)

Heavy Loads	Weight or Capacity (tons)	Guideline 1 Safe Load Paths	Guideline 2 Procedures	Guideline 3 Crane Operator Training	Guideline 4 Special Lifting Devices	Guideline 5 Slings	Guideline 6 Crane - Test and Inspection	Guideline 7 Crane Design	Interim Measure 1 Technical Specifications	Interim Measure 6 Special Attention
4. Turbine Bldg Crane										
Unit 1	125/10	--	--	C	--	--	R	I	--	--
Unit 2	175/25	--	--	C	--	--	R	I	--	--
Upper/Lower Turbine Diaphragms	9	NC	R	--	--	C	--	--	--	--
Low Pressure Rotor	114	NC	R	--	NC	--	--	--	--	--
High Pressure Rotor	59	NC	R	--	NC	--	--	--	--	--
High Pressure Casing	72	NC	R	--	--	C	--	--	--	--
Exhaust Hood	28	NC	R	--	--	C	--	--	--	--
Inner Casing	51	NC	R	--	--	C	--	--	--	--
Generator Rotor	175	NC	R	--	NC	--	--	--	--	--
Miscellaneous	--	NC	R	--	--	C	--	--	--	--

Guideline	Recommendation
2, 3	(Quad Cities Station complies with these guidelines.)
4	a. Perform a point-by-point comparison of all special lifting devices with the criteria of ANSI N14.6-1978 and the stress design factor of this guideline.
	b. Conduct a 150% load test of the reactor head strongback.
	c. Establish or verify that programs exist which satisfy the requirements of ANSI N14.6-1978, Section 5.2 (Acceptance Testing, Maintenance, and Assurance of Continued Compliance).
5, 6	(Quad Cities Station complies with these guidelines.)
7	Evaluate crane designs at Quad Cities for compliance with the 14 items identified in the FRC evaluation of CMAA-70.

3.2 INTERIM PROTECTION

The NRC staff has established (NUREG-0612, Article 5.3) that certain measures should be initiated to provide reasonable assurance that handling of heavy loads will be performed in a safe manner until final implementation of the general guidelines of NUREG-0612, Article 5.1 is complete. Specified measures include the implementation of a technical specification to prohibit the handling of heavy loads over fuel in the storage pool; compliance with Guidelines 1, 2, 3, and 6 of NUREG-0612, Section 5.1.1; a review of load handling procedures and operator training; and a visual inspection program, including component repair or replacement as necessary of cranes, slings, and special lifting devices to eliminate deficiencies that could lead to component failure. FRC's evaluation of information provided by the Licensee indicates that the following actions are necessary to ensure that the staff's measures for interim protection at Quad Cities Station are met:

Interim Measure	Recommendation
1	Implement the criteria of this interim protection measure.
2	Implement the recommendations of Guideline 1.

Interim Measure	Recommendation
3, 4, 5	(Quad Cities Station complies with these interim protection measures.)
6	Implement the criteria of this interim protection measure.

3.3 SUMMARY

NRC's general guidelines and interim protection measures of NUREG-0612 have been substantially complied with at Commonwealth Edison's Quad Cities Station. Several programs have been implemented which comply with NRC staff guidelines, including load handling procedures, operator training, use of slings, and crane inspection and maintenance programs. Licensee action is required on the remaining general guidelines and interim actions to fully comply with NUREG-0612.

4. REFERENCES

1. NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants"
   NRC, July 1980

2. V. Stello, Jr. (NRC)
   Letter to all Licensees
   Subject: Request for Additional Information on Control of Heavy Loads Near Spent Fuel
   NRC, 17 May 1978

3. NRC
   Letter to Consolidated Edison
   "Request for Review of Heavy Load Handling at Indian Point Unit Two"
   22 December 1980

4. E. D. Swartz (CE)
   Letter to D. G. Eisenhut (NRC)
   Subject: "Control of Heavy Loads Review"
   22 June 1981

5. M. S. Turbar (CE)
   Letter to V. Stello (NRC)
   Subject: response to Request for Additional Information Concerning Control of Heavy Loads Near Spent Fuel
   13 July 1978

6. ANSI B30.2-1976
   "Overhead and Gantry Cranes"

7. ANSI N14.6-1978
   "Standard for Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More for Nuclear Materials"

8. ANSI B30.9-1971
   "Slings"

9. CMAA-70
   "Specifications for Electric Overhead Traveling Cranes"
   1975

10. EOCI-61
    "Specifications for Electric Overhead Traveling Cranes"
    1961