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TECHNICAL EVALUATION REPORT

CONTROL OF HEAVY LOADS

FLORIDA POWER COMPANY

CRYSTAL RIVER UNIT 3

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FRC ASSIGNMENT 3

FRC TASK 71

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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 the Florida Power Company's (FPC) Crystal River Unit 3 Nuclear Power Plant. This evaluation had 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 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 concluded from this evaluation that existing measures to control the handling of heavy loads at operating plants provide protection from certain potential problems, but do not adequately cover the major causes of load handling accidents and should be upgraded.

To upgrade measures for the control of heavy loads, the staff developed a series of guidelines with a two-part objective. The first part of the objective, to be achieved through a set of general guidelines expressed 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 appropriately small for the critical tasks in which they are employed. The second part of the staff's objective, to be achieved through

guidelines expressed in NUREG-0612, Article 5.1.2.5, is to ensure that, for load handling systems used 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 make the potential for a load drop 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 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 FPC, the Licensee for Crystal River Unit 3, requesting that the Licensee review and evaluate provisions for handling and control of heavy loads 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. FPC responded on September 2, 1981 [4].

2. EVALUATION AND RECOMMENDATIONS

FRC's evaluation of load handling at Crystal River Unit 3 is divided into two categories which deal separately with the general guidelines of NUREG-0612 Article 5.1.1, and the recommended interim measures of Article 5.3 or their equivalents from NUREG-0612. Applicable guidelines are referenced in each category. FRC's conclusion and recommendations are presented in the summary for each guideline.

2.1 GENERAL GUIDELINES

The NRC has established seven general guidelines which must be met to provide the defense-in-depth approach to safe handling of heavy loads. They 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 by all overhead handling systems and programs used to 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 Overhead Heavy Load Handling Systems

The following systems at Crystal River Unit 3 have been identified by the Licensee as overhead heavy load handling systems subject to the criteria of NUREG-0612:

- (RCCR-1) reactor building polar crane
- (RCCR-2) reactor vessel tool handling jib crane
- (ICHT-8) incore instrument container hoist
- reactor building mechanized scaffolding
- (FHCR-5) auxiliary building crane
- (FHCR-7) spent fuel pool missile shield crane
- (SFHT-7) spent fuel pool gate chain hoist
- (CWCR-1) intake structure gantry crane.

Following review of the Licensee's response, FRC concurs with FPC that the main fuel handling bridge, the auxiliary fuel handling bridge, the turbine building crane, the emergency diesel generator service monorail, and the emergency feed pump monorails may be excluded from compliance with NUREG-0612. The Licensee states that the main fuel handling bridge and the auxiliary fuel handling bridge handle no loads greater than the weight of a spent fuel assembly and its associated handling tool. The turbine building crane has been excluded since it does not travel over safe shutdown or decay heat removal equipment. The emergency diesel generator service and emergency feed pump monorails have been excluded from compliance due to sufficient physical separation and assuming that the monorails will be used only when the respective components have been rendered out of commission.

2.1.2 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

The Licensee states that a comprehensive load handling program has been established for Crystal River Unit 3 which defines load paths for load

handling operations to avoid or minimize the time of load travel over spent fuel or equipment required for safe shutdown or decay heat removal. For those load handling systems which have been designated to comply with NUREG-0612, the Licensee has noted that safe load paths have been developed and identified in plant drawings. Exclusion areas rather than safe load paths have been established for the intake structure gantry crane, which is used primarily for pulling the circulating water pumps and motors for maintenance and for placing the stop logs in the intake structure. These exclusion areas protect buried conduits and associated equipment carrying water to the nuclear service water (NSW) pumps.

b. FRC Evaluation

Safe load paths developed at Crystal River Unit 3 satisfy the criteria of Guideline 1 based upon FRC's review of the Licensee's response and drawings submitted for review. Use of exclusion areas around the intake structure gantry cranes is not acceptable, however, in that specific pathways for the movement of loads, as specified in the guideline, have not been designated. Although FRC acknowledges that use of these exclusion areas is acceptable from the standpoint of preventing load drops in the vicinity of the NSW conduits, exclusion areas do not meet the intent of the NRC guideline, i.e., to provide specific pathways for the movement of heavy loads through the use of procedures, physical markings, and drawings. Compliance with these guidelines is not anticipated to create any significant difficulty since the Licensee has noted that this crane is used primarily for pulling circulating water pumps and motors and for movement of stop logs to the intake structure; therefore, the Licensee should be able to delineate load pathways with little difficulty.

The Licensee's response clearly states that load paths have been developed, defined in procedures, and incorporated into drawings. However, insufficient information has been provided by the Licensee for FRC to verify that load paths have been clearly marked on the floors or that deviations from established load paths require written alternative procedures approved by the plant safety review committee.

c. FRC Conclusions and Recommendations

Crystal River Unit 3 complies with Guideline 1 to a substantial degree (with the exception of the intake structure gantry crane), on the basis of the development of safe load paths and incorporation of these load paths into procedures and drawings. However, the Licensee should provide information to verify the following items:

1. safe load paths have been clearly marked on the floor in the areas where loads are handled

2. deviations from defined load paths require written alternative procedures which are approved by the plant safety review committee.

In addition, rather than define areas where loads may not be handled, the Licensee should develop safe load pathways for the intake structure gantry crane which conform with the criteria of this guideline, so that heavy loads are moved via designated pathways.

2.1.3 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

As a part of the comprehensive load handling program developed at Crystal River Unit 3, the Licensee states that operating procedures have been developed to ensure that load handling follows defined load paths. Numerous procedures are identified in the Licensee's response, including "Operation of the Reactor Building Polar Crane," "Operation of the Auxiliary Building Crane," and "Operation of Miscellaneous Cranes and Hoists." The Licensee further states that each procedure identifies load paths for each respective load that is handled.

Although safe load paths have been developed for spent fuel casks, the Licensee notes that these casks are not presently handled and no procedures have been developed; handling of these casks will be addressed in detail as a separate issue outside the scope of NUREG-0612.

b. FRC Evaluation

Although the Licensee has identified several procedures which exist for load handling systems and which contain definitions of safe load pathways, insufficient information has been provided to verify that these procedures contain the information specified in this guideline for those loads identified. Specifically, no information is available to determine if procedures in use contain the following information: (1) identification of required equipment; (2) inspection and acceptance criteria; (3) proper sequence of events; and (4) other safety precautions. In addition, no procedures have been identified governing operation of the intake structure gantry crane. Procedures should be developed which contain the information identified above, including safe load path definitions.

FRC does not concur with the Licensee's intentions to address handling of spent fuel casks as an issue separate from NUREG-0612. Since these casks may impact upon irradiated fuel, the Licensee should verify that handling of the casks will conform to the general guidelines of NUREG-0612, regardless of any further analyses performed by the Licensee regarding potential cask drop accidents. Procedures should be developed for handling of the spent fuel cask, incorporating safe load paths already identified. FRC recognizes that these procedures may be interim in nature and subject to revision following any further cask drop analyses, but they should comply with the basic criteria identified in Guideline 2. The need for development of these procedures for the spent fuel cask is based upon the fact that this review by FRC constitutes the only comprehensive evaluation of load handling practices at Crystal River Unit 3, and therefore all issues should be resolved either by compliance with the guideline, or, in the case of non-compliance, by implementation of the necessary corrective actions within a reasonable period of time so that no unresolved items are deferred to a future unspecified date.

c. FRC Conclusions and Recommendations

Crystal River Unit 3 does not comply with Guideline 2. In order to fully comply with the criteria of the guideline, the Licensee should perform the following:

1. Verify that the necessary information is contained within the format of those procedures currently in use, including identification of equipment, inspection and acceptance criteria, proper sequence of events, and other safety precautions.

2. Develop procedures for the handling of heavy loads by the intake structure gantry crane.

3. Develop procedures for the handling of the spent fuel shipping cask.

2.1.4 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' [5]."

a. Summary of Licensee Statements and Conclusions

The third phase of FPC's comprehensive load handling program at Crystal River Unit 3 consists of developing an extensive operator training program to ensure that load handling operations follow defined load paths. To accomplish this, crane operator procedures and training are being upgraded to meet the intent of ANSI B30.2-1976.

b. FRC Evaluation

FRC is unable to determine from the Licensee's response whether the requirements of ANSI B30.2-1976, Chapter 2-3, have been satisfied for training, qualification, and conduct of crane operators at Crystal River Unit 3.

c. FRC Conclusions and Recommendations

Crystal River Unit 3 does not comply with Guideline 3. In order to comply, the Licensee should state whether requirements for crane operator

training, qualification, and conduct are in accordance with those specified in Chapter 2-3 of ANSI B30.2-1976.

2.1.5 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' [6]. 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

FPC has identified one special lifting device, the reactor vessel head and internals lifting device, to be subject to the criteria of ANSI 14.6-1978. ANSI guideline criteria were not considered applicable to one other lifting device identified (the spent fuel pool missile shield lifting beam) since the load handled will float if dropped and will not impact irradiated fuel in the spent fuel pool. For the reactor vessel head and internals lifting device, the Licensee states that design and fabrication were performed prior to the existence of ANSI N14.6-1978 and, therefore, it is difficult to make strict comparisons between the actual lifting device and the standard. The Licensee's analysis of applicable sections of ANSI N14.6-1978 which deal with the load handling reliability of the lifting device is contained in the following paragraphs.

Section 3. The Licensee states that the reactor vessel head and internals lifting device was designed to industry standards and Babcock & Wilcox Company (B&W) engineering practices that were in effect at the time. No specific design specification was prepared for the special lifting device design, although the Licensee states that use of B&W standard engineering and design practices as well as B&W's knowledge of how the device would be used should

adequately fulfill these requirements. The lifting device and its components were designed to not exceed a minimum yield strength of 3 times design capacity (180 tons), without consideration for dynamic loading. Due to excess design margin, this stress design factor is in compliance with the ANSI N14.6-1978 standard as supplemented by NUREG-0612. The Licensee has been unable to retrieve any information on materials testing. In addition, since the head and internals lifting device was specifically designed for the reactor vessel head and internals, the Licensee states that the design considerations of ANSI-N14.6, Sections 3.3, 3.4, 3.5, and 3.6, were all considered in the context of the design practices in use when the device was built.

Section 4. The Licensee states that the lifting device design incorporated B&W fabrication practices in effect at the time of fabrication, although no quality assurance requirements were placed on the fabrication of the device. Application of this section in retrospect to the standard B&W manufacturing practices, however, is not considered by the the Licensee to be practical.

Section 5. Proper use and maintenance of the head and internals device, which the Licensee regards as the responsibilities of the owner, are addressed in various refueling and surveillance procedures, while current inspection practices are performed at each refueling outage. With regard to the initial acceptance load test specified in ANSI N14.6-1978, the head and internals lifting device and components were initially load tested to 255 tons, which is 160% of the weight of the reactor vessel head, the maximum load to which the device is subjected. Following this load test, non-destructive examination (NDE) was performed on all load bearing welds.

In lieu of an annual 150% load test, the Licensee states that NDE is performed on the head and internals lifting device prior to its use, in accordance with ANSI N14.6-1978, Section 5.3.1(2). These inspections are performed prior to use of the device or at refueling outages, rather than at the specified periodicity due to the inaccessibility of the handling device when stored within the containment.

Section 6. FPC cannot determine the applicability of this section at this time due to the structural, impact, and other analyses that are required to make a determination of critical loads.

b. FRC Evaluation

FRC concurs with the Licensee that it is difficult to make a strict interpretation of compliance with ANSI N14.6-1978 and agrees that only those sections which have a direct bearing on the load handling reliability of the special lifting device need be addressed. Licensee exceptions to criteria specified in Sections 3 through 6 of ANSI N14.6-1978 have been evaluated by FRC in the following paragraphs.

Section 3. Although this section deals with specifications for new handling devices and FPC has stated that no design specification was prepared for the reactor vessel head and internals lifting rig, certain information and records should be in the Licensee's possession, or should be obtained or verified by the Licensee in order to determine the load handling reliability of the lifting device. Specifically, the Licensee should verify that records are available or analyses have been performed to document the following:

1. Section 3.1
   a. limitations on the use of the device (3.1.1)
   b. identification of a critical items list (3.1.2)
   c. signed stress analyses to demonstrate adequacy (3.1.3)
   d. indication of permissible repair procedures (3.1.4)

2. Section 3.2
   a. documentation of a stress design factor of 5 for ultimate strength (3.2.1.1)
   b. load bearing pin, links, and adapter design criteria (3.2.4).
   c. conformance to standards of wire rope or chain (3.2.5)
   d. performance of drop weight or impact testing (3.2.6)

3. Section 3.3
   a. distribution of load (3.3.4)
   b. retainers for load carrying components (3.3.5)
   c. actuating mechanisms (3.3.6)
   d. means of pool retrieval (3.3.7).

FRC concurs that the remaining design sections (3.4, 3.5, and 3.6) do not deal with load handling reliability and need not be addressed by the Licensee.

Section 4. Although this section of the standard deals with the fabrication of new lifting devices, the Licensee should have available certain necessary information concerning fabrication of the previously installed head and internals lifting device, particularly since no quality assurance existed during its fabrication and the Licensee has provided no information other than "standard B&W manufacturing practices were used." Specifically, the Licensee provided no information to substantiate (1) the selection and use of materials that meet the performance criteria (4.1.3), (2) compliance with acceptable fabrication practices and the use of generally accepted good practices (4.1.4), and (3) the use of qualified welding procedures and operators (4.1.5). FRC considers that application of this section in retrospect should, at the minimum, require that the identified information be obtained, in light of the lack of quality controls during fabrication.

Section 5. Previous load tests and current inspections, performed at the intervals specified by the Licensee, satisfy the criteria of this section. However, the Licensee should verify that load testing following maintenance and inspections by both operating and non-operating personnel are performed as required by the standard.

Section 6. FRC concurs with the Licensee that applicability of this section should be determined in the subsequent analysis of the second phase of NUREG-0612.

c. FRC Conclusions and Recommendations

Insufficient information has been provided by FPC to determine compliance with Guideline 4. In order to fully comply, the Licensee should substantiate that information or analyses are available to document the design and fabrication of those items identified in FRC's evaluation which have a direct bearing on load handling reliability.

2.1.6 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 guideline of ANSI B30.9-1971, 'Slings' [7]. 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 plant procedures governing the testing and use of slings are being revised to be in accordance with ANSI B30.9-1971.

b. FRC Evaluation

Procedures being implemented for testing and installation of slings at Crystal River Unit 3 are acceptable based upon the Licensee's statement that these procedures will 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 loads
- 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

Crystal River Unit 3 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 Crystal River Unit 3 procedures provide for the following:

1. selection of slings based upon the sum of the static and maximum dynamic loads

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.

2.1.7 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

FPC is currently upgrading crane inspection, testing, and maintenance procedures to meet the intent of ANSI B30.2-1976, Chapter 2-2.

b. FRC Evaluation

When completed, FPC's crane inspection, testing, and maintenance program will satisfy the criteria of Guideline 6, on the basis of the Licensee's verification that the program is based on Chapter 2-2 of ANSI B30.2-1976.

c. FRC Conclusions and Recommendations

Crystal River Unit 3 complies with Guideline 6. The crane inspection, testing, and maintenance programs are being revised to satisfy the requirements

of ANSI B30.2-1976. When revision is complete, these programs and appropriate records should be made readily available for review and inspection by the NRC staff.

2.1.8 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' [8]. 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

The Licensee states that the three cranes of concern (RCCR-1, the reactor building polar crane; FHCR-1, the auxiliary building crane; and CWCR-1, the intake structure gantry crane) were originally built in 1969 to industry standards in effect at that time, the "Specification for Electric Overhead Traveling Cranes" (EOCI-61) [9] and the detailed crane procurement specification prepared by Gilbert Associates, Inc. A comparison of these specifications against the criteria of CMAA-70 shows that Whiting practices and procedures for welding were in accordance with the then current American Welding Standard and are considered to be equivalent to those specified in CMAA-70 and ANSI B30.2-1976.

An investigation is in progress to determine the actual design stress used for crane structural members.

b. FRC Evaluation

Cranes at Crystal River Unit 3 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 addressed 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 and has 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. Impact allowance. CMAA-70, Article 3.3.2.1.1.3 requires that crane design calculations include an impact allowance of 0.5% of the load per foot per minute of hoisting speed but not less than 15%. EOCI-61 specifies only a minimum allowance of 15%. Consequently, 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. This variation is not expected to be of consequence for the overhead cranes subject to this review since these cranes, in general, operate with hoist speeds below 30 feet per minute, most commonly in the range of 3 to 10 feet per minute.

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 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).

3. Bending stress. CMAA-70, Article 3.3.2.2 requires that bending stress calculations include a wind load of 5 pounds per square foot in design stress calculations based on the sum of dead and live loads. EOCI-61 requires that the design of outdoor cranes include a wind load of 10 pounds per square foot of projected area, but is not specific concerning the combination of wind loads with other dead and live loads. The combination of a wind load with other design loading calculations constitutes codification of the same good

engineering practice that would have been used in the cranes built to EOCI-61 specifications.

4. 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.

5. 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.

6. 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).

7. 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.

8. 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.

9. 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.

10. 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.

11. 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.

12. 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.

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

14. 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.

15. 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

Crystal River Unit 3 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. hoist speeds do not exceed 30 feet per minute
2. nonsymmetrical girder sections were not used in construction of the cranes
3. wind loadings were combined with dead load, weight of trolley, rated load, and impact allowance/lateral forces in design bending stress calculations
4. 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
5. girders with b/c ratios in excess of 38 were not used
6. 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
7. 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
8. drum design calculations were based on the combination of crushing and bending loads
9. drum groove depth and pitch conform to the recommendations of CMAA-70
10. gear horsepower ratings were based on design allowables and calculation methodology equivalent to that incorporated into CMAA-70

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

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

13. 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

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

15. controllers used were of the spring-return or momentary-contact push button 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]

"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. FRC Evaluation

The review of the Technical Specifications for Crystal River Unit 3 determined that Technical Specification 3.9.7 prohibits loads in excess of 2,750 pounds from travel over fuel assemblies in the spent fuel pool, with the exception of the pool divider gates and missile shields, which may be moved as necessary to gain access to fuel assemblies in the spent fuel pool. In addition, it is noted in the Licensee's response that the reactor building mechanized scaffold, used to retension the containment tendons, uses a 5-ton hydraulic jack and operates over the spent fuel pool in the auxiliary building. The Licensee states that this jack could be dropped into the spent fuel pool; however, operations using the scaffold are limited to times when the missile shields are in place over the spent fuel pool.

FRC's evaluation of this information indicates that Interim Protection Measure 1 has not been satisfied at Crystal River Unit 3. The Licensee is not in compliance with the interim measure in that at least three heavy loads (spent fuel pool divider gates, missile shields, and hydraulic jack) are carried over the spent fuel pool, whereas the interim measure specifies that heavy load handling should be prohibited over fuel in the spent fuel pool until Section 5.1 of NUREG-0612 has been satisfactorily implemented. No information has been provided to verify that suitable protective measures have been implemented, that analyses identified in Section 5.1.2 of NUREG-0612 have been implemented, or that an analysis has been performed to demonstrate that the spent fuel pool missile shields can withstand the impact of the 5-ton hydraulic jack.

b. FRC Conclusions and Recommendations

Crystal River Unit 3 does not comply with Interim Protection Measure 1 in that exceptions to the existing Technical Specification allow movement of several heavy loads over the spent fuel pool. In order to comply, the Licensee should revise existing Technical Specification 3.9.7 to prohibit

movement of all heavy loads over the spent fuel pool until the criteria of Sections 5.1.1 and 5.1.2 of NUREG-0612 have been satisfied, including analyses to substantiate the effects of selected load drops over the spent fuel pool or implementation of suitable system redundancy or interlocks.

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

"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 corresponding general guidelines in Sections 2.1.2, 2.1.3, 2.1.4, and 2.1.7.

b. FRC Evaluations, Conclusions, and Recommendations

FRC's evaluations, conclusions, and recommendations are contained in discussions for the corresponding general guidelines in Sections 2.1.2, 2.1.3, 2.1.4, and 2.1.7 of this report.

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

"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 of 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 regarding this interim protection measure.

b. FRC Evaluation, Conclusions, and Recommendations

The Licensee does not comply with this interim protection 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 FPC's Crystal River Unit 3. 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 the Crystal River Unit 3. 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.	Verify that safe load paths are clearly marked on the floors in areas where loads are handled.
	b.	Verify that deviations from defined load paths require written alternative procedures approved by the plant safety review committee.
	c.	Develop safe load pathways for the intake structure gantry crane.

Table 3.1 Crystal River/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. Containment Polar Crane (RCCR-1)	180(30)	--	--	NC	--	--	I	I	--	
Reactor Vessel Missile Shields	26	I	NC	--	--	R	--	--	--	
Pressurizer Missile Shields	15	I	NC	--	--	R	--	--	--	
Stud Tensioners	1	I	NC	--	--	R	--	--	--	
ISI Tool	17	I	NC	--	--	R	--	--	--	
Crane Block and Hook	5	I	NC	--	--	--	--	--	--	
Refueling Machine Components	1.3	I	NC	--	--	R	--	--	--	
Hatch Covers	10	I	NC	--	--	R	--	--	--	
Plenum	58.5	I	NC	--	--	--	--	--	--	
Internals Storage Stand	4.1	I	NC	--	--	R	--	--	--	
Core Barrel	162	I	NC	--	--	--	--	--	--	
RP Motors	50.5	I	NC	--	--	R	--	--	--	

C = Licensee action complies with NUREG-0612 Guideline.
PC = Licensee action partially 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.
-- = Not applicable.

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
RCPs	23	I	NC	--	--	R	--	--	--	NC
Reactor Vessel Head with Tripod	160	I	NC	--	I	--	--	--	--	NC
Index Fixture	6.3	I	NC	--	--	R	--	--	--	NC
Service Structure Platforms	1.5	I	NC	--	--	R	--	--	--	NC
Refueling Cavity Seal Plate	1.5	I	NC	--	--	R	--	--	--	NC
Fuel Transfer Tube Covers	1	I	NC	--	--	R	--	--	--	NC
2. Missile Shield Gantry Crane (FHCR-7)	10	--	--	NC	--	--	R	I	--	--
Spent Fuel Pit Gate Hoist (SFHT-7)	2	--	--	NC	--	--	R	I	NC	--
Spent Fuel Pool Missile Shields	3.2	I	NC	--	--	--	--	--	NC	--
Spent Fuel Pool Gate	2	I	NC	--	--	R	--	--	NC	--
3. Auxiliary Building Crane (FHCR-5)	120(15)	--	--	NC	--	--	R	I	--	--
Spent Fuel Cask	I	I	NC		I	--	--	--	NC	--

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
New Fuel Shipping Cask	3.6	I	NC		--	R	--	--	--	--
Crane Bottom Block and Hook	3.5	I	NC		--	--	--	--	--	--
New Fuel Pit Missile Shields	7	I	NC		--	--	--	--	--	--
Spent Fuel Cask Pit Gate	2	I	NC		--	R	--	--	NC	--
Spent Fuel Pool Missile Shields	4.5	I	NC		--	--	--	--	NC	--
4. Reactor Vessel Tool Handling Jib Crane (RCCR-2)	2.5	--	--	NC	--	--	R	I	--	
5. Incore Instrument Jib Crane (ICHT-8)	1	--	--	NC	--	--	R	I	--	
6. Mechanized Scaffold		--	--	NC	--	--	R	I	--	
7. Refueling Crane (FHCR-5)	120(15)	--	--	NC	--	--	R	I	--	
8. Intake Structure Gantry Crane (CWCR-1)	50	NC	NC	NC	--	--	R	I	--	

Guideline		Recommendation
2	a.	Verify that the procedural format contains the information specified in the guideline, i.e., identification of equipment, inspection and acceptance criteria, proper sequence of events, and safety precautions.
	b.	Develop procedures for the handling of heavy loads by the intake structure gantry crane.
	c.	Develop procedures for the handling of the spent fuel shipping cask.
3		State whether crane operator training, qualification, and conduct are in accordance with Chapter 2-3 of ANSI B-30.2-1976.
4		Substantiate that information or analyses are available to document the design and fabrication of those items identified in the evaluation to have a direct bearing on load handling reliability.
5, 6		(Crystal River Unit 3 complies with these guidelines.)
7		Evaluate crane designs at Crystal River Unit 3 for compliance with the 15 items identified in the FRC evaluation of CMAA-70.

3.2 INTERIM PROTECTION MEASURES

The NRC staff has stated in 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 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 Crystal River Unit 3 are taken:

Interim Measure	Recommendation
1	Revise Technical Specification 3.9.7 to prohibit movement of all heavy loads over the spent fuel pool until such time that the Licensee has completed implementation of NUREG-0612, Sections 5.1.1 and 5.1.2.
2, 3, 4	Implement the recommendations of Guidelines 1, 2, and 3 identified in Section 3.1.
5	(Crystal River Unit 3 complies with this interim protection measure.)
6	Implement the criteria of this interim protection measure.

3.3 SUMMARY

NRC's general guidelines and interim protection measures of NUREG-0612 have not been fully complied with at Florida Power Corporation's Crystal River Unit 3 Nuclear Power Plant. Several programs have been implemented which comply with staff guidelines, in particular those for crane maintenance, testing, and inspection, and lifting devices not specially designed. The Licensee's response indicated that guidelines for load handling procedures and programs for crane operator training, qualification, and conduct may have been complied with, but insufficient information was provided to substantiate full compliance. In addition, reviews by the Licensee indicate that designs of special lifting devices and cranes substantially comply with guideline criteria, but there exist several remaining items to be resolved for full compliance. Licensee action is still required to comply with safe load paths and the interim protection measures.

4. REFERENCES

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5. ANSI B30.2-1976
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