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TECHNICAL EVALUATION REPORT

CONTROL OF HEAVY LOADS

FLORIDA POWER & LIGHT COMPANY

TURKEY POINT UNITS 3 AND 4

NRC DOCKET NO. 50-250/251

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FOREWORD

This Technical Evaluation Report was prepared by Franklin Research Center under a contract with the U.S. Nuclear Regulatory Commission (Office of Nuclear Reactor Regulation, Division of Operating Reactors) for technical assistance in support of NRC operating reactor licensing actions. The technical evaluation was conducted in accordance with criteria established by the NRC.

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1. INTRODUCTION

1.1 PURPOSE OF REVIEW

This technical evaluation report documents the Franklin Research Center's (FRC) review of general load handling policy and procedures at the Florida Power and Light Company's Turkey Point Units 3 and 4. This evaluation was performed with the following objectives:

- 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
- 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 Florida Power and Light Company (FPL), the Licensee for Turkey Point, Units 3 and 4, requesting that the Licensee review provisions for handling and control of heavy loads at Turkey Point, 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 September 4, 1981, Florida Power and Light Company provided its response [4] to this request.

2. EVALUATION AND RECOMMENDATIONS

FRC's evaluation of load handling at Turkey Point is divided into two categories. These categories 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 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:

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

These seven guidelines should be satisfied for 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 Sections 2.1.1 through 2.1.8 of this report.

2.1.1 Overhead Heavy Load Handling Systems

The Licensee conducted a review of all overhead handling systems at Turkey Point to determine which overhead handling systems are subject to this

review. The Licensee identified the following overhead handling systems and equipment as those from which a load drop could result in damage to plant shutdown or decay heat removal systems taking no credit for interlocks, technical specifications, operating procedures, detailed structural analysis or system redundancy.

- o charging pump monorails
- o safety injection pump monorails
- o main steam platform monorails
- o turbine gantry cranes
- o reactor polar cranes
- o reactor cavity manipulator crane
- o fuel transfer machine
- o spent fuel bridge crane
- o fuel pool bulkhead monorail
- o spent fuel cask crane
- o intake structure bridge crane.

The Licensee also provided a tabulation of load handling systems for which they have determined by inspection that there is sufficient physical separation between any load impact point and any safety-related component.

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 has stated that "safe load paths areas" have been defined for the turbine gantry cranes, reactor polar cranes, spent fuel handling crane,

and intake structure bridge crane. A maintenance procedure (0736) has been prepared which defines the safe areas for load carrying by these cranes and requires operation within these areas. Deviation from this procedure requires prior written approval by the Maintenance Supervisor. FPL has indicated that unless safety concerns are raised in their final report on this subject, local path restriction will not be imposed during cold shutdown periods except over irradiated fuel and the reactor vessel.

FPL has indicated that no safe load path areas have been provided for the remaining load handling systems tabulated in Section 2.1.1. These systems have been determined to be exempt from these requirements on the basis of several crane-specific considerations.

- The reactor cavity manipulator crane, fuel transfer machine, and spent fuel bridge crane do not handle loads weighing more than one fuel assembly plus a handling tool. The consequences of a fuel handling accident have been evaluated and determined to be acceptable in the Turkey Point Final Safety Analysis Report.
- The fuel pool bulkhead, charging pump, safety injection pump, and main steam platform monorail physically restrict load handling to a single path. In the first three cases, special precautions and instructions will be provided to meet the intent of the safe load path requirement. In the case of the charging and safety injection pumps, for example, handling heavy loads over operating pumps, when required for safe shutdown, will be forbidden. The main steam platform monorails handle only safety-related valves which can be removed only when the plant is shut down and their safety function is not required.

b. FRC Evaluation

Review of Licensee responses and sketches indicates that areas have been established, for the turbine gantry, reactor polar, spent fuel cask, and intake structure cranes, over which the movement of heavy loads is restricted or excluded. However, specific pathways for the movement of heavy loads have not been designated. The use of exclusion areas partially satisfies the requirements of Guideline 1: it does prevent load drops in the vicinity of irradiated fuel and safe shutdown equipment. It does not, however, ensure that specific heavy loads are routed on the basis of an engineering review of

system and structural arrangements in a manner to minimize the hazard associated with a load drop. This can be accomplished only through a load-by-load analysis, giving due consideration to the location of structural members while minimizing the load travel path, which provides specific pathways for each heavy load. The implementation of these pathways, through procedures, physical markings, and suitable drawings, will ensure that these pathways are clearly identified for operators, load-handling supervisions, and plant maintenance personnel, and that the loads can be moved along well-established routes kept clear and uncluttered by temporary equipment or stores.

FPL has also indicated than any deviation from the safe load area (assumed to mean any redesignation of safe load areas or infringement upon exclusion areas) requires written approval of the Maintenance Supervisor. This approval is not consistent with the guideline requirements of approval by the plant safety review committee. While it is recognized that the specific designation of a plant safety review committee may not be applicable to all licensees, the intent of the requirement was to ensure that deviation from safe load paths, once established, was allowed only following review and approval by personnel responsible for overall plant safety and not by those primarily responsible for maintenance.

FRC concurs with the Licensee's position concerning safe load paths for the reactor cavity manipulation crane, fuel transfer machine, spent fuel bridge crane, and various monorail hoists.

c. FRC Conclusions and Recommendations

Turkey Point Units 3 and 4 partially comply with Guideline 1. In order to comply with this guideline, the Licensee should perform the following:

1. define safe load paths where practical. The use of exclusion areas should be limited to miscellaneous maintenance areas and lifts where the designation of individual load paths is impractical.

2. verify that heavy loads and their safe load paths have been identified in the plant procedure for controlling heavy loads

3. verify that the selection of load paths considers the location of structural members and beams

4. verify that safe load paths have been clearly marked on floors or structures

5. verify that deviations from load paths require written alternatives approved by the plant's safety review committee (or equivalent).

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

FPL has identified special procedures for the following heavy loads which are periodically handled in the vicinity of irradiated fuel in the reactor core or spent fuel pool:

- o spent fuel shipping cask
- o reactor missile shield
- o pressurizer missile shield
- o reactor vessel head
- o upper internals
- o fuel cask crane load block.

A procedure for handling the fuel pool bulkhead is being prepared and will be implemented prior to the next Unit 4 refueling outage.

FPL stated that the procedures follow Guideline 2.

b. FRC Evaluation

FPL has provided a response with respect only to certain heavy loads equivalent to the example loads identified in Table 3-1 of NUREG-0612. No information has been provided concerning procedures for heavy loads handled in

the vicinity of equipment required for safe shutdown or decay heat removal (e.g., loads carried by the turbine gantry crane or intake structure bridge crane).

c. FRC Conclusions and Recommendations

FPL partially complies with Guideline 2. The following is required for full compliance.

1. identify all loads which are or could be (i.e., without credit for interlocks, technical specifications, operating procedures or detailed structure analysis) carried in the vicinity of irradiated fuel or safe shutdown equipment.

2. prepare procedures containing the information identified in Guideline 2 for those loads not identified in 2.1.3.a above (i.e., Reference 4, Table 2).

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

A training program in accordance with ANSI B30.2-1976 is being developed. FPL is presently consolidating the requirement of ANSI B30.2-1976 and the Nuclear Mutual Limited Property Loss Prevention Standard on Cranes and Rigging with the intention to revise their administrative procedure (0736) covering crane operator qualification, training, and conduct. A comprehensive description of actions to be taken in response to this guideline has been deferred until FPC's final response to the NUREG-0612 Request for Information.

b. FRC Evaluation

FPL has provided insufficient information to allow a determination concerning the satisfaction of this guideline.

c. FRC Conclusions and Recommendations

Conclusions and recommendations covering Guideline 3 must be deferred until a comprehensive response is received. The Licensee should ensure that the response addresses operator selection and conduct as well as training.

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

FPL has indicated that "nuclear shipping containers meet the requirement of ANSI N14.6."

b. FRC Evaluation

FPL did not satisfactorily address Guideline 4. NUREG-0612 does not apply to the shipping container alone. This guideline addresses the implementation of ANSI N14.6 for all special lifting devices used to handle heavy loads in the vicinity of spent fuel or equipment required for safe shutdown or decay heat removal.

c. FRC Conclusions and Recommendations

Insufficient information has been provided to allow a determination of compliance with respect to Guideline 4. The Licensee should provide an evaluation concerning compliance with ANSI N14.6 for all special lifting devices (e.g., reactor vessel head and internal lifting rigs, fuel cask lifting device). Further, in performing their evaluation, the Licensee should address the imposition of static and dynamic loads when assessing design stresses.

FRC has reviewed ANSI N14.6-1978 and has identified several sections which affect load handling reliability. It is FRC's judgment that these sections (3.1 Designer's Responsibilities, 3.2 Design Criteria, 3.3 Design Considerations, 4.1 Fabricator's Responsibilities, and 5.0 Acceptance Testing, Maintenance and Assurance of Continued Compliance) identify important information which should be readily available to the Licensee (e.g., critical parts list) or provide requirements to which the Licensee should adhere in order to adequately substantiate the reliability of special lifting devices. While recognizing that this standard probably did not exist at the time of design and manufacture of Turkey Point special lifting devices, it is not anticipated that obtaining this information or compliance with selected criteria is inappropriate since (1) requirements of the standard are akin to established industry practices and this standard essentially codifies such practices for special lifting devices; and (2) these lifting devices are used for infrequent lifts of the plant's largest components, generally in the direct vicinity of irradiated fuel, which makes their design, fabrication, and continued testing a matter of significance for both the Licensee and the NRC.

With the foregoing in mind, it has been determined that compliance with Guideline 4 requires that the following specific sections of ANSI N14.6 be addressed by the Licensee:

Section 3. Although this section deals with specifications for new handling devices, certain information is important and should be readily available to the Licensee. This information includes the following:

1. Section 3.1:
   a. limitations on the use of the lifting devices (3.1.1)
   b. identification of critical components and definition of critical characteristics (3.1.2)
   c. signed stress analyses which demonstrate appropriate margins of safety (3.1.3)
   d. indication of permissible repair procedures (3.1.4).

2. Section 3.2:
   a. use of stress design factors of three for minimum yield strength and five for ultimate strength (3.2.1)
   b. similar stress design factors for load bearing pins, links, and adapters (3.2.4)

c. slings used comply with ANSI B30.9-1971 (3.2.5)
d. subjecting materials to dead weight testing or Charpy impact testing (3.2.6).

3. Section 3.3:
   a. consideration of problems related to possible lamellar tearing (3.3.1)
   b. design shall assure even distribution of the load (3.3.4)
   c. retainers fitted for load carrying components which may become inadvertently disengaged (3.3.5)
   d. verification that remote actuating mechanisms securely engage or disengage (3.3.6).

Section 4. Similar to those stated for Section 3, most standard criteria concerning fabrication cannot be applied in retrospect. However, the Licensee should have available certain information, including the following:

1. Section 4.1:
   a. verify selection and use of material (4.1.3)
   b. compliance with fabrication practice (4.1.4)
   c. qualification of welders, procedures, and operators (4.1.5)
   d. provisions for a quality assurance program (4.1.6)
   e. provisions for identification and certification of equipment (4.1.7)
   f. verification that materials or services are produced under appropriate controls and qualifications (4.1.9).

Section 5. This section deals with acceptance and follow-on testing and all criteria related to proving load handling reliability are the responsibility of the owner and should be complied with, including the following items:

1. Section 5.1:
   a. implementation of a periodic testing schedule and a system to indicate the date of expiration (5.1.3)
   b. provisions for establishing operating procedures (5.1.4)
   c. identification of subassemblies which may be exchanged (5.1.5)
   d. suitable markings (5.1.6)
   e. maintaining a full record of history (5.1.7)
   f. conditions for removal from service (5.1.8).

2. Section 5.2:
   a. load test to 150% and appropriate inspections prior to initial use (5.2.1)
   b. qualification of replacement parts (5.2.2).

3. Section 5.3:
   a. satisfying annual load test or inspection requirements (5.3.1)
   b. testing following major maintenance (5.3.2)
   c. testing after application of substantial stresses (5.3.4)
   d. inspections by operating (5.3.6) and non-operating or maintenance personnel (5.3.7).

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 guidelines 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

FPL has indicated that "the program for sling use and maintenance at Turkey Point Units 3 & 4 meets the requirement of ANSI B30.9."

b. FRC Evaluation

FPL did not satisfactorily address Guideline 5. A program for sling care and maintenance meeting the requirements of ANSI B30.9 does not ensure that slings are selected for maximum working loads as specified in ANSI B30.9-1971 based on static and dynamic loads nor that slings are marked with the maximum static load rating and crane use restrictions where applicable.

c. FRC Conclusions and Recommendation

FPL partially complies with Guideline 5. The Licensee selection and marking of slings should be evaluated.

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 Statement and Conclusion

FPL's crane inspection, testing, and maintenance program at Turkey Point Units 3 and 4 is expected to be revised by the end of 1981 to incorporate a single FPL policy on this subject based on the requirements and recommendations of ANSI B30.2-1976 and Nuclear Mutual Limited's Property Loss Prevention Standard on Cranes and Rigging, respectively.

b. FRC Evaluation

FPL is in the process of modifying Turkey Point's inspection, testing, and maintenance program with the intent of complying with the requirement of ANSI B30.2-1976.

c. FRC Conclusions and Recommendation

FPL will comply with Guideline 6. Associated procedures should be readily available for NRC staff review when completed.

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 overhead traveling bridge cranes listed in Table 1 of this report are designed to the Electric Overhead Crane Institute Specification 61. "Specifications for Electric Overhead Traveling Cranes" (EOCI #61) and the applicable ANSI safety standards in effect at the time of the manufacture of the cranes. These specifications and standards are the predecessors of CMAA #70 and ANSI B30.2-1976 now in effect and are similar.

The primary difference between the EOCI #61 and CMAA #70 specifications are changes in the design of bridge girders. These changes reflected in the CMAA #70 specification allow the use of higher allowable stresses for the better grade materials available today and also provide new design formulas. These changes are a result of advancements in the state of the art of girder structural design, allowing the use of lighter, more efficient structures and do not increase the conservativeness of the design from the older EOCI #61 specification."

b. FRC Evaluation

Cranes at Turkey Point satisfy, to a considerable extent, the criteria of Guideline 7, since the cranes were procured to accepted industrial standards at the time of manufacture. However, FPL did not specificially address the more restrictive design requirements imposed by CMAA-70, which could affect the crane's ability to safely handle a heavy load.

FRC has compared the recommendations of CMAA-70 with those of EOCI-61 and has identified several areas where revisions incorporated into CMAA-70 may affect crane safety and should therefore be evaluated to determine if the intent of NUREG-0612 is met.

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. 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. 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.

4. Allowable compressive stress. CMAA-70, Article 3.3.3.1.3 identifies allowable compressive stresses to be 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.

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

6. Hoist rope requirements. CMAA-70, Article 4.2.1 requires that the capacity load plus the bottom block divided by the number of parts of rope not exceed 20% 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 on crane safety margins of this variation depends on the ratio of the weights of the load block and the rated load.

7. Drum design. CMAA-70, Article 4.4.1 requires that the drum be designed to withstand combined crushing and bending loads. EOCI-61 requires only that the drum be designed to withstand maximum load bending and crushing loads with no stipulation that these loads be combined. This variation is not expected to be of consequence since the requirements of CMAA-70 represent the codification of good engineering practice which should have been incorporated in cranes built to EOCI-61 specifications although a specific requirement was not contained in EOCI-61.

8. 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.

9. 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.

10. Bridge brake design. CMAA-70, Article 4.7.2.2 requires that bridge brakes, for cranes with cab control and the cab on the trolley, be rated at least 75% 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 review.

11. Hoist brake design. CMAA-70, Article 4.7.4.2 requires that hoist holding brakes, when used with a method of control braking other than mechanical, have torque ratings no less than 125% 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 procured when EOCI-61 was the standard. 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.

12. Bumpers and stops. CMAA-70, Article 4.12 provides substantial guidance for the design and installation of bridge and trolley bumpers and stops for cranes which operate near the ends of bridge and trolley travel. No similar guidance is provided in EOCI-61. 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 good engineering practice and will be expected to be satisfied by equivalent requirements for cranes procured according to EOCI-61.

13. Static control systems. CMAA-70, Article 5.4.6 provides substantial guidance for the use of static control systems. EOCI-61 provides guidance for magnetic control systems only. This variation is not expected to be of consequence 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.

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

Turkey Point Units 3 and 4 comply with Guideline 7, to a substantial degree, on the basis of compliance with EOCI-61 criteria. However, insufficient information has been made available to verify that the following CMAA-70 requirements have been satisfied for cranes subject to this review. The Licensee should make this information available or provide suitable justification for concluding that the requirements of CMAA-70 have been satisfied by equivalent means.

1. Hoist lifting speeds do not exceed 30 feet per minute.
2. Nonsymmetrical girder sections were not used in crane construction.
3. 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.
4. Girders with b/c ratios in excess of 38 were not used.
5. Fatigue failure was considered in crane design and the number of design loading cycles at or near rated load is less than 20,000 cycles.

6. 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 manufacturers' published breaking strength.

7. Drum design calculations were based on the combination of crushing and bending loads.

8. Drum groove depth and pitch conform to the recommendations of CMAA-70.

9. Gear horsepower ratings were based on design allowables and calculation methodology equivalent to that incorporated in CMAA-70.

10. A cab-control, cab-on-trolley configuration was not used.

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

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

13. Any static control systems in use conform to the requirements of CMAA-70.

14. Controllers in use are the spring-return or momentary-contact pushbutton type or are equipped with a device which disconnects all motors on power failure and will not permit restart until the controller handle is brought to the OFF position.

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 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.

Licensee implementation and evaluation of these interim protection measures is contained 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 statements or conclusions regarding this interim protection measure.

b. FRC Evaluation, Conclusions, and Recommendations

Turkey Point Units 3 and 4 do not comply with Interim Protection Measure 1 and the criteria of this interim measure should be implemented as specified.

2.2.2 Administrative Controls [Interim Protection Measures 2, 3, 4, and 5, NUREG-0612, Articles 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(6)]

"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 has indicated that a review of crane operations over the core has been conducted, and that these operations have been addressed in their Administrative Procedure 0736, "Heavy Load Handling."

b. FRC Evaluation

The Licensee's response does not provide sufficient information or detail for FRC to evaluate compliance or determine if the scope of the review at Turkey Point satisfies the requirement of this interim protection measure.

c. FRC Conclusions and Recommendations

Insufficient information has been provided for Turkey Point Units 3 and 4 to evaluate compliance with Interim Protection Measure 6. The intent of this interim measure was to provide, on the basis of a one-time detailed inspection, assurance of a high degree of load handling system reliability during the period when certain hardware-associated guidelines (Guidelines 4, 5, and 7) were being evaluated. A general review of crane operations to establish procedure improvements may not meet the intent of this interim measure. In order to allow a finding of compliance, the Licensee should provide sufficient information for FRC to verify that the extent of this review was comparable to that identified for 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 Turkey Point Units 3 and 4. 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 Turkey Point Units 3 and 4. 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.	Define safe load paths where practical. The use of exclusion areas should be limited to miscellaneous areas and lifts where the designation of individual load paths is impractical.
	b.	Verify that heavy loads and their respective load paths have been identified in the plant procedure for controlling heavy loads.
	c.	Verify that the selection of safe load paths considers the location of structural members and beams.

Table 3.1. Turkey Point Units 3 and 4/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. Reactor Polar Crane Units 3 & 4	135/35	—	--	I	--	--	R	I	--	I
Reactor Missile Shields	60	P	C	--	--	P	--	--	--	I
Pressurizer Missile Shields	25.6	P	C	--	--	P	--	--	--	I
Polar Crane Load Block	6	P	C	--	--	--	--	--	--	I
Reactor Vessel Head	57.5	P	C	--	I	--	--	--	--	I
Upper Internals	42	P	C	--	I	--	--	--	--	I
2. Fuel Cask Crane	105/15	--	--	I	--	--	R	I	NC	--
Spent Fuel Shipping Cask	25	P	C	--	I	--	--	--	NC	--
Fuel Cask Crane Load Block	4.8	P	C	--	--	--	--	--	NC	--
3. Fuel Pool Bulkhead Monorail		--	--	I	--	--	R	I	NC	--
Fuel Pool Bulkhead	1.5	--	R	--	--	P	--	--	NC	--

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.
-- = Not applicable.
P = Licensee action partially complies with NUREG-0612.

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. Fuel Transfer Machine		--	--	I	--	--	R	I	NC	--
New/Spent Elements	0.9	--	I	--	--	--	--	--	NC	--
5. Turbine Gantry Cranes, Units 3 & 4	145/35	P	I	I	I	P	R	I	--	--
6. Spent Fuel Bridge crane	1	--	I	I	--	--	R	I	NC	--
7. Intake Structure Gantry Crane	25	P	I	I	I	P	R	I	--	--
8. Reactor Cavity Manipulator Crane	1	--	I	I	--	--	R	I	--	--
9. Charging Pump Monorails	5	--	I	I	--	P	R	I	--	--
10. Safety Injection Pump Monorail	5	--	I	I	--	P	R	I	--	--
11. Main Steam Platform Monorail	1	--	I	I	--	P	R	I	--	--

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.
-- = Not applicable.
P = Licensee action partially complies with NUREG-0612.

Guideline	Recommendation
d.	Verify that safe load paths have been clearly marked on floors or structures.
e.	Verify that deviations from load paths require written alternatives to be approved by the plant safety review committee (or equivalent).
2	Develop procedures complying with this guideline for those heavy loads and associated handling systems (e.g., charging pump, and diesel generator monorails, intake structure bridge crane) identified by the Licensee to carry heavy loads in the vicinity of equipment required for safe shutdown or decay heat removal (i.e., heavy loads in addition to those identified in the generic Table 3-1 of NUREG-0612).
3	Establish a training program and standard for operator qualification and conduct in substantial compliance with Chapter 2-3 of ANSI B30.2-1976.
4	Evaluate special lifting devices to determine if they satisfy applicable criteria of ANSI N14.6-1978 and this guideline.
5	Verify that use of slings complies with the requirements of this guideline concerning consideration of dynamic loads, marking, and restriction as well as the requirements of ANSI B30.9-1971.
6	(Turkey Point Units 3 and 4 comply with this guideline.)
7	Evaluate the 14 issues which have been identified concerning crane design and determine whether cranes in use at Turkey Point Units 3 and 4 meet the intent of the guideline.

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 Turkey Point Units 3 and 4 are met:

Interim Measure	Recommendation
1	Implement the criteria of this interim protection measure.
2, 3, 4	Implement the recommendations of Guidelines 1, 2, and 3.
5	(Turkey Point Units 3 and 4 comply with this interim protection measure.)
6	Provide adequate information to verify that the Licensee's review satisfies the requirements 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 and Light Company's Turkey Point Units 3 and 4. Crane inspection, testing, and maintenance programs currently comply with these criteria, and the Licensee's response indicates that programs for training, qualification, and conduct of crane operators very nearly comply with NUREG-0612 guidelines.

On the other hand, considerable analysis of lifting devices (both specially designed and non-specially designed) and cranes is still required by the Licensee to determine whether these items satisfy the requirements of standards identified in NUREG-0612. In addition, Turkey Point Units 3 and 4 safe load paths require modification to meet the intent of Guideline 1. Licensee action is required on the remaining general guidelines and interim measures in order for Turkey Point Units 3 and 4 to 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, May 17, 1978

3. NRC
   Letter to FPL
   Subject: Request for Review of Heavy Load Handling at St. Lucie Unit 1
   December 22, 1980

4. R. E. Uhrig (FPL)
   Letter to D. G. Eisenhut (NRC)
   Subject: Interim Actions for Control of Heavy Loads
   July 2, 1981

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

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

7. ANSI B30.9-1971
   "Slings"

8. CMAA-70
   "Specifications for Electric Overhead Traveling Cranes"