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TECHNICAL EVALUATION REPORT

CONTROL OF HEAVY LOADS (C-10)

DUKE POWER COMPANY

McGUIRE NUCLEAR STATION UNITS 1 AND 2

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Prepared by

Franklin Research Center
20th and Race Street
Philadelphia, PA 19103

Author: T. Hofkin

FRC Group Leader: I. H. Sargent

Prepared for

Nuclear Regulatory Commission
Washington, D.C. 20555

Lead NRC Engineer: F. Clemenson

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Franklin Research Center
A Division of The Franklin Institute
The Benjamin Franklin Parkway, Phila., Pa. 19103 (215) 448-1000

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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.

Mr. T. Hofkin and Mr. I. H. Sargent contributed to the technical preparation of this report through a subcontract with WESTEC Services, Inc.

1. INTRODUCTION

1.1 PURPOSE OF REVIEW

This technical evaluation report documents an independent review of general load-handling policy and procedures at the Duke Power Company's (DPC) William B. McGuire Nuclear Station Units 1 and 2. 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 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 provided to control the handling 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 part of the objective, achieved through a set of general guidelines identified in NUREG-0612, Section 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 part of the staff's objective, achieved through guidelines identified in NUREG-0612, Sections 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 the intent of the guidelines is to ensure that licensees of all operating nuclear power plants perform the following:

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 DPC, the Licensee for McGuire Nuclear Station Units 1 and 2, requesting that the Licensee review provisions for the handling and control of heavy loads at McGuire Station, 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. DPC responded to this request on March 3, 1982 [4], June 4, 1982 [5], and July 26, 1982 [6].

2. EVALUATION AND RECOMMENDATIONS

The evaluation of load handling at McGuire Station is divided into two categories. These categories deal separately with the general guidelines of Section 5.1.1 and the recommended interim measures of Section 5.3 of NUREG-0612. Applicable guidelines are referenced in each category. Conclusions 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 by all overhead handling systems and procedures 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 evaluations of this verification are contained in the succeeding paragraphs.

2.1.1 Overhead Heavy Load Handling Systems

a. Summary of Licensee Statements and Conclusions

The Licensee's review of overhead handling systems in the auxiliary building and spent fuel pool areas revealed a total of 83 monorails, 10 jib cranes, and 8 bridge cranes to be subject to the criteria of NUREG-0612.

Review of overhead handling systems inside the reactor building indicates that a total of 29 cranes are subject to compliance with NUREG-0612.

Numerous handling devices identified by the Licensee have been excluded from compliance with NUREG-0612. The following handling systems were excluded on the basis that they do not carry loads that satisfy the weight requirement for a heavy load:

Auxiliary Building

- o radiation monitoring jib crane
- o waste tank monorail
- o steam generator blowndown tank monorail
- o miscellaneous equipment jibs
- o radiation monitoring and lead shielding jibs
- o radiation monitoring and lead shielding monorails
- o monorail for cable of manipulator crane.

Reactor Building

- o manipulator crane with auxiliary hoist.

The following handling systems were excluded on the basis that no safety-related equipment or irradiated fuel is located in close proximity:

Auxiliary Building

- o SFI filter monorail
- o dog house monorail
- o miscellaneous equipment bridge crane
- o large electronics monorail
- o turbulator monorail
- o decontamination trough and receiving monorails
- o spray booth monorail

- o access aisle monorail
- o miscellaneous equipment monorail.

b. Evaluation, Conclusion, and Recommendations

The Licensee's exclusion of the above listed handling systems from compliance with NUREG-0612 is acceptable on the basis of the Licensee's justification that either (1) heavy loads are not carried by the excluded systems, or (2) no systems or components required for plant shutdown or decay heat removal are located in the areas where the handling systems are located.

2.1.2 Safe Load Paths [Guideline 1, NUREG-0612, Section 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 safe load paths have been established which avoid spent fuel for cranes A108A and A111A in the auxiliary building. These load paths are marked on General Arrangement drawings and are described in procedures but are not painted on the floor at the station because the floor is covered by plastic. Station procedure "B&W Spent Fuel Receipt, Storage, and Shipping with an NLI Cask" (ID No. OP/01A/6550/13) has been implemented with enclosures showing the actual paths.

Conditions of operations have been established as follows to control movement of heavy loads in the reactor building:

Condition	Plant Status	Handling System Status
1	Full or reduced power	A heavy load drop cannot occur under these conditions.

Condition	Plant Status	Handling System Status
2	Hot shutdown	A heavy load drop cannot occur under these conditions.
3	Cold shutdown, fuel loaded	All load handling systems are subject to use.
4	Cold shutdown, fuel unloaded	A heavy load drop would have no impact on the station.

Based upon the status of heavy load handling, only load handling operations which occur during Condition 3 require consideration. The Licensee further states that load drop areas were developed for each handling system in the reactor building and vital systems within these areas identified. Station Directive 3.3.7, "Handling of Heavy Loads," has been implemented to explain the purpose of safe load paths.

Paths for all remaining cranes and monorails in the reactor and auxiliary buildings have not been established for the following reasons:

1. For monorails subject to NUREG-0612, the monorail safe load path can only be the vertical projection of the monorail on the underlying floor.

2. For jib cranes subject to NUREG-0612, the safe load path can only be the vertical projection of the radius of curvature on the underlying floor, since the small radius of curvature produces only one set path for equipment that is being lifted.

3. For cranes used only on the diesel generators, no safe load paths will be established due to the diesel generators being directly underneath the crane and the vast number of generator parts that must be moved by these cranes.

4. No safe load paths will be developed for the polar cranes since each piece of equipment has a specific storage point; the crane will lower the equipment to the same point each time.

5. No safe load paths will be developed for the ice condenser cranes since access is required to all parts of the ice condenser.

b. Evaluation

The Licensee's response has been evaluated with respect to the NRC's objective of a defense-in-depth approach for the handling of heavy loads (as

discussed in Section 1.2 of this evaluation). Two distinct phases must be implemented to achieve this objective:

- o first phase - overall improvement of procedures, training, maintenance, and verification of crane and lifting device design, as well as establishment of safe travel paths which avoid irradiated fuel and safe shutdown equipment, as a means to ensure reliable operation of handling systems.

- o second phase - implementation of additional safeguards by satisfying single-failure-proof crane criteria; or installation of mechanical or electrical interlocks; or performance of analyses that substantiate the Licensee's contention that damage to irradiated fuel will not exceed limits for criticality or release of radioactivity, or that damage to redundant or dual safe shutdown systems will not result in loss of required safety functions.

The intent of the first phase of NUREG-0612 is to ensure that all cranes operating in the vicinity of irradiated fuel or safe shutdown equipment meet the requirements of the general guidelines (Section 5.1.1) with no regard or credit given for system redundancy, mechanical or electrical interlocks, administrative procedures, or single-failure-proof cranes. The intent of Guideline 1 is to ensure the existence of preconceived and defined load paths, developed by knowledgeable engineering staff familiar with overall plant arrangement and equipment functions, so that the direction of load movements is not the responsibility of individual crane operators or maintenance supervisors who may not be knowledgeable of various functions or locations of safety-related equipment.

The Licensee's response states that load paths for auxiliary building cranes A108A and A111A have been developed, defined in procedures, and incorporated into drawings. They have not been marked on the floors, nor is there any indication that a suitable alternative has been provided. Load path markings are intended to be used by load-handling operators and their supervisors as a guide to ensure that safe load paths are used. The Licensee may provide suitable alternatives to the permanent marking of load paths, including such visual aids as tape, temporary stanchions, or having the handling supervisor verify the path clear prior to the load movement.

The Licensee's position regarding safe load paths for monorails is acceptable. However, lack of load paths for the diesel generator cranes due to the location of the diesel generators (directly underneath) and the "vast number of generator parts that must be moved" are not sufficient justification to preclude development of load paths. Load paths may not be required, however, if the Licensee can demonstrate that these cranes are sole-purpose systems for a single diesel generator, do not carry heavy loads over other safety-related equipment, and are used to service equipment when the diesel generator has been placed out of service in accordance with plant specifications or procedures.

Safe load paths for jib cranes should be developed. Location of the load can be varied to any point on the boom of the jib crane; therefore, it is not necessarily accurate to state that jib cranes can produce one one set path.

The Licensee's statement that each piece of equipment for the polar cranes has a specific storage point is not sufficient to preclude development of load paths for these cranes. Load paths should be developed in accordance with the guideline which would control movements of this equipment to and from these storage sites. For the ice condenser bridge cranes, the requirement that the cranes be accessible to all parts of the ice condensers is again not sufficient to preclude development of load paths. If necessary, the Licensee may develop a general purpose or "preferred" load path for use by these cranes; movement of individual loads within the ice condenser would then be by the most direct route to this general purpose path for subsequent movement to other areas in the condenser.

Lastly, information has been provided by the Licensee to verify that deviations from established load paths will require written alternatives which must be approved by the plant safety review committee.

c. Conclusion and Recommendations

DPC does not complies with Guideline 1 for McGuire Station. In order to adhere to the criteria of this guideline, the Licensee should:

1. Develop safe load paths for all cranes subject to the criteria of NUREG-0612, including jib, polar, diesel generator, and ice condenser cranes.

2. For auxiliary building cranes A108A and A111A, provide suitable visual aids to operators to ensure movement of loads along established load paths.

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

2.1.3 Load Handling Procedures [Guideline 2, NUREG-0612, Section 5.1.1(2)]

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

a. Summary of Licensee Statements and Conclusions

A detailed list of heavy loads and verification that a procedure governs the handling of each load in the reactor and auxiliary buildings supplied by the Licensee, who further states that procedures in the auxiliary building fully comply with the requirements of Section 5.1.1(2) of NUREG-0612.

b. Evaluation

Specific procedures identified by the Licensee for load handling in the auxiliary building satisfy the requirements of this guideline on the basis of the Licensee's verification that procedures fully comply with NUREG-0612. The Licensee should verify that the information required by this guideline also exists for all heavy loads listed in the reactor building.

c. Conclusion and Recommendation

DPC complies with Guideline 2 for the McGuire Station auxiliary building. The Licensee should verify that procedures in use in the reactor building contain the information specified in this guideline.

2.1.4 Crane Operator Training [Guideline 3, NUREG-0612, Section 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' [7]."

a. Summary of Licensee Statements and Conclusions

The Licensee stated that all crane operators are trained in accordance with the requirements of ANSI B30.2-1976.

b. Evaluation

Programs for crane operators at the McGuire Station satisfy the requirements of this guideline on the basis of the Licensee's verification that existing programs comply with ANSI B30.2-1976.

c. Conclusion

DPC complies with Guideline 3 for McGuire Station.

2.1.5 Special Lifting Devices [Guideline 4, NUREG-0612, Section 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' [8]. 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 stress design factor on only the weight (static load) of the load and of the intervening components of the special handling device [NUREG-0612, Guideline 5.1.1(4)]."

a. Summary of Licensee Statements and Conclusions

The Licensee stated in Station Directive 3.3.7, "Handling of Heavy Loads," that special lifting devices will be defined and placed in the McGuire Station preventive maintenance program or will be included in the installation instructions. Special lifting devices shall be inspected to the requirements of ANSI N14.6-1978.

b. Evaluation

Insufficient information has been provided by the Licensee to conduct an evaluation of compliance of special lifting devices with the requirements of this guideline. All special lifting devices that handle heavy loads near irradiated fuel or safety-related equipment should be evaluated with respect to the requirements of ANSI N14.6-1978. The following is an independent evaluation of the criteria contained in the ANSI Standard and is forwarded to assist the Licensee in evaluating special lifting devices.

It is acknowledged that strict interpretation of compliance of existing special lifting device design with the criteria of ANSI N14.6-1978 cannot be made. Accordingly, the position that only those sections directly related to load-handling reliability of the lifting devices need be addressed is satisfactory. Several sections of ANSI N14.6-1978 do not contain requirements concerning load-handling reliability: Scope (Section 1), Definitions (2), Design Considerations to Minimize Decontamination Efforts (3.4), Coatings (3.5), Lubrication (3.6), Inspector's Responsibilities (4.2), and Fabrication Considerations (4.3). Evaluation of compliance with Section 6 (Special Lifting Devices for Critical Loads) need not be included in this review since no load has been determined to be a "critical load."

Several sections of ANSI N14.6-1978 contain requirements important to load-handling reliability, which should be addressed by the Licensee. Several sections, including 3.1, Designer's Responsi- bilities; 3.2, Design Criteria; 3.3, Design Considerations; and 5.0, Acceptance Testing, Maintenance, and Assurance of Continued Compliance, identify important information that should be readily available or requirements to which the Licensee should adhere in order to substantiate adequately the load-handling reliability of the special lifting devices. Although this standard did not exist when lifting devices were designed and manufactured, it is not anticipated that obtaining information or complying with the standard's requirements will create undue hardship, since the criteria of the standard are akin to established industry practices; this standard merely codifies such practices for special lifting devices. These special lifting devices are used for infrequent lifts of the plant's largest components, generally in the direct vicinity of irradiated

fuel; this makes the reliability of design, fabrication, and continued testing of those special lifting devices a relatively sensitive concern.

A determination of compliance with Guideline 4 requires that the following specific sections of ANSI N14.6 be addressed:

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)

Section 3.2:

a. use of stress design factors of 3 for minimum yield strength and 5 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)

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 4.1:

a. verify selection and use of material (4.1.3)
b. compliance with fabrication practices (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 5.1:

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)

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)

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)

c. Conclusion and Recommendations

Insufficient information has been provided to determine compliance with this guideline. The Licensee should review the actual design and fabrication of all special lifting devices and address the specific sections of ANSI N14.6-1978 listed above.

2.1.6 Lifting Devices (Not Specially Designed) [Guideline 5, NUREG-0612, Section 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' [9]. 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' that 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 stated that "lifting devices... consist of the appropriate size and number of chain-falls, chockers, and slings as determined by the rigger. In making his selection, the rigger draws on his experience and the Elementary and Advance Rigger Training provided at the Duke Power Company Training Center. Choker and sling sizing is determined by the estimated

weight of the load. If additional information is needed, the Riggers Handbook is used. All lifts are made by qualified people who, by experience and training, are cognizant in the movement of loads." The License also stated that lifting devices "shall be inspected according to the applicable ANSI standard."

b. Evaluation

Procedures for use and installation of lifting devices at McGuire Nuclear Station are acceptable based upon the Licensee's stated compliance with ANSI standards, with the following exceptions:

1. sling selection is not based upon the sum of the static and maximum dynamic loads.

2. slings are not marked with the 'static load' that produces the maximum static and dynamic loads.

3. slings restricted in use to only certain cranes have not been clearly marked to so indicate.

c. Conclusion and Recommendations

McGuire Station partially complies with Guideline 5. In order to comply fully, DPC should perform the following:

1. base sling selection upon the sum of the static and maximum dynamic loads

2. mark slings with the "static load" which produces the maximum static and maximum dynamic loads

3. clearly mark slings restricted in use to only certain cranes.

2.1.7 Cranes (Inspection, Testing, and Maintenance) [Guideline 6, NUREG-0612, Section 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 when 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, tests, and maintenance should be performed prior to their use)."

a. Summary of Licensee Statements and Conclusions

DPC stated that crane inspection, testing, and maintenance programs at McGuire Station comply with Chapter 2-2 of ANSI B30.2-1976.

b. Evaluation

McGuire Station satisfies the criteria of this guideline on the basis that crane inspection, testing, and maintenance programs comply with ANSI B30.2-1976, with no exceptions taken.

c. Conclusion and Recommendations

McGuire Station complies with Guideline 6.

2.1.8 Crane Design [Guideline 7, NUREG-0612, Section 5.1.(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, [7] and of CMAA-70, 'Specifications for Electric Overhead Traveling Cranes' [10]. 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

DPC stated that all cranes and hoists used at McGuire Station comply with Chapter 2-1 of ANSI B30.2-1976 and with the specifications of CMAA-70, with the exception of the ice condenser bridge crane, which was designed to Electric Overhead Crane Institute (EOCI) Specification No. 61.

b. Evaluation

McGuire Station subtantially satisfies the criteria of this guideline on the basis of the Licensee's verification that all cranes and hoists, with the

exception of the ice condenser bridge crane, are in verbatim conpliance with ANSI B30.2-1976 and CMAA-70, with no exceptions taken. The ice condenser bridge crane in the reactor building was built to the specifications of EOCI-61.

A comparison of the recommendations of CMAA-70 with those contained in EOCI-61, the standard which CMAA-70 superseded, revealed several areas where revisions incorporated into CMAA-70 may affect crane safety. The following issues should be addressed by the Licensee to determine compliance of the ice condenser bridge crane with this guideline.

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 the 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. 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.

4. 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.

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 of this variation on crane safety margins 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 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.

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 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.

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 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.

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 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.

14. Restart protection. CMAA-70, Article 5.6.2 requires that cranes not equipped with spring-return controllers or momentary-contact pushbuttons 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 pushbuttons.

c. Conclusion and Recommendations

McGuire Station complies with Guideline 7 for all cranes and hoists with the exception of the ice condenser bridge crane in the reactor building. In order to fully comply, the Licensee should provide information to verify that the following CMAA-70 requirements have been satisfied for the above crane, or provide suitable justification for concluding that the requirements 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. 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 was 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 manufacturer's published breaking strength
7. drum design calculations were based on the combination of crushing and bending loads
8. drum groove depth conforms to the recommendations of CMAA-70
9. gear horsepower ratings were based on design allowables and calculation methodology equivalent to that incorporated into CMAA-70
10. cab-control, cab-on trolley configurations were 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 the 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 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 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 are contained in the succeeding paragraphs of this section.

2.2.1 Technical Specifications [Interim Protection Measure 1, NUREG-0612, Section 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 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. Evaluation, Conclusion, and Recommendations

The Licensee has made no statements or conclusions regarding this interim protection measure. DPC should report the completion of the special revision identified in this interim measure.

2.2.2 Administrative Controls [Interim Protection Measures 2, 3, 4, and 5, NUREG-0612, Sections 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. Evaluation

The specific requirements for load-handling administrative controls are contained in NUREG-0612, Section 5.1.1, Guidelines 1, 2, 3, and 6. The Licensee's compliance with these guidelines has been evaluated in Sections 2.1.2, 2.1.3, 2.1.4, and 2.1.7, respectively, of this report.

b. Conclusions and Recommendations

Conclusions and recommendations concerning the Licensee's compliance with these administrative controls are contained in Sections 2.1.2, 2.1.3, 2.1.4, and 2.1.7 of this report.

2.2.3 Special Review for Heavy Loads Handled Over the Core [Interim Protection Measure 6, NUREG-0612, Section 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 operation, and content of procedures."

a. Evaluation, Conclusion, and Recommendations

The Licensee has made no statements or conclusions regarding this interim protection measure. DPC should report the completion of the special review identified in this interim measure.

3. CONCLUDING SUMMARY

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

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 appropriately small for the critical functions and potential consequences of failures of cranes at nuclear power plants. These guidelines are partially satisfied at McGuire Nuclear Station. This conclusion is presented in tabular form as Table 3.1. Specific recommendations for achieving full compliance with these guidelines are provided as follows:

Guideline	Recommendations
1	a. Develop safe load paths for all cranes subject to the criteria of NUREG-0612, including the jib polar, diesel generator, and ice condenser cranes.
	b. For auxiliary building cranes A108A and A111A, provide suitable visual aids to ensure movement of loads along established load paths.
	c. Verify that deviations from established load paths require written alternatives which are approved by the plant safety review committee.

Table 3.1. McGuire Nuclear Power Station/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
Auxiliary Building										
1. RHR & Sump Access Monorail	5	--	--	C	--	--	C	--	--	--
Hatch Cover	3.6	--	C	--	--	P	--	--	--	--
Pump	0.1	--	C	--	--	P	--	--	--	--
Pump Motor	4.2	--	C	--	--	P	--	--	--	--
2. ND & NS Pump Access Monorail	5	--	--	C	--	--	C	--	--	--
Hatch Cover	4.6	--	C	--	--	P	--	--	--	--
ND Pump	4.8	--	C	--	--	P	--	--	--	--
NS Pump	1.2	--	C	--	--	P	--	--	--	--
NS Pump Motor	3.8	--	C	--	--	P	--	--	--	--
3. Recp. Chg. Pump and Fluid Drive Access Monorail	6	--	--	C	--	--	C	--	--	--
Recp. Chg. Pump	5.6	--	C	--	--	P	--	--	--	--
Recp. Chg. Pump Motor	0.6	--	C	--	--	I	--	--	--	--
Fluid Drive	1	--	C	--	--	P	--	--	--	--

C = Licensee action complies with NUREG-0612 Guideline.
P = Licensee action partially complies with NUREG-0612 Guidelines.
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
4. Can. Chg. Pump Access Monorail	4	--	--	C	--	--	C	--	--	--
Hatch Cover	3.2	--	C	--	--	P	--	--	--	--
Center Fugal Change Pump	3.8	--	C	--	--	P	--	--	--	--
Centr. Chg Pump Motor	2.4	--	C	--	--	P	--	--	--	--
5. Safety Inj. Pump Access Monorail	2.5	--	--	C	--	--	C	--	--	--
Hatch Cover	1.2	--	C	--	--	P	--	--	--	--
Safety Injection Pump	2.6	--	C	--	--	P	--	--	--	--
Safety Injection Pump Motor	2	--	C	--	--	P	--	--	--	--
6. Filter Storage Access Monorail	5	--	--	C	--	--	C	--	--	--
Filter Storage	5	--	C	--	--	P	--	--	--	--
7. Demineralizer Access Monorail	4	--	--	C	--	--	C	--	--	--
Hatch Cover	3.5	--	C	--	--	P	--	--	--	--
Misc. Equip.	4	--	C	--	--	P	--	--	--	--

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
8. Misc. Filter Access Monorail	3	--	--	C	--	--	C	--	--	--
Hatch Cover	2.3	--	C	--	--	P	--	--	--	--
Misc. Equip.	3	--	C	--	--	P	--	--	--	--
9. Access Hatch Monorail	5	--	--	C	--	--	C	--	--	--
Hatch Cover	4.3	--	C	--	--	P	--	--	--	--
Misc. Equip.	5	--	C	--	--	P	--	--	--	--
10. Duct Shaft Access Monorail	2	--	--	C	--	--	C	--	--	--
Misc. Equip	2	--	C	--	--	P	--	--	--	--
11. Dog House Monorail	7.5	--	--	C	--	--	C	--	--	--
Main Steam Valve Operating Mechanism	3.1	--	C	--	--	P	--	--	--	--
Misc. Equip.	7.5	--	C	--	--	P	--	--	--	--
12. Miscellaneous Equipment Monorail	10	--	--	C	--	--	C	--	--	--
Hatch Cover	4.6	--	C	--	--	P	--	--	--	--
Misc. Equip	10	--	C	--	--	P	--	--	--	--

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
13. Misc. Equipment Jib Crane	3	--	--	C	--	--	C	C	--	--
Main Steam Oper. Relief Valve	2	NC	C	--	--	P	--	--	--	--
Hatch Cover	2.7	NC	C	--	--	P	--	--	--	--
Misc. Equip.	3	NC	C	--	--	P	--	--	--	--
14. Diesel Generater Access Bridge Crane	2	--	--	C	--	--	C	C	--	--
Misc. Generator Parts	2	NC	C	--	--	P	--	--	--	--
15. Fuel Handling Bridge Crane	125/4/2	--	--	C	--	--	C	C	I	--
Spent Fuel Cask	25	P	C	--	I	--	--	--	I	--
New Fuel Cask and Assemblies	3.4	P	C	--	I	--	--	--	I	--
Fuel Assembly	0.8	P	C	--	I	--	--	--	I	--
Ocone Fuel	I	P	C	--	I	--	--	--	I	--
Refueling Canal Gate	I	P	C	--	--	P	--	--	I	--
Fuel Cask Area Gate	I	P	C	--	--	P	--	--	I	--

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
Reactor Building										
16. VL Fan Motor Monorail	2	--	--	C	--	--	C	--	--	--
VL Fan Motor	1.2	--	NC	--	--	P	--	--	--	--
Misc. Equip.	2	--	NC	--	--	P	--	--	--	--
17. Pipe Chase Monorail	2	--	--	C	--	--	C	--	--	--
Misc. Equip.	2	--	NC	--	--	P	--	--	--	--
18. Pipe Chase Jib Crane	5	--	--	C	--	--	C	C	--	--
Misc. Equip.	5	NC	NC	--	--	P	--	--	--	--
19. Reactor Coolant Pump Jib Crane	3	--	--	C	--	--	C	C	--	--
Misc. Equip.	3	NC	NC	--	--	P	--	--	--	--
20. Control Rod Drive Mechanism Jib Crane	3	--	--	C	--	--	C	C	--	I
Control Rod Drive Mechanism	3	NC	NC	--	--	P	--	--	--	I
21. Reactor Equipment Access Door Jib Crane	15	--	--	C	--	--	C	C	--	I
Misc. Equip.	15	NC	NC	--	--	P	--	--	--	I

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
22. Polar Crane	175/25	--	--	C	--	--	C	C	--	I
Reactor Vessel Head	50	NC	NC	--	I	--	--	--	--	I
Reactor Coolant Pump	27.6	NC	NC	--	I	--	--	--	--	I
RCP Motor	44.2	NC	NC	--	I	--	--	--	--	I
Missile Shields	80	NC	NC	--	I	--	--	--	--	I
Pressurizer	153.9	NC	NC	--	--	P	--	--	--	I
RCP Hatch	18	NC	NC	--	--	P	--	--	--	I
Misc. Equip.	25	NC	NC	--	--	P	--	--	--	I
23. Ice Condenser Bridge Crane	3	--	--	C	--	--	C	I	--	--
Ice Condenser Equipment	3	NC	NC	--	--	P	--	--	--	--
24. Misc. Equip. Monorail	2	--	--	C	--	--	C	--	--	--
Misc. Equip.	2	--	NC	--	--	P	--	--	--	--

Guideline	Recommendations
2	Verify that procedures in use in the reactor building contain the information specified in this guideline.
3	(McGuire Station complies with this guideline.)
4	Evaluate special lifting devices in accordance with the information identified in the independent evaluation of ANSI N14.6-1978.
5	Verify that selection of slings includes consideration of the maximum dynamic loads, including suitable markings. Verify that those slings restricted to use on only certain cranes are marked to so indicate.
6	(McGuire Station complies with this guideline.)
7	Evaluate the ice condenser bridge crane in the reactor building for compliance with the items identifed in the evaluation of CMAA-70.

3.2 INTERIM PROTECTION

The NRC staff has established certain measures (NUREG-0612, Section 5.3) that 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, Section 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. 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 McGuire Station are taken:

Interim Measure	Recommendation
1	Verify that plant technical specifications prohibit movement of heavy loads over the spent fuel pool, or implement the technical specification identified in the interim protection measure.

Interim Measure	Recommendation
2	Implement the recommendations concerning Guideline 1 identified in Section 3.1.
3,4,5	(McGuire Station complies with these interim measures)
6	Complete the special review of procedures, equipment, and personnel qualifications for the handling of heavy loads over the core.

3.3 SUMMARY

The NRC's general guidelines and interim protection measures established in NUREG-0612 have not been fully satisfied at DPC's McGuire Station. Compliance with staff guidelines has been noted for load-handling procedures, crane operator training, and crane inspection, testing, and maintenance. Several items, however, must still be resolved before compliance can be determined for safe load paths, special and non-special lifting devices, and crane design.

Licensee action is also required for compliance with the following interim protection measures: (1) handling of heavy loads over fuel in the storage pool, (2) safe load paths, and (6) handling of heavy loads over the core.

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