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TECHNICAL EVALUATION REPORT Enclosure 1

CONTROL OF HEAVY LOADS (C-10)

OMAHA PUBLIC POWER DISTRICT

FORT CALHOUN STATION

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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 an independent review of general load-handling policy and procedures at the Omaha Public Power District's (OPPD) Fort Calhoun Station. This evaluation was performed with the following objectives:

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

- o to assess conformance to the interim protection measures of NUREG-0612, Section 5.3.

1.2 GENERIC BACKGROUND

Generic Technical Activity Task A-36 was established by the 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 used in areas where their failure might result in significant consequences, either (1) features are provided, in addition to those required for all load-handling systems, to 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 OPPD, the Licensee for the Fort Calhoun Station, requesting that the Licensee review provisions for handling and control of heavy loads at the Fort Calhoun 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. OPPD responded to this request on June 22, 1981 [4], November 30, 1981 [9], December 21, 1981 [10], and January 21, 1982 [11].

Based upon this information, a draft technical evaluation report (TER) was prepared and informally transmitted to the Licensee. A telephone conference call was subsequently conducted on February 9, 1982 involving representatives of the NRC, FRC, and OPPD to discuss unresolved issues in this draft TER. As a result of the conference call, OPPD provided an additional submittal on June 2, 1982 [12], which has been incorporated into this final TER.

2. EVALUATION

This section presents a point-by-point evaluation of load handling provisions at the Fort Calhoun Station with respect to NRC staff guidelines provided in NUREG-0612. Separate subsections are provided for both the general guidelines of NUREG-0612, Section 5.1.1 and the interim measures of NUREG-0612, Section 5.3. In each case, the guidelines or interim measure is presented, Licensee-provided information is summarized and evaluated, and a conclusion as to the extent of compliance, including recommended additional action where appropriate, is presented. These conclusions are summarized in Table 2.1.

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

Table 2.1 Fort Calhoun/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. Polar Crane										
Main Hook	130	--	--	C	--	--	C	C	--	--
Aux Hook	10	--	--	C	--	--	C	C	--	--
Reactor Vessel Closure Head	120	NC	C	--	P	--	--	--	--	C
Upper Guide Structure	40	NC	C	--	P	--	--	--	--	C
Missile Shields	10	NC	C	--	--	C	--	--	--	C
2. Auxiliary Building Crane										
Main Hook	75	--	--	C	--	--	C	C	--	--
Aux Hook	10	--	--	C	--	--	C	C	--	--
Spent Fuel Pool Gates	1	NC	C	--	--	C	--	--	C	--
New Fuel Receipt	1.5	NC	C	--	--	--	--	--	C	--
Spent Fuel Shipping Cask	30	NC	C	--	--	--	--	--	C	--
3. Concrete Slab Removal Monorail	I	--	--	C	--	--	C	C	--	--
4. Waste Evaporator Equip. Handling Monorail	I	--	--	C	--	--	C	C	--	--
5. Deborating Demin Area Monorail	I	--	--	C	--	--	C	C	--	--
6. Intake Structure Crane	I	--	--	C	--	--	C	NC	--	--

C = Licensee action complies with NUREG-0612 Guideline.
P = Licensee action partially complies with NUREG-0612 Guideline.
NC = Licensee action does not comply with NUREG-0612 Guideline.
I = Insufficient information provided by the Licensee.
-- = Not applicable.

2.1.1 Overhead Heavy Load Handling Systems

a. Summary of Licensee Statements and Conclusions

The Licensee's review of overhead handling systems identified the following cranes to be subject to the criteria of NUREG-0612:

- o containment polar crane
- o auxiliary building crane
- o concrete slab removal monorail
- o waste evaporator equipment handling monorail
- o deborating demineralizer area monorail
- o intake structure crane

Other handling devices identified by the Licensee have been excluded from compliance with NUREG-0612 for the following reasons:

1. No safety-related equipment or irradiated fuel is located in close proximity to the handling system:

   - o turbine building crane
   - o turbine building hoist
   - o drumming area crane
   - o maintenance shop crane
   - o filter area crane

2. The handling devices are sole-purpose systems that are used only when the related equipment has been placed out of service in accordance with plant technical specifications or administrative procedures:

   - o diesel generator area monorails

3. The system does not carry loads that satisfy the weight requirement for a heavy load:

   - o containment jib crane.

b. Evaluation and Conclusion

The Licensee's exclusion of the listed load handling systems from compliance with NUREG-0612 is consistent with NUREG-0612 on the basis of the Licensee's justification that (1) no systems or components required for plant shutdown or decay heat removal are located in the areas where the handling systems are located, (2) the devices are sole-purpose systems and are used only when the equipment is out of service, or (3) heavy loads are not carried by the excluded systems.

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 stated that safe load paths are defined in the load handling procedures such that all paths, with the exception of the restricted areas, are considered equally acceptable. The restricted areas are indicated in plant layout drawings. Since all other areas (except for the restricted areas) are safe load path areas, to define individual load paths is not necessary.

Also, it is the Licensee's opinion that if load paths were to follow structural members, increased complexity, greater operator stress, and therefore a higher probability of a load drop due to operator error would result.

No provisions have been made to mark load paths on the floor. The safe load path boundaries, however, are indicated otherwise. The monorails do not have any indications as they have only one possible load path.

Regarding deviation from the safe load paths, the Licensee stated that any deviations from established plant procedures would require plant review committee approval.

b. Evaluation

The Licensee's response indicates that defining safe load areas for all loads is equivalent to defining a safe load path for each load. Therefore, to define individual load paths is not necessary, and to indicate restricted areas on plant layout drawings is a substitute for the marking of load paths for each heavy load.

In essence, the Licensee has taken exception to this guideline.

The use of restricted areas in lieu of specific load pathways does not meet the intent of this guideline: 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 movement avoids safe shutdown equipment and irradiated fuel and is not the responsibility of individual crane operators or maintenance supervisors who may not be knowledgeable about the functions or locations of this safety-related equipment. It is recognized that if these restricted areas are made large enough, the intent of this guideline may be met by the establishment of reasonably constrained and well-defined safe load corridors to be used when transporting heavy loads. However, the use of limited restricted areas which do not produce safe load corridors and allow the direction of load movement to be determined on the floor at the time of the move clearly does not meet the intent of this guideline.

Although the Licensee states that load paths will not be permanently marked, some equivalent means should be devised to provide the crane operator with suitable visual aids to ensure that load movement adheres to the established load path. Such aids may consist of tape, temporary stanchions, rope guidelines, or having a supervisor walk the path to verify it clear of obstructions and direct the crane operator during the load movement. The responsibilities of this individual should be clearly specified in procedures. Allowing deviations from plant procedures contingent upon plant safety review committee, approval is consistent with this guideline.

c. Conclusion and Recommendations

Fort Calhoun Station does not comply with Guideline 1. To comply, the following Licensee action is required:

1. designate specific load paths or load path corridors for the movement of heavy loads identified by the Licensee

2. provide suitable visual aids to assist crane operators when moving heavy loads along designated load paths.

2.1.3 Lc d 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

The Licensee stated that written procedures govern the handling of each heavy load, with the exception of the spent fuel shipping cask. These procedures include identification of required equipment, inspections and acceptance criteria required before the movement of the load, and steps and proper sequence to be followed in handling the load. These procedures meet the intent of Section 5.1.1(2) of NUREG-0612.

A procedure for the spent fuel shipping cask will be written prior to first use of the shipping cask. At present, the Licensee does not have a shipping cask.

b. Evaluation and Conclusion

OPPD complies with Guideline 2 for current operations at Fort Calhoun Station.

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'[5]."

a. Summary of Licensee Statements and Conclusions

OPPD has stated that the current training program, "Control of Crane Operations," does comply with ANSI B30.2-1976, and that crane operators will be advised of new requirements resulting from NUREG-0612.

b. Evaluation and Conclusion

Fort Calhoun Station complies with Guideline 3.

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' [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

OPPD states that the special lifting devices of concern (the reactor closure head and the upper guide structure lift rigs) were designed and purchased in 1968. Steel members and components were designed in accordance with the guidelines of the American Institute of Steel Construction (AISC), Edition 6. Although this code does not provide detailed guidelines, it does provide, in the Licensee's opinion, sufficient requirements to achieve a safe design of steel components. In addition, the Licensee has performed a detailed comparison of these special lifting devices with the specific items related to load-handling reliability contained in ANSI N14.6-1978. The results of this comparison are contained in Tables 2.2 and 2.3.

In addition, for the upper guide structure lift rig, information provided by the vendor indicates that design safety factors of 5 on ultimate strength and 2 on yield strength were used in designing this devices. Since ANSI N14.6-1978 did not exist at the time of manufacture, the Licensee states that using a design factor of 2 instead of 3 is considered adequate.

In some cases, the vendor has been unable to provide information pertaining to some items required by the ANSI code, due to the lack of information available in the vendor's file or to lack of time. In addition, no information is available regarding quality assurance or fabrication procedures used when these devices were manufactured. However, OPPD states that the available design data demonstrate that these lift rigs do comply with the intent of the ANSI code. Load tests were not performed because they were not required by AISC. However, OPPD states that sufficient justification exists to waive this load testing on the basis that these lifting rigs have been inspected and used to rated load capacity over a 10-year period with no identified defects.

In conclusion, the Licensee states that critical items such as design stress, inspection, and testing have been addressed and meet the intent of ANSI N14.6. Areas dealing with documentation control could not be addressed due to the lack of available information. In the Licensee's opinion, however, it has been demonstrated that safe engineering practices were used in the design of these rigs.

b. Evaluation

The Licensee has performed an extensive comparison of the two lifting devices of concern with the criteria of ANSI N14.6-1978. On the basis of this comparison, both the head lifting rig and the upper guide structure lift rig

Table 2.2

Comparison of Fort Calhoun Special Lifting Devices with ANSI N14.6-1978

ANSI N14.6-1978 Section Reference	Reactor Closure Head Lift Rig	Upper Guide Structure Lift Rig
Section 3.1		
3.1.1 Limitations on the use of the lifting device.	Used only for reactor vessel head.	Used only for upper guide structure.
3.1.2 Identification of critical components and definition of critical characteristics.	All components are considered critical.	All components are considered critical.
3.1.3 Signed stress analyses, demonstrating appropriate margins of safety.	Information verified from CE report S/102/P dated Aug. 14, 1970. See Table 2.3.	Unable to address for lack of information from the vendor. Margins of safety were in accordance with AISC, 6th Edition.
3.1.4 Indication of permissible repair procedures.	No repairs are contemplated, so no procedures are available.	No repairs are contemplated, so no procedures are available.
Section 3.2		
3.2.1 Use of stress design factors of 3 for minimum yield strength and 5 for ultimate strength.	See Table 2.3.	Designed with a 5:1 safety factor (ultimate). In addition, use of a design factor of 2 instead of 3 (on yield) is considered adequate.
3.2.4 Similar stress design factors for load bearing pins, links, and adapters.	Complies. See Table 2.3.	Unable to address for lack of information from the vendor.
3.2.5 Slings used comply with ANSI B30.9.	Complies.	Complies.

Table 2.2 (Cont.)

ANSI N14.6-1978 Section Reference	Reactor Closure Head Lift Rig	Upper Guide Structure Lift Rig
3.2.6 Subject materials to dead weight test or charpy impact test.	Unable to address for lack of information from the vendor.	Unable to address for lack of information from the vendor.
Section 3.3		
3.3.1 Consideration of problems related to possible lamellar tearing.	Unable to address for lack of information from vendor.	Unable to address for lack of information from vendor.
3.3.4 Design shall ensure even distribution of the load.	Complies (CE Report).	Unable to address for lack of information from vendor. However, the AISC, 6th Edition requires that design shall ensure even distribution of the load.
3.3.5 Retainers fitted for load carrying components which may become inadvertently disengaged.	Unable to address due to lack of information from the vendor.	Unable to address due to lack of information from the vendor.
Section 4.1		
4.1.3 Verify selection and use of materials.	Materials verified from the list indicated on drawings.	Materials verified from the list indicated on drawings.
4.1.4 Compliance with fabrication practice.	Fabricated in accordance with AISC, 6th Edition.	Fabricated in accordance with AISC, 6th Edition.
4.1.5 Qualification of welders, procedures, and operators.	Unable to address due to lack of information from the vendor.	Unable to address due to lack of information from the vendor.

Table 2.2 (Cont.)

ANSI N14.6-1978 Section Reference	Reactor Closure Head Lift Rig	Upper Guide Structure Lift Rig
4.1.6 Provisions for a quality assurance program.	Unable to address due to lack of information from the vendor.	Unable to address due to lack of information from the vendor.
4.1.7 Provisions for identification and certification of equipment.	Unable to address due to lack of information from the vendor.	Unable to address due to lack of information from the vendor.
4.1.8 Verification that materials or services are produced under appropriate controls and qualifications.	Unable to address due to lack of information from the vendor.	Unable to address due to lack of information from the vendor.
Section 5.1		
5.1.3 Implementation of a periodic testing schedule and a system to indicate date of expiration.	By procedure visually inspect prior to use.	By procedure visually inspect prior to use.
5.1.4 Provisions for establishing operating procedures.	Procedures for use of lift rigs are detailed in the removal of RCVH procedure #MP-RC-6-1, RC-6-2.	Procedure MP-RC-7-2, guidelines for use of UGS lift rig.
5.1.5 Identification of subassemblies which may be exchanged.	Subassemblies may not be exchanged.	Subassemblies may not be exchanged.
5.1.6 Suitable markings.	Complies.	Complies.
5.1.7 Maintaining a full record of history.	This requirement is being met as follows: a) This device is used to lift the reactor vessel head, only. b) The lift rig is qualified for this load.	This requirements is being met as follows: a) This device is used to lift the upper guide structure, only. b) The lift rig is qualified for this load.

Table 2.2 (Cont.)

ANSI N14.6-1978 Section Reference	Reactor Closure Head Lift Rig	Upper Guide Structure Lift Rig
5.1.7 (Cont.)	c) The lift rig is visually inspected prior to every lift. d) The lift rig is used twice during the refueling outage only.	c) The lift rig is visually inspected prior to every lift. d) The lift rig is used twice during the refueling outage only.
5.1.8 Conditions for removal from service.	Subject to visual inspection.	Subject to visual inspection.
Section 5.2		
5.2.1 Load test to 150% and appropriate inspections prior to initial use.	Load test was not performed. However, the lifting rigs have been inspected and used to rated loads for over 10 years without any defect.	Tested to 125% inspected prior to use.
5.2.2 Qualification of replacement parts.	No program established for qualification of replacement parts.	No program established for qualification of replacement parts.
Section 5.3		
5.3.1 Satisfying annual load test or inspection requirements.	Inspected prior to use every 1.25-1.5 years depending upon frequency of refueling.	Inspected prior to use every 1.25-1.5 years depending upon frequency of refueling.
5.3.2 Testing following major maintenance.	No procedures for testing after major maintenance.	No procedures for testing after major maintenance.
5.3.4 Testing after application of substantial stress.	No procedure for testing after substantial stress.	No procedure for testing after substantial stress.
5.3.6 Inspections by operating personnel.	(No information)	(No information)
5.3.7 Nonoperating or maintenance personnel.	Inspections are performed by quality control personnel.	Inspections are performed by quality control personnel.

Table 2.3

Summary of Stress Levels and Safety Factors
in Head Lift Rig Component Parts

[REF. Combustion Engineering Calculation No. RS-102 dated August 24, 1970 and CE Letter No. CE-18074-989 dated June 30, 1981.]

Element	Stress Condition	Ratio = Ult. Stress/ Nor. Load	Ratio = Yld. Stress/ Nor. Load
Tripod	Tension	14.7	7.4
Lifting Eye	Shear	9.4	4.1
Tripod Lifting Eye Shank	Tension	6.4	3.2
Lifting	Shear	7.5	3.5
Frame Lug	Bearing	5.3	2.85*
Pin	Shear	9.9	6.6
Rod	Tension	10.7	8.3
	Shear (THD)	19.0	12.7
Clevis	Shear	11.9	5.2
	Bearing	8.9	4.5
	Tension	28.0	14.2
Pipe and	Compression	17.1	
Pipe Weld	Shear	22.8	13.9
Tubing	Tension	6.4	4.5
Lifting	Bearing	11.7	5.9
Eye and Weld	Shear	16.7	7.2
Tube and	Tension	7.6	4.7
Tube Shell Weld	Shear	3.7*	2.3*
Shell	Tension	48.3	30.0

*The safety margins are lower than required by ANSI N14.6-1978. However, the safety margins are not significantly lower than required.

are noted to substantially comply with ANSI requirements. Both lifting rigs satisfy the requirements of Section 3.1 (Designer's Responsibilities). In addition, it is recognized that information regarding Sections 3.3 and 4.1 may be difficult to obtain since it has been several years since the devices were fabricated, and proof of quality workmanship can be evaluated with the continuing compliance testing program. Regarding design safety margins, the following comments are applicable. Detailed analysis by the Licensee indicates that two components of the head lift rig do not satisfy the design margins of 3 and 5. The head lifting frame lug has a design safety margin on yield of 2.85 (bearing) which is considered to substantially meet the requirements. However, the tube and tube shell weld design margins on shear are 3.7 (ultimate) and 2.3 (yield), values which are less than 80% of the values specified in ANSI N14.6. Therefore, the Licensee should modify the lifting device to comply or ensure that special considerations be made in the continuing compliance testing program to make specific periodic inspections of this weld. Similarly, for the upper guide structure lift rig, use of the design margin (on yield) of 2 is considered adequate; again, however, the Licensee should ensure complete compliance with the testing and inspection program to compensate for the reduction in design margin from the ANSI standard.

The programs that the Licensee has identified to comply with Section 5.1 of ANSI N14.6 meet the intent of this guideline. Neither device, however, has been load tested to 150% of the maximum load carried as specified by ANSI N14.6-1978, Sections 5.2.1 and 5.3.1. The intent of this load test is to provide an appreciable overstress condition above the maximum load lifted as a proof of workmanship and mechanical elements in the assembled device. Satisfactory use of the device for a period of years at or near maximum load does not meet this intent, particularly since the frequency and duration of use were, in all probability, limited. The Licensee has indicated that the upper guide structure lift rig has been tested to 125%; this overstress is considered adequate to meet the intent of the guideline. No load test has been performed for the reactor closure head lift rig, and therefore this lift rig should be weight-tested at the first convenient opportunity by the Licensee. As guidance for this load test, the Licensee is referred to the recommendations of ANSI B30.2-1976, Section 2-2.2.2, which specifies accepted industrial practices for weight testing of cranes. Such practices have been found acceptable as bases for which to load test these special lifting devices.

The Licensee's plan to conduct inspections based upon the frequency of refueling outages are consistent with the annual requirements specified in this guideline. However, additional information is needed to verify that inspection techniques other than visual (i.e., dimensional testing and nondestructive testing) are performed as specified in Section 5.3.1 during the periodic inspections. In addition, since major maintenance or substantial overstress has not been experienced by these devices, it is also recognized that no procedures are in use, nor have "generic" procedures been developed. The need for these procedures in the event that either circumstance should occur should be recognized and the Licensee should commit to conduct such testing should the need arise.

The Licensee has indicated that inspections are performed by quality control personnel; in addition, assurance is requested to verify that inspections are also performed by operating personnel as required by Section 5.3.6 of ANSI N14.6-1978.

c. Conclusion and Recommendations

Special lifting devices in use at Fort Calhoun Station substantially comply with this guideline. In order to fully comply, the following major items should be accomplished:

1. Conduct a load test of the reactor closure head lift rig to a capacity sufficiently in excess of the maximum load lifted.

2. Develop and implement or verify the existence of a rigorous program for continued compliance in accordance with the provisions of Section 5, ANSI N14.6-1978, including requirements for dimensional testing, visual inspection, and non-destructive testing.

In addition, the following items, although not items of non-compliance, should be verified by the Licensee:

1. Should major maintenance or substantial overstress occur, verify that appropriate testing in accordance with ANSI guidelines will be performed.

2. Verify that inspections by operating personnel are performed as specified in ANSI N14.6-1978.

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 guideline of ANSI B30.9-1971, 'Slings' [7]. However, in selecting the proper sling, the load used should be the sum of the static and maximum dynamic load. The rating identified on the sling should be in terms of the 'static load' which produces the maximum static and dynamic load. Where this restricts slings to use on only certain cranes, the slings should be clearly marked as to the cranes with which they may be used."

a. Summary of Licensee Statements and Conclusions

The Licensee has stated that non-special lifting devices are installed and used in accordance with ANSI B30.9-1971, including dynamic and static loading.

b. Evaluation

The Licensee satisfies the requirements of this guideline on the basis that slings are installed and used per ANSI B30.9-1971. In addition, Fort Calhoun Station satisfies the requirements for incorporating dynamic loads into sling selection and use; information to substantiate this compliance should be readily available for review.

c. Conclusion

The Fort Calhoun Station complies with Guideline 5.

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 where it is not practical to meet the frequencies of ANSI B30.2 for periodic inspection and test, or where frequency (e.g., the polar crane inside a PWR containment may only be used every 12 to 18 months during refueling operations, and is generally not accessible during power operation. ANSI B30.2, however, calls for certain inspections to be performed daily or monthly. For such cranes having limited usage, the inspections, test, and maintenance should be performed prior to their use)."

a. Summary of Licensee Statements and Conclusions

The Licensee stated that the crane inspection, testing, and maintenance program at Fort Calhoun Station complies with Chapter 2-2 of ANSI B30.2-1976.

b. Evaluation and Conclusion

OPPD complies with Guideline 6 for Fort Calhoun Station.

2.1.8 Crane Design [Guideline 7, NUREG-0612, Section 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

OPPD has evaluated its overhead heavy load handling systems for design compliance with CMAA-70 and ANSI B30.2-1976. The Licensee states that the auxiliary building crane is currently being retrofitted and will be classified as a "single-failure-proof" retrofitted trolley system. This crane was designed to meet ANSI B30.2-1976 and CMAA-70 standards.

The monorails and intake structure cranes were not designed to the CMAA-70 code or the ANSI B30.2 Chapter 2.1 criteria. However, the intake structure crane was designed to EOCI-61 criteria. With regard to the design of the monorails, the CMAA-70 and ANSI B30.2 codes do not specify criteria for their design.

The containment polar crane was purchased to Gibbs, Hill, Durham, and Richardson (GHD&R) specifications for hoisting equipment. These specfications were based on EOCI-61, "Specifications for Electric Overhead-Traveling Cranes" [9] and USAS Safety Code B30.2-1967. The Licensee has compared the GHD&R specifications point by point with CMAA-70. As a result of this comparison, the following items of difference between EOCI-61 and CMAA-70 were noted and, where available, OPPD's compliance with the requirements of CMAA-70 are noted for the containment polar crane.

1. Torsional forces. CMAA-70, Article 3.3.2.1.3 requires that twisting moments due to overhanging loads and lateral forces acting eccentric to the horizontal neutral axis of a girder be calculated on the basis of the distance between the center of gravity of the load, or force center line, and the girder shear center measured normal to the force vector. EOCI-61 states that such moments are to be calculated with reference to 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). Nonsymmetrical girders were not used on the containment polar crane.

2. Longitudinal stiffeners. CMAA-70, Article 3.3.3.1 specifies (1) the maximum allowable web depth/thickness (h/t) ratio for box girders using longitudinal stiffeners and (2) requirements concerning the location and minimum moment of inertia for such stiffeners. EOCI-61 allows the use of longitudinal stiffeners but provides no similar guidance. Ratios for h/t comply with CMAA-70 for the containment polar crane. The moment of inertia is 5.1% less than that required by CMAA-70 and is considered acceptable by OPPD.

3. 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. Since the polar crane lifts loads of less than its design condition on a 2-lifts-per-refueling basis, the near design loading cycle is not close to the CMAA-70 guidelines, and is therefore not of consequence to this crane.

4. 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. No information is available regarding this issue.

5. Drum design. CMAA-70, Article 4.4.3 provides recommended drum groove depth and pitch. EOCI-61 provides no similar guidance. Drum groove depth and pitch on the containment polar crane comply with the recommendations of CMAA-70.

6. 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. This issue is not of consequence since the cab control, cab-on-trolley arrangement was not used at Fort Calhoun.

7. 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. No information is available regarding the hoist holding brake other than that it was designed to EOCI-61. OPPD states that the 100% provides sufficient margin of safety.

8. 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. Because it is a polar crane, no bumpers are necessary for the polar crane

bridge. Bumpers and stops are provided for the trolley near the end of trolley travel.

9. Static control systems. CMAA-70, Article 5.4.6 provides substantial guidance for the use of static control systems. EOCI-61 provides guidance for magnetic control systems only. The Fort Calhoun polar crane uses a static control system; however, insufficient information is available in order to address the requirements of CMAA-70.

10. 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. OPPD states that the polar crane is equipped with momentary contact push buttons and therefore complies with CMAA-70. In addition, OPPD has verified that the breaking strength of the wire rope in use complies with CMAA-70 requirements.

b. Evaluation

Fort Calhoun Station satisfies the requirements of Guideline 7 for the auxiliary building crane on the basis of the Licensee's verification that this crane was designed and built to CMAA-70 and ANSI B30.2-1976 standards.

The containment polar crane also meets the intent of Guideline 7 on the basis that the crane was originally built to EOCI-61 and substantially complies with those sections of CMAA-70 noted to contain more restrictive requirements. Three items were noted for which no information could be obtained but are noted to be of adequate design to meet the intent of the guideline:

1. Verification that the drum was designed to withstand combined crushing and bending loads; actual design does not specify that these loads be combined.

2. Verification that the hoist holding brake has a torque rating of no less than 125% of hoist motor torque; actual design used a 100% brake only.

3. Static control systems were used but information required by CMAA-70 was not required by EOCI-61.

For the intake structure gantry crane, substantial compliance is noted since this crane was procured in accordance with EOCI-61. However, the Licensee should provide a comparison with the added requirements of CMAA-70 similar to that provided for the containment polar crane to determine compliance with this guideline.

c. Conclusion and Recommendations

Fort Calhoun Station substantially complies with this guideline on the basis that the containment polar crane and the auxiliary building crane were designed to or meet the criteria of CMAA-70. To fully comply, the Licensee should evaluate the intake structure gantry crane with the added requirements of CMAA-70.

2.2 INTERIM PROTECTION MEASURES

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

1. Heavy load technical specifications
2. Special review for heavy loads handled over the core.

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 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 stated that the potential to impact irradiated fuel is minimized by not allowing loads to be carried over irradiated fuel and by the fact that a new retrofitted "single-failure-proof" crane in the auxiliary building is being installed.

b. Evaluation and Conclusion

The Fort Calhoun Station will satisfy this interim protection measure by providing a single-failure-proof crane.

2.2.2 Administrative Controls [Interim Protection Measures 2, 3, 4, and 5, NUREG-0612, Section 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]."

b. 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 Reviews for Heavy Loads 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 of deficiencies that could lead to failure of the component; (3) appropriate repair and replacement of defective components; and (4) verify that the crane operators have been properly trained and are familiar with specific procedures used in handling these loads, e.g., hand signals, conduct of operations, and content of procedures."

a. Summary of Licensee Statements and Conclusions

The Licensee stated that clear and concise instructions for handling heavy loads over the core will be provided. Also, requirements for necessary inspections will be included. If required, appropriate repairs will be made. In addition, only qualified crane operators are allowed to operate cranes; they are also briefed prior to the start of the procedures.

b. Evaluation and Conclusion

OPPD will comply with this interim measure upon completion of their inspection of load handling devices used over the core.

3. CONCLUSION

This summary is provided to consolidate the results of the evaluation contained in Section 2 concerning individual NRC staff guidelines into an overall evaluation of heavy load handling at the Fort Calhoun Station. Overall conclusions and recommended Licensee actions, where appropriate, are provided with respect to both general provisions for load handling (NUREG-0612, Section 5.1.5) and completion of the staff recommendations for interim protection (NUREG-0612, Section 5.3).

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 equipment required for safe shutdown or decay heat removal. The intent of these guidelines is twofold. A plant conforming to these guidelines will have developed and implemented, through procedures and operator training, safe load travel paths such that, to the maximum extent practical, heavy loads are not carried over or near irradiated fuel or safe shutdown equipment. A plant conforming to these guidelines will also have provided sufficient operator training, handling system design, load handling instructions, and equipment inspection to ensure reliable operation of the handling system. As detailed in Section 2, it has been found that load handling operations at Fort Calhoun Station can be expected to be conducted in a generally reliable manner consistent with the staff's objectives as expressed in these guidelines. A need for further Licensee action, however, was identified in the following three areas:

- o OPPD should designate specific load paths or corridors for the movement of heavy loads and provide suitable visual aids to assist crane operators and ensure compliance with these designated load paths.
- o OPPD should develop and implement a program that verifies, through scheduled periodic testing, that special lifting devices continue both to meet performance criteria and to be capable of reliable and safe performance of their functions. Such a program should conform

to the requirements of ANSI N14.6-1978, Sections 5.1, 5.3, 5.4, and 5.5. In addition, the Licensee should load-test the reactor closure head lift rig to a capacity sufficiently in excess the maximum load lifted.

- OPPD should verify that the intake structure gantry crane complies with the added requirements 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 all interim protection actions have been implemented, with the exception of the NRC staff measures for safe load paths, which have been addressed in Section 3.1 of this report.

4. REFERENCES

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"Control of Heavy Loads at Nuclear Power Plants"
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5. American National Standards Institute
"Overhead and Gantry Cranes"
New York: 1976
ANSI B30.2-1976

6. American National Standards Institute
"Standard for Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More for Nuclear Materials"
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10. W. C. Jones (OPPD)
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11. W. C. Jones (OPPD)
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Subject: Control of Heavy Loads
2 June 1982

ADDITIONAL INFORMATION REQUIRED FROM FORT CALHOUN STATION

1.a. RECOMMENDATION/OPEN ITEM

To ensure that loads are safely handled at Fort Calhoun Station, Omaha Public Power District (OPPD) should (1) designate specific load paths or load corridors for the movement of heavy loads and (2) provide suitable visual aids to assist crane operators when moving heavy loads.

b. EVALUATION CRITERIA

The general guidelines of NUREG-0612 require that specific safe load paths be defined to control movement of heavy loads to avoid irradiated fuel and equipment needed for safe shutdown. The intent of this guideline is to identify the best or most preferable load path based upon analysis by engineering staff familiar with overall plant arrangement and then to incorporate these paths into plant procedures and drawings. Formal determination of the load path in this manner would avoid ad hoc load path decisions made on the handling floor by crane operators not familiar with plant equipment or system functions. Similarly, to ensure compliance and avoid unnecessary distractions to crane operators while controlling suspended loads (e.g., trying to read procedural steps or drawings with the hook under load), NUREG-0612 required that these load paths be marked on the floors. Due to the number of load paths as well as contamination control methods, several licensees have argued against such markings; previously, it has been acceptable to use other appropriate visual aids in lieu of permanent markings to accomplish the same purpose. Such visual aids may consist of tape, pylons, rope, crane benchmarks, or use of a crane supervisor/signalman (with responsibilities delineated in appropriate procedures) to direct the crane operator along the designated load path.

c. DISCUSSION

OPPD states that all paths, with the exception of restricted areas indicated on plant drawings, are equally safe. Therefore, it is not necessary to define individual safe load paths.

The use of restricted areas in lieu of specific load pathways does not meet the intent of this guideline: 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 movement avoids safe shutdown equipment and irradiated fuel and is not the responsibility of individual crane operators or maintenance supervisors who may not be knowledgeable about the functions or locations of this safety-related equipment. It is recognized that if these restricted areas are made large enough, the intent of this guideline may be met by the establishment of reasonably constrained and well-defined safe load corridors to be used when transporting heavy loads. However, the use of limited restricted areas which do not produce safe load corridors and which allow the direction of load movement to be determined on the floor at the time of the move clearly does not meet the intent of this guideline.

In addition, no provisions have been made by the Licensee to mark load paths or provide another suitable visual aid as an alternative to permanent markings.

2.a. RECOMMENDATIONS/OPEN ITEM

OPPD should develop and implement a program which verifies, through scheduled periodic testing, that special lifting devices continue to meet performance criteria and are capable of reliable and safe performance of their functions. Such a program should conform to the requirements of ANSI N14.6-1978, Section 5. In addition, the Licensee should load test the reactor closure head lift rig as part of this program to ensure continuing compliance.

b. EVALUATION CRITERIA

The general guidelines of NUREG-0612 specify that special lifting devices used to carry heavy loads should satisfy the requirements of ANSI N14.6-1978. In order to determine if the devices are in compliance or whether equivalence with the standard may be established, the licensee, as a minimum, should demonstrate that the following issues have been adequately addressed for each device identified:

- o adequacy of design (i.e., stress design factors, qualify assurance, fabrication controls)
- o proof of workmanship and mechanical integrity (initial load test)
- o programs to assure continuing compliance (test and inspection program).

c. DISCUSSION

OPPD has identified two special lifting devices in use at Fort Calhoun Station: the reactor closure head lifting rig (RCHLR) and the upper guide structure lifting rig (UGSLR). Sufficient information has been provided by the Licensee to demonstrate adequacy of design of both devices.

For proof of workmanship, the Licensee states that the UGSLR has been load tested to 125% of rated load, which is considered to be consistent with the intent of this guideline. No such load test has been performed to date for RCHLR. The Licensee states that sufficient justification exists to waive the load test requirements on the basis that the RCHLR has been inspected and used to rated load capacity over a 10-year period with no identified defects. However, it should be recognized that the intent of this load test is to provide an appreciable overstress condition above the maximum load lifted as a proof of workmanship and mechanical elements in the assembled device. Satisfactory use of this device over a period of years does not meet this intent, particularly since the frequency and duration of use were, in all probability, limited.

It is recognized that performance of such a load test may be difficult, depending upon load-test capabilities of the plant, contamination of the lifting device, and the actual logistics of moving the device outside the containment.

From a technical viewpoint, the difficulty or impracticality of conducting a load test does not, of itself, justify a determination that a load test is not required. The circumstances under which a load test could be considered unnecessary, on the basis of engineering judgment, would include overall consideration of the following issues:

- o <u>The device is of simple design.</u> Simplicity of design eliminates complex, and therefore difficult to analyze, components. Simplicity also reduces the fabrication requirements and consequent potential for inadequate workmanship.

- o <u>The device was fabricated under a rigorous quality program.</u> A rigorous program of quality assurance and in-progress inspection, including thorough nondestructive examination (NDE), is expected to eliminate material flaws or errors in workmanship which would otherwise be detected by a proof test.

- o <u>A conservative design was used.</u> The use of substantial conservatism in design, for both stressed structural members and hardware (e.g., turnbuckles, U-bolts, threaded fasteners), could provide stress margins sufficient to accommodate potential material or fabrication shortcomings.

Information provided thus far by the Licensee is not sufficient to form a technical basis upon which an independent determination can be made that a proof test need not be conducted.

3.a. RECOMMENDATION/OPEN ITEM

Confirmation is requested to ensure that the following provisions are incorporated into the continuing compliance program for special lifting devices:

- o Should major maintenance or substantial overstress occur, lifting devices will be tested in accordance with Sections 5.3.2 and 5.3.3 of ANSI N14.6-1978.
- o Inspections are performed by operating personnel in accordance with Section 5.3.6 of ANSI N14.6-1978.

b. EVALUATION CRITERIA

As required by the continuing compliance program of ANSI N14.6-1978, special lifting devices are required to be load tested to 150% of the maximum load that is lifted by the device either (1) following any major maintenance or alteration, or (2) following any incident in which any of the load-bearing components of the special lifting devices have been subjected to stresses substantially in excess of those for which the devices has been qualified by previous testing.

In addition, visual inspections are to be performed by operating personnel for indications of damage or deformation prior to use.

c. DISCUSSION

Information provided by OPPD indicates that no procedures currently exist for load testing following major maintenance or substantial overstress. Since neither event has occurred, it is recognized that no procedures have been prepared to date, and there is no need to develop a "generic" procedure to satisfy this requirement. However, the Licensee should verify that necessary provisions are incorporated into Fort Calhoun's continuing compliance program for special lifting devices so that, should major maintenance or substantial overstress occur, there is assurance that the necessary load testing will be performed.

Regarding inspections, OPPD has stated that inspections are performed by quality control personnel, which satisfies the ANSI N14.6-1978, Section 5.3.7, requirements for inspections by maintenance or other non-operating personnel. Similar information is requested to verify that inspections by operating personnel are also performed (ANSI N14.6-1978, Section 5.3.6).

4.a. RECOMMENDATION/OPEN ITEM

OPPD should verify that the intake structure gantry crane complies with the added requirements of CMAA-70.

b. EVALUATION CRITERIA

The general guidelines of NUREG-0612 require that the design of cranes meets the criteria of ANSI B30.2-1976 and CMAA-70, "Specifications for Overhead Traveling Cranes." Cranes owned by most licensees were built to EOCI-61, the forerunner of CMAA-70. A detailed comparison has been performed to identify differences between CMAA-70 and EOCI-61 which may affect load handling reliability and safety. To demonstrate the equivalence of cranes built to EOCI-61 with the added requirements of CMAA-70, licensees were requested to evaluate compliance with those items identified for their individual cranes.

c. DISCUSSION

Information provided by the Licensee has identified three cranes of concern which must satisfy the criteria of CMAA-70: the auxiliary building crane, the containment polar crane, and the intake structure gantry crane.

The auxiliary building crane was originally designed to meet ANSI B30.2-1976 and CMAA-70 standards and is currently being retrofitted to be classified as a single-failure-proof handling system; this crane is in compliance with NUREG-0612. Similarly, the containment polar crane, although built to EOCI-61, is in compliance with NUREG-0612 on the basis of a detailed comparison of those crane design items noted to be revised in CMAA-70.

For the intake structure gantry crane, however, OPPD has stated only that the crane was built to EOCI-61; therefore, the Licensee should perform a detailed comparison of those differences noted between EOCI-61 and CMAA-70 for this crane, similar to the review conducted for the containment polar crane.

SYNOPSIS OF ISSUES ASSOCIATED WITH NUREG 0612

The following information is provided to identify exceptions or interpretations related to verbatim compliance with NUREG 0612 Guidelines that have occurred during the course of this review. For each of the major Guidelines specific exceptions are identified, a discussion concerning the underlying objective of that Guideline is provided, and approaches felt to be consistent and inconsistent with that guideline are identified. While each such exception has been handled on a case by case basis, and has been considered in light of overall compliance with NUREG 0612 at a particular plant, the topics are of a nature general enough to be of interest to other plants.

GUIDELINE 1 SAFE LOAD PATHS

Exception 1

In the opinion of the licensee, development of individual load paths is impractical since there are a significant number of loads for which the pickup and laydown areas vary from outage to outage. Further, in some cases the location of safety related equipment combined with the design of the floor over which heavy loads are carried indicates that for a number of lifts there is no preferred load path.

Discussion

The purpose of this portion of Guideline 1 is to ensure that the paths over which heavy loads are carried have been developed and approved in advance of the lift and are based on considerations of safety. In particular it is provided to avoid the ad hoc selection of load paths by maintenance personnel since such a situation could result in the use of a load path which has been established by a process wherein considerations other than safety have taken precedence.

It is recognized that there are a class of loads which, although in excess of the weight specified for classification as a heavy load, are actually miscellaneous or maintenance related loads for which it is impractical to identify a specific laydown area which can be fixed from outage to outage. Conversely there are a number of loads for which specific laydown areas have been allocated in the original plant design and which should reasonably be expected to be carried over the same load paths during every outage. A tabulation of loads in this latter category, generally applicable to PWR's and BWR's, was provided in NUREG 0612 as Table 3-1.

A fundamental principal of NUREG 0612 is protection through defense in depth. Specifically, the first line of protection from an accident which could result in damage to spent fuel or equipment required for safe shutdown or decay heat removal is to avoid or minimize the exposure of such equipment to crane borne loads overhead. Where such exposure is minimized, rather than avoided, a second line of defense can then be provided by intervening barriers such as floors or the provision of additional lifting device redundancy or safety factors. Considering the foregoing, the use of exclusion areas, rather than safe load paths, is consistent with this guideline only under circumstances where there is no safety related equipment located beneath the area accessible to the crane hook but outside of the exclusion area. This situation has been found in buildings such as the turbine hall or screen house where safety related equipment is concentrated in a specific area within the crane path. It is unlikely to occur within containment due to the numerous safety related piping and electrical systems provided to support decay heat removal.

Approaches Consistent With This Guideline

Specific safe load paths are prepared and approved for major components for which hazardous areas are well established. For miscellaneous lifts load corridors are established such that any movement within that corridor cannot result in carrying a heavy load over spent fuel or systems required for safe shutdown or decay heat removal (regardless of intervening floors). Movement within these corridors is at the discretion of the load handling party.

Specific safe load paths are prepared and approved for major components for which hazardous areas are well established. For miscellaneous lifts detailed directions are prepared and approved for developing safe load paths which include floor plans showing the location of safety related equipment and instructions to avoid such equipment. Specific safe load paths are then prepared each time a miscellaneous lift qualifying as a heavy load is made. These individual load paths are temporary and may change from outage to outage.

Approaches Inconsistent With this Guideline.

Use of limited exclusion areas in containment which merely prohibited the carrying of heavy loads directly over the core or specific components and allow full load handling party discretion in other areas.

Exception 2

In the opinion of the licensee marking of load paths on the floor is impractical. This may be caused by the general use of temporary floor coverings which would cover the load path markings, or, due to the number of loads involved, a requirement for multiple markings which could confuse the crane operator.

Discussion

The purpose of this feature of Guideline 1 is to provide visual aids to assist the operator and supervisor in ensuring that designated safe load paths are actually followed. In the case of the operator it has the additional function of avoiding undesirable distractions while handling suspended loads (e.g., trying to read procedural steps or drawings while controlling the crane). This feature should also be seen as a provision necessary to complete a plan for the implementation of safe load paths. Specifically it provides some additional assurance that, having spent the time and effort to develop safe load paths, those paths will be followed.

Approaches Consistent With this Guideline

Rather than mark load paths a second member of the load handling party (that is, other than the crane operator) is made responsible for assuring that the designated safe load path is followed. This second person, a signalman is typically used on cab operated cranes, checks out the safe load path prior to the lift to ensure that it is clear, refers to the safe load path guidance during the lift and provides direction to the operator and that the load path is followed. To support this approach the duties and responsibilities of each member of the load handling party should be clearly defined.

Prior to a lift the appropriate load path is temporarily marked (rope, pylons, etc.) to provide a visual reference for the crane operator. In cases where the load path cannot be marked (e.g., transfer of the upper internals in a PWR) temporary or permanent match marks can be employed to assist in positioning the bridge and/or trolley during the lift.

In either case reasonable engineering judgement would indicate that in certain specific lifts marking of safe load paths is unnecessary due to physical constraints on the load handling operation (e.g., simple hoists, monorails, or very short lifts where movement is limited to one coordinate axis in addition to the vertical).

Approaches Inconsistent With this Guideline

Positions which in effect do not recognize the need for realistically providing visual aids to the crane operator and imply that, for all lifts, the operator will remember the load path from review of procedures or by reference to a drawing.

Exception 3

Obtaining written alternative procedures approved by the plant safety review committee for any deviations from a safe load path is considered too cumbersome to accommodate the handling of maintenance loads where laydown areas may have to change or load paths altered as a result of unanticipated maintenance requirements.

Discussion

The purpose of this portion of this guideline is to ensure that deviations from established safe load paths receive a level of review appropriate to their safety significance. In general it is highly desirable that once safe load paths are established they are retained and kept clear of interference rather than routinely deviated from. It is recognized, however, that issues associated with plant safety are the responsibility of an individual licensee plant safety review committee (or equivalent) and the details of their excercizing this responsibility should be within their jurisdiction.

Approach Consistent With this Guideline

A plant safety review committee (or equivalent) delegates the responsibility for approving temporary changes to safe load paths to a person, who may or may not be a member of that committee, with appropriate training and education in the area of plant safety. Such changes are reviewed by the safety review committee in the normal course of events. Any permanent alteration to a safe load path is approved by the plant safety review committee.

Approach Inconsistent With this Guideline

Activities which in effect allow decisions as to deviations from safe load paths to be made by persons not specifically designated by the plant safety review committee.

GUIDELINE 2 LOAD HANDLING PROCEDURES

No significant exceptions to this guideline have been encountered. Occasionally a question arises concerning the need for individual procedures for each lift. In general, it was not the purpose of this guideline to require separate procedures for each lift. A reasonable approach is to provide separate procedures for each major lift (e.g., RV head, core internals, fuel cask) and use a general procedure for handling other heavy loads as long as load specific details (e.g., load paths, equipment requirements) are provided in an attachments or enclosures.

Exception

The only exception occassionally encountered with respect to this Guideline other than fairly minor, site unique, exceptions has been a desire to deviate from the requirement of ANSI B30.2-3.1.7.o for testing of all controls before beginning a new shift. In some cases a licensee has qualified a commitment in this area by noting that only crane controls "necessary for crane operation" will be tested at the start of a shift.

Discussion

This requirement (ie. not a recommendation) of ANSI B30.2 is important since crane control system failures are relatively significant contributors to load handling incidents. The only reason that can be seen for an exception in this area is a general aversion to the word "all". Specifically, it appears that some licensees fear that a commitment to this requirement will force them to test all control type devices (eg. motor overloads, load cells, emergency brakes) rather than just those features generally known as controls (ie. hoist, bridge, and trolley motion controllers).

Approaches Consistent With this Guideline

Exceptions that clearly indicate that all normal controls (hoist, bridge, and trolley motion controllers) will be tested at the start of each shift and that the purpose of not committing to "all" controls is to avoid a misunderstanding concerning other control devices.

Approaches Inconsistent With This Guideline

A response that implies that a decision to test or not test a normal control will be made by the crane operator on the basis of what type of lift or direction of motion he expects for the forthcoming shift.

GUIDELINE 4 SPECIAL LIFTING DEVICES

Exception 1

Some licensees have indicated that their special lifting devices were designed and procured prior to the publication of ANSI N14.6 and therefore are not designed in accordance with that standard. This fact is sometimes combined with a reference to the title of that standard to reach a conclusion that the standard is not applicable.

Discussion

The purpose of this section is to ensure that special lifting devices were designed and constructed under controlled conditions and that sufficient documentation is available to establish existing design stress margins and support future maintenance and repair requirements. ANSI N14.6 is an existing standard that provides requirements supporting this goal for lifting device applications where the consequence of a failure could be similar to that which could be expected in the event of the failure of a special lifting device carrying a load within the jurisdiction of NUREG 0612. Consequently it seems appropriate that for special lifting devices subject to NUREG 0612 it should be able to be demonstrated that, from a design standpoint, they are as reliable as a device for which ANSI N14.6 was developed.

Approaches Consistent With This Guideline

Although not originally specified to be designed in accordance with ANSI N14.6 the special lifting device in question was provided by a reactor vendor, in accordance with appropriate quality assurance and quality control procedures, for a specific application associated with power plant components provided by that vendor. Based on either the review of the original stress report or, if such a stress report is unavailable, the preparation of a new stress report, the licensee has determined that margins to material yield and ultimate strength are comparable to those specified in ANSI N14.6. Although not required of the lifting device vendor, the licensee has reviewed the design of the lifting device and prepared a list of critical components whose repair or replacement should be performed under controlled conditions.

Approaches Inconsistent With This Guideline

No information is available concerning the original design but it is probably allright because the device has been used for ten years and never failed.

The device was built before the publication of ANSI N14.6, does not carry shipping containers of nuclear material weighing more than 10,000 pounds, and thus need not comply with ANSI N14.6.

Exception 2

No 150% overload test has been performed and, in the opinion of the licensee, such a test is impractical.

Discussion

The performance of a load test in excess of the load subject to NUREG 0612 is an important contributor to the ability to assess the overall reliability of a device. Such a test supplements design reliability by demonstrating that the device was properly fabricated or assembled and that a portion of the design safety margin has been demonstrated. Such proof of workmanship is particularly important for a fairly complicated device. It is recognized, however, that the specification of a 150% overload test is somewhat arbitrary and that, in some cases, the nature of the device is such that the liklihood of workmanship shortcomings is remote.

Approaches Consistent With This Guideline

The licensee has evaluated the lifting device in question and has determined that design stress margins are substantial. Further it has been established that the device itself is uncomplicated and principally put together with mechanical joints such that an assembly error is highly unlikely. The use of welded joints is severly limited and where employed were performed in accordance with substantial quality controls (eg AWS D1.1) including NDE. The device has been tested to 100% of rated load.

Although a 150% overload test has not been performed the lifting device has been subjected to a manufacturer recommended overload to demonstrate proof of workmanship (typically 120-125%).

Approaches Inconsistent With This Guideline

See this topic for Exception 1 above.

Exception 3

The requirement of ANSI N14.6 for an annual 150% load test or full NDE is excessive. Both the load test (due to the inability to make the test lift within containment) and the NDE (due to the need to remove protective coatings) are impractical and not justified by the infrequent use of these devices.

Discussion

A continuing inspection program to assure the continued maintenance of safety margins incorporated in the original design of the device is important to demonstrate the reliability of special lifting devices. It is recognized, however, that some devices employed in a nuclear power plant, particularly those associated with refueling, are used under conditions of control and at frequencies of use that are substantially less severe than that possible for the type of lifting device for which ANSI N14.6 was originally prepared. Consequently a reasonable relaxation of the inspection interval seems appropriate.

Approaches Consistent With This Guideline

Overload tests will be conducted but at a longer interval, 5 years, between tests to be consistent with the number of operational lifts required.

NDE of load bearing welds will be conducted at 5 year intervals or, alternatively, load bearing welds will be examined through a program that ensures that all welds will be examined over a normal inservice inspection interval of 10 years in a manner similar to that specified in the B&PV Code for Class 2 Component Supports.

Approach Inconsistent With This Guideline

Continuing inspection will be limited to an annual visual examination of the device.

GUIDELINE 5 LIFTING DEVICES NOT SPECIALLY DESIGNED

Exception

Licensees have taken exception to the requirement to select slings in accordance with the maximum working load tables of ANSI B30.9 considering the sum of static and dynamic loads. Most commonly it is the licensees position that the approximate factor of safety of five on rope breaking strength inherent in these tables adequately accomodates dynamic loading.

Discussion

The intent of this portion of this Guideline, which also applies to special lifting devices under Guideline 4, is to reserve the ANSI B30.9 safety factors for accomodating sling wear and unanticipated overloads and avoid a reduction of this safety factor as a result of the routine dynamic loads inherent in hook/load acceleration and deceleration. While it is acknowledged that, for operating characteristics typical of cranes employed at nuclear power plants, these dynamic loads are unlikely to be substantial, such a determination cannot be made generically. Typically the actual dynamic load due to hook/load acceleration or deceleration is a function of design hook speeds and the type of hoist control system employed. It should also be recalled that ANSI B30.9 is a general industrial standard which applies to all load handling devices and does not in itself provide for any additional conservatism in consideration of the potential consequences of a load handling accident at a nuclear power plant. Based on this, it is considered reasonable that individual licensees evaluate the potential contribution of dynamic loading in their operations and if such dynamic loading is indeed significant accomodate it in their procedures for sling selection.

Approach Consistent With This Guideline

The licensee has evaluated the potential routine dynamic loading for lifting devices not specially designed and found them to be a relatively small fraction (typically 5-15%) of static load. This estimate has been made on the basis of either calculated acceleration and deceleration rates or through use of the industrial standard for impact loading of cranes specified in CMAA-70. In either case having verified that routine dynamic loading of a specific hoist is indeed small the licensee has drawn the conclusion that revised selection criteria to accomodate such minor additional loads will not have a substantial effect on overall load handling reliability.

Approach Inconsistent With This Guideline

Statement to the effect that dynamic loads are accomodated in the tables of ANSI B30.9 with no indication that the licensee has assessed the actual dynamic loading imposed on cranes subject to NUREG 0612.

Exception

The only exception occasionally encountered with respect to this Guideline other than fairly minor and site-unique exceptions has been a desire to deviate from the requirement of ANSI B30.2-1.1.2.a.2 and 3.2.4 for testing of hoist limit devices before beginning a new shift. In some cases a licensee has qualified a commitment in this area by noting that this limit switch will be tested only if operations in the vicinity of the limit switch are anticipated.

Discussion

While this issue is treated somewhat ambigously in ANSI B30.2 (it is a recommendation in article 1.1.2 and a requirement in article 3.2.4) it is important since two-blocking incidents are relatively significant contributors to load handling incidents. Further it should be noted that this test has been incorporated as a requirement of OSHA in 29 CFR 1910.179.(n).(4).(i). It is recognized, however, that there may be circumstances where such a test is not prudent. First, such a test clearly should not be made with the hook under load. Consequently if a shift change is made with the hook loaded (this, by the way, is not a desireable practice and could be precluded through strict compliance with ANSI B30.2-3.2.3.j) a hoist limit switch test should not be performed. Second, there may be circumstances where the nature of forthcoming load handling operations indicates that the time (and minor risk) associated with this test is not justified. In particular if it is known that a hoist will not be used or used only in an area substantially removed from the upper travel limit, it would seem reasonable to defer the limit switch test until the start of the next shift. If such an approach is taken, however, it should be approached with care. Requirements for deferring an upper limit switch test should accomodate the uncertainty associated with maintenance plans and establish unambiguous criteria concerning what operations can be determined to be remote from upper travel limits. Such criteria should recognize that the need for upper travel limit switch protection may be preceeded by a control system failure and consequently should conservatively allow for operater response time and potential delays associated with emergency shutdown of the crane.

Approach Consistent With This Guideline

General compliance with this requirement. Certain specific provisions made for deferring upper limit switch testing under conditions that are not subject to operater interpretation.

Approaches Inconsistent With This Guideline

An approach that implies that a decision to test or not is left to the discretion of the operator or implies that such a test will be required only if operations are planned in close proximity to the hook upper travel limit.

Exception

Occasionally a licensee has indicated that the overhead electric travelling cranes employed at a site were purchased prior to the publication of CMAA-70 or ANSI B30.2-1976 and thus these standards should not be applied.

Discussion

The purpose of this Guideline is to ensure that all cranes carrying heavy loads in nuclear power plants meet certain minimum criteria in their design and, consequently, can be assumed to provide an acceptable standard of mechanical, electrical, and structural reliability. It is also recognized, however, that cranes in operating plants may have been designed and procured prior to the publication of current standards and, thus, not strictly comply with some details of these standards. In general, though, current standards have evolved from predecesor standards in existence at the time of crane procurement (EOCI 61, ANSI B30.2-1967) and, since the later standards are not revolutionary, it is likely that cranes at nuclear power plants will provide a degree of reliability equivalent to that provided by the current standards. Such a general determination canot be made, however, by the staff since nuclear power plant cranes are usually unique and provided with site specific design features. It is up to the licensee then to make a systematic comparison of their crane design with the requirements of current standards and determine if additional design features are appropriate.

Approach Consistent With This Guideline

The licensee has compared original crane procurement specifications or existing crane designs with the requirements of the referenced standards in areas effecting load handling reliability. In instances where the current standard provides additional protection against the consequences of operater error or component failure the licensee has proposed modifications which will result in a degree of load handling reliability similar to that provided in the current standard.

Approach Inconsistent With This Guideline

Positions to the effect that the cranes satisfied standards in existence at the time of procurement and what was good enough then is good enough now.