CONTROL OF HEAVY LOADS AT NUCLEAR POWER PLANTS
LA SALLE UNITS 1 AND 2

Docket No. [373/4]

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ABSTRACT

The Nuclear Regulatory Commission (NRC) has requested that all nuclear plants either operating or under construction submit a response of compliancy with NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants." EG&G Idaho, Inc. has contracted with the NRC to evaluate the responses of those plants presently under construction. This report contains EG&G's evaluation and recommendations for La Salle Nuclear Station.

EXECUTIVE SUMMARY

La Salle does not totally comply with the guidelines of NUREG-0612. In general, compliance is insufficient in the following areas:

- Justification for excluding cranes from the provision of NUREG-0612 is inadequate.
- Safe load paths are not provided for all applicable loads and marking is not provided.
- Load handling procedures appear to be inadequate since a general procedure is used for nearly all loads.
- Inadequate information was provided to verify that crane operators are trained qualified and conduct themselves as required by ANSI B30.2-1976.
- Special lifting devices do not appear to comply with ANSI N14.6-1978.
- Insufficient information was provided to verify that slings comply with dynamic load requirements.

- Comparison of the requirements of CMAA-70 with the standards used for La Salle cranes did not appear to be complete.

The main report contains recommendations which will aid in bringing the above items into compliance with the appropriate guidelines.

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TECHNICAL EVALUATION REPORT
FOR
LA SALLE NUCLEAR STATION UNITS 1 AND 2

1. INTRODUCTION

1.1 Purpose of Review

This technical evaluation report documents the EG&G review of general load handling policy and procedures at Commonwealth Edison's La Salle Nuclear PLant Units 1 and 2. This evaluation was performed with the objective of assessing conformance to the general load handling guidelines of NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants" [1], Section 5.1.1.

1.2 Generic Background

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

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

In order to upgrade measures for the control of heavy loads, the staff developed a series of guidelines designed to achieve a two-phase objective using an accepted approach or protection philosophy. The first portion of the objective, achieved through a set of general guidelines identified in NUREG-0612, Article 5.1.1, is to ensure that all load handling systems at nuclear power plants are designed and operated such that their probability of failure is uniformly small and appropriate for the critical tasks in which they are employed. The second portion of the staff's objective, achieved through guidelines identified in NUREG-0612, Articles 5.1.2 through 5.1.5 is to ensure that, for load handling systems in areas where their failure might result in significant consequences, either (1) features are provided, in addition to those required for all load handling systems, to ensure that the potential for a load drop is extremely small (e.g., a single-failure-proof crane) or (2) conservative evaluations of load handling accidents indicate that the potential consequences of any load drop are acceptably small. Acceptability of accident consequences is quantified in NUREG-0612 into four accident analysis evaluation criteria.

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

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

- 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

- 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.

1.3 Plant-Specific Background

In December 22, 1980, the NRC issued a letter [3] to Commonwealth Edison, the Licensee for the La Salle Nuclear Plant requesting that the Licensee review provisions with respect to the guidelines of NUREG-0612, and provide certain additional information to be used for an independent determination of conformance to these guidelines. On June 22, 1981, Commonwealth Edison provided the initial response to this request.

2. EVALUATION AND RECOMMENDATIONS

2.1 Overview

EG&G's evaluation of load handling at the La Salle Nuclear Plan deals with two items. The first item is a review of Commonwealth Edison's list of overhead handling systems which are subject to the criteria of NUREG-0612 and a review of the justification for excluding overhead handling systems from the above mentioned list. The second item deals with the exent to which the applicable handling systems comply with the general guidelines of NUREG-0612 Article 5.1.1. EG&G's conclusions and recommendations are provided in the summary of each item or guideline.

2.2 Heavy Load Overhead Handling Systems

2.2.1 Scope

"Report the results of your review of plant arrangements to identify all overhead handling systems from which a load drop may result in damage to any system required for plant shutdown or decay heat removal (taking no credit for any interlocks, technical specifications, operating procedures, or detailed structural analysis) and justify the exclusion of any overhead handling system from your list by verifying that there is sufficient physical separation from any load-impact point and any safety-related component to permit a determination by inspection that no heavy load drop can result in damage to any system or component required for plant shutdown or decay heat removal."

A. Summary of Licensee Statements

The Licensee's review of overhead handling systems identified the cranes and hoists shown in Table 2.1 as those which handle heavy

... in the vicinity of irradiated fuel or safe shutdown equipment.

The Licensee has also identified numerous other cranes that have been excluded from satisfying the criteria of the general guidelines of NUREG-0612. The licensee justified the exclusion of the above mentioned cranes by stating that their review "verified that there is sufficient physical separation between any load-impact and any nuclear safety-related component to prevent potential load drop damage to safety-related components required for achieving and maintaining plant shutdown."

B. EG&G Evaluation

The Licensee did not state what type of criteria they used to establish sufficient physical separation between any load impact point and any safety related equipment or any irradiated fuel. The lack of such criteria or other information such as drawings showing the relationship between crane coverage and location of safety equipment makes a detailed evaluation of the Licensee's statements difficult.

C. EG&G Conclusions and Recommendations

Based on the information provided EG&G concludes that the Licensee has included all applicable hoists and cranes in their list handling systems which must comply with the requirements of the general guidelines of NUREG-0612. However, EG&G does recommend that the Licensee supply a better justification for the exclusion of cranes and hoists from the referenced list. This could be done by stating the criteria that was used to justify sufficient physical separation between load impact point and safety related equipment, fuel, etc.

TABLE 2.1 CRANE/HOIST SYSTEMS CONSIDERED AS POTENTIAL SOURCES FOR DAMAGE OF SAFETY COMPONENTS

Equipment Number	Equipment Name
0HC02G	Reactor Bldg. Crane
0HC22G	New Fuel Vault Jib Crane JB-3
0HC23G	Jib Crane No. 5 (fuel inspection
0HC38G	Trolley Hand Hoist TH04
0H39G	Trolley Hand Hoist TH05
0HC41G	Trolley Hand Hoist TH06
0HC95G	New Fuel Handling Gentry Crane
1HCB7G	Rail Hugger Hoist RH28
1HCB8G	Trolley Wire Rope Hoist TWR21
2HCB9G	Trolley Wire Rope Hoist TWR22
1HCE1G	Jib Crane No. 8
1HC08G	Rail Hugger Hoist RH05
1HC09G	Rail Hugger Hoist RH06
1HC20G	Trolley Wire Rope Hoist TWR01
1&2HC21G	Trolley Wire Rope Hoist TWR02/TWR12
1&2HC22G	Trolley Wire Rope Hoist TWR03/TWR13
1&2HC23G	Trolley Wire Rope Hoist TWR04/TWR14
1&2HC24G	Trolley Wire Rope Hoist TWR05/TWR15
1&2HC27G	Trolley Wire Rope Hoist TWR06/TWR09
1HC29G	Rail Hugger Hoist RH13
2HC37G	Hand Chain Hoist HCH03
1HC46G	Trolley Wire Rope Hoist TWR07
1&2HC66G	Rail Hugger Hoist RH33
1HC67G	Trolley Wire Rope Hoist TWR17
2HC68G	Trolley Wire Rope Hoist
1HC70G	Rail Hugger Hoist RH34
1HC75G	Hand Trolley T33
2HC76G	Hand Trolley T34
1HC79G	Rail Hugger Hoist RH17
1HC80G	Rail Hugger Hoist RH36
2HC81G	Rail Hugger Hoist RH37
1HC87G	Hand Trolley T40
1HC89G	Rail Hugger Hoist RH22
2HC90G	Rail Hugger Hoist RH23

2.3 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:

A. Guideline 1--Safe Load Paths

B. Guideline 2--Load Handling Procedures

C. Guideline 3--Crane Operator Training

D. Guideline 4--Special Lifting Devices

E. Guideline 5--Lifting Devices (not specially designed)

F. Guideling 6--Cranes (Inspection, Testing, and Maintenance)

G. Guideline 7--Crane Design.

These seven guidelines should be satisfied for all overhead handling systems and programs in order 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 EG&G's evaluation of this verification are contained in the succeeding paragraphs.

2.3.1 Safe Load Paths (Guideline 1, NUREG-0612, Article 5.1.1(1))

"Safe load paths should be defined for the movement of heavy loads to minimize the potential for heavy loads, if dropped, to impact irradiated fuel in the reactor vesel and in the spent fuel pool, or to impact safe shutdown equipment. The

path should follow, to the extent practical, structural floor members, beams, etc., such that if the load is dropped, the structure is more likely to withstand the impact. These load paths should be defined in procedures, shown on equipment layout drawings, and clearly marked on the floor in the area where the load is to be handled. Deviations from defined load paths should require written alternative procedures approved by the plant safety review committee."

A. Summary of Licensee Statements and Conclusions

The licensee has evaluated safe load path locations for La Salle Units 1 and 2. While load paths are not defined for all loads, the Licensee states that load movement follows the safest and shortest route with the load as close to the floor as practical. Due to the configurations and number of load paths, the Licensee states that marking the paths on the floor is generally not feasible nor would such markings contribute to the health and safety of plant personnel.

B. EG&G Evaluation

The Licensee response and drawings submitted indicates that Guideline 1 criteria have not been satisfied at La Salle Station. Load paths have not been developed for all heavy loads which have been identified. EG&G does not concur that movement of heavy loads following the safest and shortest route is an acceptable substitute for the development of specific load paths for the individual loads. Load paths which have been developed for the drywell head, reactor vessel head, dryer, separator, etc. appear to be acceptable and should be used as an example for developing load pathways for the remaining heavy loads identified by the Licensee.

The Licensee's position on the unfeasibility of marking load paths on the floor is not acceptable. EG&G does agree that for some area's and/or loads floor marking is not the best method for designating a load path, but for certain loads it may be the best method available.

Load path markings are meant to be used by load handling operators and their supervisors as a means for monitoring proper areas where movements of heavy loads will take place so that personnel not directly involved in load handling will be alerted to keep these pathways clear of non-related materials. By consolidating the various load paths, the Licensee should be able to develop a systematic sequence of pathways for the movement of heavy loads to their lay-down or staging areas which is not overly complex or confusing to operators and supervisors, thus contributing to the general safety of plant personnel by minimizing inteference with load handling operations. For some crane systems such as monorails the load paths are defined by the routing of the monorail and the marking necessary would be minimal.

No 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. EG&G Conclusions and Recommendations

EG&G concludes from the Licensee's response that the La Salle Station does not comply with Guideline 1.

In order to adhere to the criteria of this guideline, EG&G recommends that the Licensee should perform the following:

(1) develop safe load paths for all heavy loads identified by the Licensee, similar to those already established for the drywell and reactor vessel heads, the dryer, separator, etc.

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

(3) clearly mark safe load paths on the floor or by some other means in areas where the loads are handled

(4) submit verification that deviations from established load paths require written alternatives which are approved by the plant safety review committee.

Items 1 thru 3 above should be accomplished before the lack of safe load paths becomes an immediate impact on plant safety.

2.3.2 Load Handling Procedures (Guideline 2, NUREG-0612, Article 5.1.1(2))

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

A. Summary of Licensee Statements and Conclusions

A detailed list of heavy loads and procedures governing the handling of each load has been supplied by the Licensee, who

states that these procedures meet the intent of Section 5.1.1(2) of NUREG-0612 and generally include sections such as equipment description, purpose, references, initial conditions and appropriate precautions or limitations. Although most-loads are governed by specific procedures, all loads are also handled in accordance with La Salle Station movement procedure MP-GM-9, "Safe Rigging Practices." MP-GM-9 will be revised by the Licensee to prohibit handling of heavy loads over fuel in the spent fuel pool or over the open reactor cavity unless a specific procedure has been written directing or permitting such action.

B. EG&G Evaluation

EG&G concurs that specific procedures identified by the Licensee for load handling satisfy the criteria of Guideline 2 with the exception that safe load paths have not been developed for movements of each heavy load.

For other heavy loads, the Licensee has provided insufficient information for EG&G to determine if all criteria specified in the guideline have been satisfied by use of the general procedure for rigging MP-GM-9. A general procedure may be adequate for some loads and cranes if supplemented by specific procedures defining safe load paths, inspection criteria, etc. as applicable to each load or crane.

C. EG&G Conclusions and Recommendations

La Salle Station partially complies with Guideline 2.

In order to comply with the remaining critria of this guideline, the Licensee should perform the following:

(1) incorporate defined safe load paths into all current procedures

(2) submit certification that general handling procedure MP-GM-9 and instructions contained on applicable drawings satisfy the guideline criteria, including safe load path definition, or incorporate these items into procedures which comply.

The above items should be complete before the use of cranes, near fuel or equipment critical for plant safety, is necessary.

2.3.3 Crane Operator Training (Guideline 3, NUREG-0612, Article 5.1.1(3))

"Crane operators should be trained, qualified and conduct themselves in accordance with Chapter 2-3 of ANSI B30.2-1976, 'Overhead and Gantry Cranes' [4]."

A. Summary of Licensee Statements and Conclusions

The Licensee states that La Salle Station's crane operator training program is substantially in compliance with ANSI B30.2-1976. Station employees currently undergo an annual physical examination for the purpose of respirator qualification. The LaSalle Station medical director has compared this examination with that required by ANSI B30.2-1976 and has concluded that the current medical evaluation meets the requirements of the standard.

B. EG&G Evaluation

Crane operator training and qualification programs at La Salle Station satisfy the criteria of this guideline on the basis of the Licensee's statement that the current program substantially complies with the standard. No information has been provided to

verify that conduct of operators is monitored for conformance to the requirements of Section 2.3.1.7 of ANSI B30.2-1976.

C. EG&G Conclusion and Recommendations

La Salle Station partially complies with Guideline 3. In order to achieve full compliance, the Licensee should verify that suitable means exist to monitor crane operator conduct in accordance with ANSI B30.2-1976. Procedures and program records should be readily available for review and inspection by the NRC staff.

2.3.4 Special Lifting Devices (Guideline 4, NUREG-0612, Article 5.1.1(4))

"Special lifting devices should satisfy the guidelines of ANSI N14.6-1978, 'Standard for Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More for Nuclear Materials' [5]. 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) or the load and of the intervening components of the special handling device."

A. Summary of Licensee Statements and Conclusions

The Licensee states that all lifting devices were designed according to industrial standards using good engineering

practices. Additionally, load tests have been performed on the following lifting devices to the weights specified:

(1) reactor head strongback--156 tons (150% of load)

(2) dryer/separator lifting rig--140 tons (200% of load).

B. EG&G Evaluation

The Licensee has not verified that any special lifting devices have been evaluated with respect to the design, fabrication, testing, and maintenace requirements specified in ANSI N14.6-1978 or with respect to the stress design factor identified in this guideline. Insufficient information has been provided by the Licensee for EG&G to verify that periodic testing is performed to maintain continuing compliance in accordance with Section 5.2 of ANSI N14.6-1978, although the weight tests identified (for the dryer/separator lifting rig and the reactor head strongback) meet or exceed the required 150% load test requirement.

C. EG&G Conclusions and Recommendations

La Salle Stations does not comply with Guideline 4. In order to satisfactorily comply with the criteria, the Licensee should perform the following:

(1) review, evaluate and report on the design and fabrication of all special lifting devices with respect to the requirements of ANSI N14.6-1978 and Guideline 4

(2) submit verification that procedures exist for all special lifting devices which satisfy the requirments of Section 5

(Acceptance Testing, Maintenance, and Assurance of Continued Compliance) of ANSI N14.6-1978.

Compliance with this guideline should be complete for each lifting device before they are used in a critical situation.

2.3.5 Lifting Devices (Not Specially Designed) (Guideline 5, NUREG-0612, Article 5.1.1(5))

"Lifting devices that are not specially designed should be installed and used in accordance with the guidelines of ANSI B30.9-1971, 'Slings' [6]. However, in selecting the proper sling, the load used should be the sum of the static and maximum dynamic load. The rating identified on the sling should be in terms of the 'static load' which produces the maximum static and dynamic load. Where this restricts slings to use on only certain cranes, the slings should be clearly marked as to the cranes with which they may be used."

A. Summary of Licensee Statements and Conclusions

The Licensee states that all lifting devices were designed according to industrial standards using good engineering practices and that La Salle Station complies with ANSI B30.9-1971.

B. EG&G Evaluation

Procedures for use and installation of slings at La Salle Station are acceptable based upon the Licensee's stated compliance with ANSI B30.9-1971, with the following exceptions:

(1) no information has been provided by the Licensee to verify that sling selection is based upon the sum of the static and maximum dynamic load

(2) no information is available to verify that the slings are marked with the static load identified as per guideline requirement

(3) no verification has been made that slings restricted in use to only certain cranes have been clearly marked to so indicate.

C. EG&G Conclusions and Recommendations

La Salle Station partially complies with Guideline 5. In order to fully comply the Licensee should submit verification for the following:

(1) sling selection is based upon the sum of the static and maximum dynamic loads

(2) slings are marked with the "static load" which produces the maximum static and maximum dynamic loads

(3) slings restricted in use to only certain cranes are clearly marked to so indicate.

2.3.6 Cranes (Inspection, Testing, and Maintenance) (Guideline 6, NUREG-0612, Article 5.1.1(6))

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

calls for certain inspections to be performed daily or monthly. For such cranes having limited usage, the inspections, test, and maintenance should be performed prior to their use)."

A. Summary of Licensee Statements and Conclusions

Crane inspection, testing, and maintenance at La Salle Station comply with Chapter 2-2 of ANSI B30.2-1976. All routinely operated cranes are given a documented monthly inspection and all hooks are examined using magnetic particle inspection (or liquid penetrant, if appropriate) on an annual basis. The Licensee states that special use cranes are inspected prior to their use.

B. EG&G Evaluation

The Licensee's states that crane inspection, testing, and maintenance programs comply with ANSI B30.2-1976 with exceptions as allowed by Guideline 6.

C. EG&G Conclusions and Recommendations

La Salle Station complies with Guideline 6 on the basis of the Licensee's statement.

2.3.7 Crane Design (Guideline 7, NUREG-0612, Article 5.1.1(7))

"The crane should be designed to meet the applicable criteria and guidelines of Chapter 2-1 of ANSI B30.2-1976, 'Overhead and Gantry Cranes,' and of CMAA-70, 'Specifications for Electric Overhead Traveling Cranes' [7]. An alternative to a specification in ANSI B30.2 or CMAA-70 may be accepted in lieu of specific compliance if the intent of the specification is satisfied."

A. Summary of Licensee Statements and Conclusions

The Licensee states that the cranes used at La Salle Station were purchased to Sargent and Lundy Specification, which is based upon specifications of the American Institute of Steel Construction, the Electric Overhead Crane Institute, Inc. (EOCI), and USAS Safety Code B30.2.0-1967. Based upon a comparison between actual design specifications and those of CMAA-70, the Licensee states that the La Salle procurement specification meets the intent of CMAA-70. Specific differences identified by the Licensee include the following: the EOCI-61 and procurement specifications require a design force equal to 15% of the rated capacity of the crane, while CMAA-70 specifies that the impact load be 0.5% of the load times the hoist speed (in fpm) and neither less than 15% nor greater than 50% of the rated capacity; therefore, La Salle cranes have been procured to a criteria which conforms to the requirements of CMAA-70 for a hoist speed of less than 30 fpm.

B. EG&G Evaluation

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

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

has reviewed FRC's work and concurs with it. We used FRC's comparison for the following evaluation. Of the following design recommendations, two have been addressed by the Licensee:

(1) Impact allowance. This issue has been addressed by the Licensee. However, 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 overhead cranes subject to this review since these cranes, in general, operate with hoist speeds below 30 feet per minute. Insufficient information has been provided by the Licensee to verify that La Salle cranes operate with hoist speeds of less than 30 feet per minute.

(2) Torsional forces. CMAA-70, Article 3.3.2.1.3 requires that twisting moments due to overhanging loads and lateral forces acting eccentric to the horizontal neutral axis of a girder be calculated on the basis of the distance between the center of gravity of the load, or force center line, and the girder shear center measured normal to the force vector. EOCI-61 states that such moments are to be calculated with reference to girder center of gravity. For girder sections symmetrical about each principal central axis (e.g., box section or I-beam girders commonly used in cranes subject to this review), the shear center coincides with the centroid of the girder section and there is no difference between the two requirements. Such is not the case for nonsymmetrical girder sections (e.g., channels).

(3) Longitudinal stiffeners. CMAA-70, Article 3.3.3.1 specifies (1) the maximum allowable web depth/thickness (h/t) ratio for box girders using longitudinal stiffeners and (2) requirements concerning the location and minimum

moment of inertia for such stiffeners. EOCI-61 allows the use of longitudinal stiffeners but provides no similar guidance. Requirements of CMAA-70 represent a codification of girder design practice, and they are expected to be equivalent to design standards employed in cranes built to EOCI-61 specifications.

(4) Allowable compressive stress. CMAA-70, Article 3.3.3.1.3 identifies allowable compressive stresses to be approximately 50% of yield strength of the recommended structural material (A-36) for girders, where the ratio of the distance between web plates to the thickness of the top cover plate (b/c ratio) is less than or equal to 38. Allowable compressive stresses decrease linearly for b/c ratios in excess of 38. EOCI-61 provides a similar method for calculating allowable compressive stresss 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. This issue was also addressed by the Licensee but no information was given verifying that b/c ratio's are less than 38.

(5) Fatigue considerations. CMAA-70, Article 3.3.3.1.3 provides substantial guidance with respect to fatigue failure by indicating allowable stress ranges for various structural members in joints under repeated loads. EOCI-61 does not address fatigue failure. The requirements of CMAA-70 are not expected to be of consequence for cranes subject to this review since the cranes are not generally subjected to frequent loads at or

near design conditions (CMAA-70 provides allowable stress ranges for loading cycles in excess of 20,000) and are not generally subjected to stress reversal (CMAA-70 allowable stress range is reduced to below the basic allowable stress for only a limited number of joint configurations).

(6) Hoist rope requirements. CMAA-70, Article 4.2.1 requires that the capacity load plus the bottom block divided by the number of parts of rope not exceed 20% of the published rope breaking strength. EOCI-61 requires that the rated capacity load divided by the number of parts of rope not exceed 20% of the published rope breaking strength. The effect on crane safety margins of this variation depends on the ratio of the weights of the load block and the rated load.

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

(8) Drum design. CMAA-70, Article 4.4.2 provides recommended drum groove depth and pitch. EOCI-61 provides no similar guidance. The recommendations in CMAA-70 constitute a codification of good engineering practice with regard to reeving stability and reduction of rope wear and are not expected to differ substantially from practices employed

in the design of cranes subject to this review and built to EOCI-61 specifications.

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

(10) Bridge brake design. CMAA-70, Article 4.7.2.2 requires that bridge brakes, for cranes with cab control and the cab on the trolley, be rated at least 75% of bridge motor torque. EOCI-61 requires a brake rating of 50% of bridge motor torque for similar configurations. A cab-on-trolley control arrangement is not expected for cranes subject to this review.

(11) Hoist brake design. CMAA-70, Article 4.7.4.2 requires that hoist holding brakes, when used with a method of control braking other than mechanical, have torque ratings no less than 125% of the hoist motor torque. EOCI-61 requires a hoist holding brake torque rating of no less than 100% of the hoist motor torque without regard to the type of control brake employed. This variation is not expected to be of consequence for cranes subject to this review since mechanical load brakes were typically specified for cranes procured when EOCI-61 was the standard. The addition of a holding brake safety margin in conjunction with electric control braking is a codification of good engineering practice. Some manufacturers provide holding brakes rated at up to 150%

of hoist motor torque when used with electrical control braking systems.

(12) Bumpers and stops. CMAA-70, Article 4.12 provides substantial guidance for the design and installation of bridge and trolley bumpers and stops for cranes which operate near the ends of bridge and trolley travel. Further, the guidance of CMAA-70 constitutes the codification of good engineering practice and will be expected to be satisfied by equivalent requirements for cranes procured according to EOCI-61.

(13) Static control systems. CMAA-70, Article 5.4.6 provides substantial guidance for the use of static control systems. EOCI-61 provides guidance for magnetic control systems only. This variation is not expected to be of consequence because magnetic control systems were generally employed in cranes designed when EOCI-61 was in effect and the static control requirements identified in CMAA-70 constitute a codification of the same good engineering practice that would have been used in the design of static control systems in cranes built to EOCI-61 specifications.

(14) Restart protection. CMAA-70, Article 5.6.2 requires that cranes not equipped with spring return controllers or momentary contact push buttons be provided with a device that will disconnect all motors upon power failure and will not permit any motor to be restarted until the controller handle is brought to the OFF position. No similar guidance is provided in EOCI-61. This variation is not expected to be of consequence for cranes subject to this review since they are generally design with spring-return controllers or momentary-contact push buttons.

C. EG&G Conclusion and Recommendation

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

(1) Hoist lifting speeds do not exceed 30 feet per minute.

(2) Nonsymmetrical girder sections were not used in crane construction.

(3) Any longitudinal stiffeners in use conform to the requirments of CMAA-70, and allowable h/t ratios in box girders using these stiffeners do not exceed ratios specified in CMAA-70.

(4) Girders with b/c ratios in excess of 38 were not used.

(5) Fatigue failure was considered in crane design and the number of design loading cycles at or near rated load is less than 20,000 cycles.

(6) Maximum crane load weight, plus the weight of the bottom block, divided by the number of parts of rope does not exceed 20% of the manufacturers' published breaking strength.

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

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

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

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

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

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

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

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

3. CONCLUDING SUMMARY

This summary is provided to consolidate the conclusions and recommendations of Section 2 and to document EG&G's overall evaluation of the handling of heavy loads at La Salle Station. In each case, recommendations for additional Licensee action, and additional NRC staff action where appropriate, are provided.

3.1 Applicable Load Handling Systems

Based on the information provided EG&G concludes that the list of cranes and hoists supplied by the Licensee as being subject to the provisions of NUREG-0612 is adequate. However, EG&G does recommend that a more thorough justification be provided for excluding cranes.

3.2 Guideline Recommendations

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 due to these factors is very small for the critical functions performed by cranes at nuclear power plants. These guidelines are partially satisfied at La Salle Station. This conclusion is represented in tabular form as Table 3.1. Specific recommedations for achieving full compliance with these guidelines are provided as follows:

Guideline	Recommendation	
1 (Section 2.3.1)	a.	Develop safe load paths for all heavy loads identified by the Licensee similar to those already established for the drywell and reactor vessel heads, the dryer, separator, etc.
	b.	Incorporate load paths into load handling procedures and equipment layout drawings.
	c.	Clearly mark safe load paths on the floor or by some other means in the areas where loads are handled.
	d.	Submit verification that deviations from established load paths require written alternatives approved by the plant safety review committee.
2 (Section 2.3.2)	a.	Incorporate defined safe load paths into all current procedures.
	b.	Certify that general handling procedure MP-GM-9 and instructions contained on applicable drawings satisfy the guideline criteria, including safe load path definitions, or incorporate these items into procedures which comply.
3 (Section 2.3.3)		Submit verification that suitable means exist to monitor crane operator conduct in accordance with ANSI B30.2-1976.

4 (Section 2.3.4)	a.	Review, evaluate and report on the design and fabrication of all special lifting devices with respect to the requirements of ANSI N14.6-1978 and Guideline 4.
	b.	Submit verification that suitable program of procedures exist for all special lifting devices which satisfy the requirements of Section 5 (Acceptance Testing, Maintenance, and Assurance of Continued Compliance) of ANSI N14.6-1978.
5 (Section 2.3.5)	a.	Submit verification that sling selection is based upon the sum of the static and maximum dynamic loads.
	b.	Mark slings with the "static load" that produces the maximum static and dynamic loads.
	c.	Clearly mark slings restricted in use to only certain cranes.
6 (Section 2.3.6)	La Salle complies with this guideline.	
7 (Section 2.3.7)	Evaluate those criteria identified from CMAA-70 which have not been addressed by the Licensee to determine whether these items have been satisfied in design of cranes in use at La Salle Station.	

4. REFERENCES

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

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

3. USNRC, Letter to Commonwealth Edison. Subject: NRC Request for Additional Information on Control of Heavy Loads Near Spent Fuel NRC, December 22, 1980.

4. ANSI B30.2-1976, "Overhead and Gantry Cranes".

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

6. ANSI B30.11-1971, "Slings".

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

Table 3.1

Equipment Designation	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
Reactor Bldg. Crane	Shield Plugs	125(M) 10(A) (93)	NC	I	I	NC	I	C	-I
	Dryer/Separator Shield Plugs	(39)	NC	I	-	NC	I	-	-
	Fuel Pool Plugs	(8)	NC	I	-	NC	I	-	-
	Drywell Head	(70)	NC	I	-	NC	I	-	-
	Head Insulation	(5)	NC	I	-	NC	I	-	-
	Reactor Head	(100)	NC	I	-	I	I	-	-
	Steam Dryer	(40)	NC	I	-	I	I	-	-
	Steam Separator	(73.25)	NC	I	-	I	I	-	-
	Vessel Service Platform	(5)	NC	I	-	NC	I	-	-
	Spent Fuel Pool Plugs	(6.5)	NC	I	-	NC	I	-	-
	Refueling Shield Chute	(23)	NC	I	-	NC	I	-	-
	Spent Fuel Pool Gates	(2.5)	NC	I	-	NC	I	-	-
	Fuel Pool Gates	(4)	NC	I	-	NC	I	-	-
	Spent Fuel Shipping Cask	(100)	NC	I	-	NC	I	-	-
	RHR Heat Exchange Plugs	(8)	NC	I	-	NC	I	-	-
	Clean-up Filter Demineralizer Plugs	(4)	NC	I	-	NC	I	-	-
	Skimmer Surge Tank Plugs	(2.2)	NC	I	-	NC	I	-	-

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

Table 3.1 (Cont'd)

Equipment Designation	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
	Equipment Hatch Plugs	(3.5	NC	I	-	NC	I	-	-
	Fuel Vault Plugs	(6)	NC	I	-	NC	I	-	-
	Elc. 140 Open Plugs	(3.5)	NC	I	-	NC	I	-	-
	Nut Carrier with 6 Nuts and Washers	(0.25)	NC	I	-	NC	I	-	-
	Stud Rack With 5 Studs	(1.2)	NC	I	-	NC	I	-	-
	RCIC Piping & Seismic Iron Work	(0.65)	NC	I	-	NC	I	-	-
	Head Vent Line & Instrument Lines & Seismic Iron Work	(0.75)	NC	I	-	NC	I	-	
	"O" Ring Protector	(0.9)	NC	I	-	NC	I	-	-
	Dryer/Separator Gate-Storage	(25)	NC	I	-	NC	I	-	-
New Fuel Vault Jib Crane JD-3	Misc. Equipment	1(0.4)	NC	I	I	NC	I	C	I
Jib Crane No. 5 (Fuel Inspection)	Fuel Assembly	0.25(0.4)*	NC	I	I	NC	I	C	I
Trolley Hand Hoist TIH04	Flange 1/2 N62-D017	2(0.4)	NC	I	I	NC	I	C	I
Trolley Hand Hoist TIH05	Flange 1 N62 D007A&B	2(0.4)	NC	I	I	NC	I	C	I
Trolley Hand Hoist TIH06	Flange 2 N62 D007A&B	2(0.4)	NC	I	I	NC	I	C	I
New Fuel Handling Gentry Crane	Fuel Assembly	0.65(M) 0.5(A) (0.4)	NC	I	I	NC	I	C	I

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* Indicated capacity less than indicated load weight

Table 3.1 (Cont'd)

Equipment Designation	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
Rail Hugger Hoist RH28	Misc. Equipment	2(0.5)	NC	I	I	NC	I	C	I
Trolley Wire Rope Hoist TWR21	Misc. Equipment	10(5.68)	NC	I	I	NC	I	C	I
Trolley Wire Rope Hoist TWR22	Misc. Equipment	2(0.4)	NC	I	I	NC	I	C	I
Jib Crane No. 8	Misc. Equipment	3(0.4)	NC	I	I	NC	I	C	I
Rail Hugger Hoist RH05	R. Feed Pump Motor	16(15.25)	NC	I	I	NC	I	C	I
Rail Hugger Hoist RH06	R. Feed Pump Motor	16(15.25)	NC	I	I	NC	I	C	I
Trolley Wire Rope Hoist TWR01	HPCS Pump	20(16.35)	NC	I	I	NC	I	C	I
Trolley Wire Rope Hoist TWR02/TWR12	RHR Pump	20(3.75)	NC	I	I	NC	I	C	I
Trolley Wire Rope Hoist TWR03/TWR13	RHR Pump	20(3.75)	NC	I	I	NC	I	C	I
Trolley Wire Rope Hoist TWR04/TWR14	RHR Pump	20(3.75)	NC	I	I	NC	I	C	I
Trolley Wire Rope Hoist TWR05/TWR15	LPCS Pump	20(3.90)	NC	I	I	NC	I	C	I
Trolley Wire Rope Hoist TWR06/TWR09	Fuel Pool Components	0.5(0.4)	NC	I	I	NC	I	C	I
Rail Hugger Hoist RH13	Recovery Coils	5(3.5)	NC	I	I	NC	I	C	I
Hand Chain Hoist	Swivel Crane	1(0.4)	NC	I	I	NC	I	C	I
Trolley Wire Rope Hoist TWR07	Misc. Equipment	5(0.4)	NC	I	I	NC	I	C	I

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Table 3.1 (Cont'd)

Equipment Designation	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
Rail Hugger Hoist RH33	Control Rod Drive	3(0.23)	NC	I	I	NC	I	C	I
Rail Hugger Hoist RH35	Control Rod Drive	1(0.23)	NC	I	I	NC	I	C	I
Trolley Wire Rope Hoist TWR17	Feedwater Pump Turbine	15(25)*	NC	I	I	NC	I	C	I
Trolley Wire Rope Hoist	Feedwater Pump Turbine	15(25)*	NC	I	I	NC	I	C	I
Rail Hugger Hoist RH34	Misc. Equipment	10(3.45)	NC	I	I	NC	I	C	I
Hand Trolley T33	Fans	5(3)	NC	I	I	NC	I	C	I
Hand Trolley T34	Fans	5(3)	NC	I	I	NC	I	C	I
Rail Hugger Hoist RH17	Recirc. Pump	2@16(30)	NC	I	I	NC	I	C	I
Rail Hugger Hoist RH36	Reactor Feedwater Pump	16 (15.25)	NC	I	I	NC	I	C	I
Rail Hugger Hoist RH37	Reactor Feedwater Pump	16 (15(25)	NC	I	I	NC	I	C	I
Hand Trolley T40	Safety Valve	2 (1.06)	NC	I	I	NC	I	C	I
Rail Hugger Hoist RH22	F. W. Flowmeter	2@12(15.25)	NC	I	I	NC	I	C	I
Rail Hugger Hoist RH23	F. W. Flowmeter	2@12(15.25)	NC	I	I	NC	I	C	I
Jib Crane JB-1	Misc. Equipment	0.5(0.4)	NC	I	I	NC	I	C	I
Jib Crane JB-4	Misc. Equipment	0.5(0.4)	NC	I	I	NC	I	C	I

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