JUN 2 8 1985

TO ALL LICENSEES FOR OPERATING REACTORS

Gentlemen:

SUBJECT: COMPLETION OF PHASE II OF "CONTROL OF HEAVY LOADS AT NUCLEAR POWER PLANTS" NUREG-0612. (GENERIC LETTER 85-11)

On December 22, 1980, NRC issued a generic letter (unnumbered) which was supplemented February 3, 1981 (Generic Letter 81-07) regarding NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants". This letter requested that you implement certain interim actions and provide the NRC information related to heavy loads at your facilities. Your submittals were requested in two parts; a six month response (Phase I) and a nine month response (Phase II).

All licensees have completed the requirement to perform a review and submit a Phase I and a Phase II report. Based on the improvements in heavy loads handling obtained from implementation of NUREG-0612 (Phase I), further action is not required to reduce the risks associated with the handling of heavy loads (See enclosed NUREG-0612 Phase II). Therefore, a detailed Phase II review of heavy loads is not necessary and Phase II is considered completed. However, while not a requirement, we encourage the implementation of any actions you identified in Phase II regarding the handling of heavy loads that you consider appropriate.

For each plant which has a license condition requiring commitments acceptable to the NRC regarding Phase II, an application for license amendment may be submitted to the NRC to delete the license condition citing this letter as the basis. If you have any questions, contact your Project Manager or Don Neighbors (301) 492-4837.

Sincerely,

Original Signed by
Hugh L. Thompson, Jr.

Hugh L. Thompson, Jr., Director
Division of Licensing

Enclosure:
As Stated

*See previous concurrences

ORB#1:DL*	ORB#1:DL*	BC-ORB#1:DL*	D/DSI*	AD:OR:DL*	D:DL
CParrish	JDNeighbors	SVarga	RBernero	GLainas	HThompson
3/7/85	5/6/85	3/11/85	3/13/85	3/19/85	5/30/85

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NUREG-0612, "CONTROL OF HEAVY LOADS AT NUCLEAR POWER PLANTS"
RESOLUTION OF PHASE II

Generic Technical Activity A-36 was established to systematically examine the staff's licensing criteria, adequacy of measures in effect at operating plants and recommend necessary changes to assure the safe handling of heavy loads. The task involved review of licensee information, evaluation of historical data, performance of accident analyses and criticality calculations, development of guidelines for operating plants, and review of licensing criteria. The review indicated that the major causes of load handling accidents include operator errors, rigging failures, lack of adequate inspection and inadequate procedures. The results of the review culminated in the issuance of NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants" in July 1980. NUREG-0612 described a resolution of Task A-36.

NUREG-0612 presents an overall philosophy that provides a defense-in-depth approach for controlling the handling of heavy loads. The approach is directed to preventing load drops. The following summarizes this defense-in-depth approach:

1. Assure that there is a well designed handling system.

2. Provide sufficient operator training, load handling instructions, and equipment inspection to assure reliable operation of the handling system.

3. Define safe load travel paths and procedures and operator training to assure to the extent practical that heavy loads are not carried over or near irradiated fuel or safe shutdown equipment.

4. 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.

5. Where mechanical stops or electrical interlocks cannot be provided, provide a single-failure-proof crane or perform load drop analyses to demonstrate that unacceptable consequences will not result.

By Generic Letters dated December 22, 1980, and February 3, 1981 (Generic Letter 81-07), all utilities were requested to evaluate their plants against the guidance of NUREG-0612 and to provide their submittals in two parts; Phases I (six month response) and Phase II (nine month response). Phase I responses were to address Section 5.1.1 of NUREG-0612 which covers the following areas:

1. Definition of safe load paths
2. Development of load handling procedures
3. Periodic inspection and testing of cranes
4. Qualifications, training and specified conduct of operators
5. Special lifting devices should satisfy the guidelines of ANSI N14.6 6.
6. Lifting devices that are not specially designed should be installed and used in accordance with the guidelines of ANSI B30.9
7. Design of cranes to ANSI B30.2 or CMAA-70

Phase II responses were to address Sections 5.1.2 thru 5.1.6 of NUREG-0612 which cover the need for electrical interlocks/mechanical stops, or alternatively, single-failure-proof cranes or load drop analyses in the spent fuel pool area (PWR), containment building (PWR), reactor building (BWR), other areas and the specific guidelines for single-failure-proof handling systems.

We have completed our review of the utilities' submittals for Phase I for nearly all operating reactors. Only one plant still remains to be reviewed. During our review we verified that the seven guidelines listed above were providing the desired level of safety indicated in NUREG-0612. By way of the utilities' responses to the criteria of NUREG-0612, Section 5.1.1 and through discussions with our consultants based on their experiences from the reviews, we have concluded that the Phase I guidelines have provided an increased awareness by the utilities of the importance of heavy load handling.

Our review has indicated that satisfaction of the Phase I guidelines assures that the potential for a load drop is extremely small. We have noted improvements in heavy load handling procedures and training and crane and handling tool inspection and testing. These changes have been geared to limiting the handling of heavy loads over safety-related equipment and spent fuel to the extent practical, but where this can not be avoided, to accomplishing it with the operational and other features of the program implemented in Phase I. We therefore conclude that the guidelines of Phase I are adequately providing the intended level of protection against load drop accidents.

To date we have received Phase II submittals from all licensees. We interpret Phase II of NUREG-0612 as an enhancement to Phase I. Thus, prior to undertaking a review of the utilities' Phase II response for all of the operating reactors, and as a test of the adequacy of the Phase I program, we decided to undertake a pilot program with a limited number of plants. The findings from the pilot program would then provide a basis for a decision on whether to proceed with the review of the Phase II submittals for all operating reactors, to reduce the scope of the review, or to totally eliminate the review.

The pilot program involved the review of operating reactors at 12 sites, a total of 20 reactors (eight BWRs and 12 PWRs). Of the 20 reactors, 5 BWRs (Browns Ferry 1, 2 and 3 and Peach Bottom 2 and 3) have single-failure-proof cranes for all heavy load lifts. "Single-failure-proof" is used to mean a crane which meets the guidelines of NUREG-0554, "Single-Failure-Proof Cranes for Nuclear Power Plants." Three BWR units (Dresden 2 and 3 and Big Rock Point) have taken credit for a combination of single-failure-proof cranes in some plant areas and load drop analyses in others. Five PWR reactors (Millstone 2, Prairie Island 1 and 2, and Surry 1 and 2) have utilized the load drop analysis approach. One plant (Kewaunee) has taken credit for a combination of electrical interlocks in some plant areas and load drop analyses in others. The remaining six reactors (Davis Besse, Indian Point 2, Arkansas 1 and 2 and Calvert Cliffs 1 and 2) chose to take credit for a combination of administrative controls, procedures and Technical Specification restrictions in conjunction with some type of load drop analysis. This approach does not meet the criteria of Sections 5.1.2 to 5.1.6 of NUREG-0612. Rather, it is an amplification of the guidelines of the Phase I effort, reflecting Section 5.1.1 of NUREG-0612.

It should also be noted that we have completed our review of Phase II for five operating license applicants. Of these, two (WNP-2 and Fermi-2) have single-failure-proof cranes. The remaining three (Callaway, Wolf Creek and Catawba 1 and 2) employ a combination of electrical interlocks, mechanical stops, limit switches and load drop analyses.

In addition to the detailed reviews of the Phase II reports in the pilot program and in connection with the five operating license applications, we have performed a sufficient review of all other Phase II reports to flag any outstanding plant-specific concerns reported.

From our pilot program and OL Phase II reviews, together with the above-mentioned reviews of the other Phase II reports, we have concluded that the risks associated with damage to safe shutdown systems are relatively small because:

1. nearly all load paths avoid this equipment
2. most equipment is protected by an intervening floor
3. of the general independence between crane failure probability and safety-related systems which has been observed
4. redundancy of components

We did not identify any outstanding plant specific safety concern associated with heavy loads handling.

Therefore, most of the risk appears to be associated with carrying heavy loads over or in a location where spent fuel could be damaged. The single most important example of this concerns loads handled over the open reactor vessel during refueling (such as the reactor vessel head). However, as previously mentioned, this is limited to the extent practical and where necessary, is performed with a specifically implemented program in conformance with the Phase I guidelines.

From the pilot program and OL reviews, we noted that nine of the twenty reactors, all PWRs, do not have single-failure-proof cranes. To date, we have not identified any PWRs with single-failure-proof cranes. Further, since electrical interlocks and mechanical stops are not possible for PWR polar cranes, these reactors would be required to perform costly detailed load drop analyses. If satisfactory results could not be demonstrated from these analyses, NUREG-0612 would call for installation of a single-failure-proof crane.

Based on the above, since a single failure proof crane becomes the only solution for satisfying the NUREG-0612 criteria, the cost/benefit should be examined. Because we are dealing primarily with PWRs, the cost for modification of a polar crane to meet single failure criteria (NUREG-0554) guidelines) is approximately $30 million. This includes, as the dominant cost element, the cost of the extended shutdown which is required in order to gain access to containment. On the benefit side, given the improvements obtained from the Phase I implementation and the information obtained in the course of the pilot program and OL Phase II reviews, we cannot perceive a significant enough benefit in conversion to single-failure-proof polar cranes to warrant the high costs. (See Attachment I for a cost-benefit analysis.) We believe that tbe cost/benefit analysis in NUREG-0612 is no longer valid because of the benefits realized by Phase I implementation.

We believe the above assessment is further borne out by the industry experience with handling of heavy loads over the years. Precautions have been and are being taken such that no heavy load drop accidents affecting any features of the defense-in-depth against severe core-damage accidents have occurred.* This determination is also supported by the recommendation of our contractor for the pilot program reviews (Franklin Research Center) and our benefit-cost analysis suggesting that we accept other, less strigent but less costly means for Phase II compliance as an alternative to the criteria of NUREG-0612 with respect to conversion to single-failure-proof cranes.

Conclusion and Recommendation

Based on the above, we believe the Phase I implementation has provided sufficient protection such that the risk associated with potential heavy load

*There have, however, been recent occurrences of lesser severity. (See for example, IE Information Notice No. 85-12: Recent Fuel Handling Events; LER 84-015, Fort Calhoun 1, Load Over the RCS; and LER 84-006, San Onofre 2, Polar Crane Malfunction). Accordingly, nothing in this determination should be regarded as a basis for any de-emphasis of continued attention to the safe handling of heavy loads.

drops is acceptably small. We further conclude that the objective identified in Section 5.1 of NUREG-0612 for providing "maximum practical defense in depth" is satisfied by the Phase I compliance, and that the Phase II analyses did not indicate the need to require further generic action at this time. This conclusion has been confirmed by the results obtained from the Phase II pilot program and additional Phase II reviews, which identified no residual heavy loads handling concerns of sufficient significance to demand further generic action. All plants have examined their load handling practices against the recommendations of Phase II and submitted the Phase II report. In this way, the utilities were required to identify any unexpected problems to the staff.

ATTACHMENT I

SUMMARY OF COST-BENEFIT ANALYSIS OF
PWR POLAR CRANE CONVERSION TO SINGLE-FAILURE-PROOF FEATURES

SCOPE

The safety benefit of converting the polar crane in the containment of an operating or completed or nearly completed PWR to single-failure-proof features and the cost of the conversion were estimated and compared.

The safety benefit was estimated in terms of the resulting reduction in the risk of a severe accident, involving major radioactive material release, during the remaining plant life. The risk was expressed as the product of the accident probability and the population radiation dose from the release, should the accident occur.

The cost estimate included the cost of shutdown (or extension of a non-operating period) needed to accomplish the conversion.

ACCIDENT FREQUENCY ESTIMATES

Crane Failure Frequency

There were 32 crane LER events in the approximately 400 reactor-years of U.S. power-reactor operation in the 10-year period July 1969 to July 1979 (NUREG-0612, p. 4-6). None resulted in radioactive release. Of the 32 events, 17 (i.e., just over half) were apparently due to hardware design or fabrication causes, the other 15 to human factors. (Navy crane statistics, cited in NUREG-0612, for 40 load-drop or potential load-drop events in 1974-77 show 80% of the events to be due to human factors.)

It may be assumed, as a rough approximation, that Phase I of NRC's heavy-loads generic program is addressed to all the human factors causes and one-half of the hardware causes and succeeds in reducing the affected part of the failure frequency to a quite small fraction of the frequency originally present. Since human factors and hardware each contribute about one-half of the failures, approximately 3/4 of the total crane failures can be expected to be eliminated by the Phase I program. Single-failure-proof (SFP) cranes should substantially reduce the remaining 1/4 of the failure frequency, though those failures would not be eliminated altogether, since the SFP feature (as defined in NUREG-0554) does not protect against all types of possible failure (e.g., the bridge is not SFP and the SFP feature itself is subject to defeat by some types of human error). On the other hand, the SFP feature would make the cranes more "forgiving" of imperfections in the Phase I implementation. Accordingly, one may reasonably assume that the SFP feature would have a net effect of eliminating 1/4 of the pre-Phase I failure frequency.

Frequency of Accidents Involving Radioactive Release

Not all LER events involve radioactive release. In over 600 reactor-years of U.S. power-reactor operation to date [1982] there have, to our knowledge, been no radioactive releases due to load drops. The 10-year period covered by the survey in NUREG-0612, which included 32 crane LER events, all without release, represents about 60% of all U.S. power-reactor operating time to date. An assumption of a pre-fix frequency of some radioactive release once in 1,000 reactor-years appears consistent with the LER-reflected failure experience, taken together with the absence of releases to date. With 1/4 of these releases averted by an SFP crane feature, the pertinent release frequency reduction would be 1 in 4,000 RY. For the most part, these can be assumed to be minor releases due to limited fuel damage in the spent-fuel storage pool or in the reactor.

Frequency of Accidents Involving Major Releases

For a load-drop event to cause a major accident, with major radioactive release, special circumstances need to be present -- circumstances that Phase I is intended to make much less likely to occur. A highly damaging heavy load drop, such as one that could destroy a core cooling feature through violation of -- or imperfections in -- Phase I provisions combined with other failures, should be unlikely, and very unlikely to lead to major release, because of back-up safety provisions (e.g., independent additional core cooling provisions).

Review of typical load paths and associated crane-operation frequencies suggests that of all load drops in a typical PWR plant that could have radiological consequences, some 1/4 could involve equipment with a role in safe reactor shutdown, including primary-system piping. If one assumes that there is typically a 1% probability that back-up revisions would also fail, then the pertinent major-release frequency is 1 in 1,600,000 reactor-years.

Frequency Reduction

Single-failure-proof cranes may reasonably be expected to eliminate most, perhaps 90%, of the residual load-drop probability after the Phase I improvements. Thus, the frequency reduction for major release is approximately 1 in 1,800,000 RY (90% of 1/1,600,000).

It should be noted that these estimates are sensitive to plant layout. Plant-specific evaluations could, depending on case specifics, point to a much higher or lower major-release frequency estimate for a specific case. For example, should layout of a specific plant be such that a particularly unfortunate load drop could destroy all means of core cooling or incapacitate the control room (possibilities suggested by the situations at Montecello and Arkansas Nuclear 1, respectively, before remedial actions were taken at those plants), the above generic analysis could be wide of the mark for such a plant. The major-release accident frequency could well be an order of magnitude higher for such a plant (i.e., of the order of 1 in 100,000 reactor-years) -- or even higher, depending on plant and crane features, load paths, and operating practices.

CONSEQUENCES ESTIMATE

Potential radiological consequences of load-drop accidents encompass a wide range of possibilities, depending on specific features of plant design, operating practices, and the nature and location of the specific load-drop event. We assume that some -- though very rough -- indication of the severity of the load-drop accident risks may be gained by using in these simplified calculations certain selected release categories described in WASH-1400, Appendix VI, pp. 2-1 to 2-4. Category PWR 4 was selected for the major-release estimates for pressurized water reactors.

In PWR 4 core cooling and containment both fail. Core melt occurs. This release category is used to explore consequences of a load drop that incapacitates core cooling (during or promptly after reactor operation), with containment open.

The release estimates, stated as resulting public dose, based on representative generic estimates, for a hypothetical site with a projected Year 2000 mean U.S. power-reactor-site population density, developed by Battelle Pacific Northwest Laboratories (NUREG/CR-2800) is 2,700,000 person-rem.

COST ESTIMATE

Costs of change-over to single-failure-proof cranes are subject to wide plant-specific variation, depending on the number of features of the specific cranes involved and other aspects of plant design and status.

Based on advice from the Auxiliary Systems Branch, DSI, and limited vendor and utility contacts, we take the following estimates as representative (as of 1982, when the estimates were made).

For future plants, the cost differential for original inclusion of SFP features is estimated at about $250,000 for PWRs (based on information from Ederer Crane Co.).

At the pre-operating-license stage, with no startup delay, the costs -- including planning, engineering, hardware, installation, and testing -- are estimated at $2 million per plant. This is based on the Monticello experience (1 M in 1976, adjusted for inflation). (The Monticello information was obtained from the licensee through the NRC resident inspector.)

For operating PWRs the estimated costs are dominated by plant shutdown during modifications of the polar crane located inside the containment building. (The shutdown may be an extension of a shutdown for refueling or other purposes.) The cost effect of a startup delay for a completed or nearly completed plant would be similar. With a 3-month shutdown and with shutdown costs taken as determined by the cost of replacement power at $300,000 per day, representative total change-over costs for operating PWRs are estimated at about $30 million.

RISK REDUCTION

Based on the foregoing frequency and consequences estimates, the "expected value" of the risk subject to being affected by the possible Phase II SFP feature, i.e., the magnitude of release times the frequency of its occurrence, integrated for the remaining plant life taken as 20 years, is as follows:

$$\text{Major release risk} = 20 \times \frac{2,700,000}{2,800,000} = 30 \text{ person-rem/reactor}$$

COST-BENEFIT RATIO

The cost-benefit ratio indicated by the foregoing estimates is approximately $1,000,000/person-rem. This estimate is subject to wide plant-to-plant variation as well as large uncertainties in the underlying estimates of accident frequency and consequences. Nevertheless, it is possible to conclude with reasonable confidence that the benefit-cost ratio for the crane conversion would fail to meet a $1,000/person-rem worthwhileness criterion by a large margin.

TO ALL LICENSEES FOR OPERATING REACTORS

Gentlemen:

SUBJECT: COMPLETION OF PHASE II OF "CONTROL OF HEAVY LOADS AT NUCLEAR POWER PLANTS" NUREG-0612. (GENERIC LETTER 85-)

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All licensees have completed the requirement to perform a review and submit a Phase I and a Phase II report. We believe that further action is not required based on the improvements in heavy loads handling obtained from implementation of NUREG-0612 (Phase I). Therefore, a detailed Phase II review of heavy loads is not necessary and Phase II is considered completed. However, while not a requirement, we encourage the implementation of any actions identified in Phase II regarding the handling of heavy loads.

For each plant which has a license condition requiring commitments acceptable to the NRC regarding Phase II, an application for license amendment may be submitted to the NRC to delete the license condition citing this letter as the basis. If you have any questions, contact your Project Manager or Don Neighbors (301) 492-4837.

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As for Phase II, we believe that further NRC action is not necessary. As indicated in the enclosure, we conclude this on the basis of the improvements in heavy loads handling obtained from implementation of NUREG-0612 (Phase I), the results of the Phase II pilot program performed by our contractor, Franklin Research Center, which identified no further heavy loads handling concerns, additional evaluations of Phase II submittals by the staff and cost benefit.

We, therefore, consider this portion (Phase II) of our review of heavy loads complete. However, while not a requirement, we encourage the implementation of any actions identified in Phase II regarding the handling of heavy loads.

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CONTACT:
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We, therefore, consider this portion (Phase II) of our review of heavy loads complete. [However, this action is not intended to preclude licensees from making improvements in their load handling systems which they feel are necessary for safe load handling.)

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