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TECHNICAL EVALUATION REPORT

CONTROL OF HEAVY LOADS (C-10)

VERMONT YANKEE NUCLEAR POWER CORPORATION

VERMONT YANKEE NUCLEAR POWER STATION

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Prepared by

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

Author: C. Bomberger

FRC Group Leader: I. H. Sargent

Prepared for

Nuclear Regulatory Commission
Washington, D.C. 20555

Lead NRC Engineer: F. Clemenson

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

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FOREWORD

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

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

1. INTRODUCTION

1.1 PURPOSE OF REVIEW

This technical evaluation report documents an independent review of general load handling policy and procedures at Vermont Yankee Nuclear Power Corporation's (VYNPC) Vermont Yankee Nuclear Power Station. This evaluation was performed with the following objectives:

- to assess conformance to the general load handling guidelines of NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants" [1], Section 5.1.1
- to assess conformance to the interim protection measures of NUREG-0612, Section 5.3.

1.2 GENERIC BACKGROUND

Generic Technical Activity Task A-36 was established by the U.S. Nuclear Regulatory Commission (NRC) staff to systematically examine staff licensing criteria and the adequacy of measures in effect at operating nuclear power plants to assure the safe handling of heavy loads and to recommend necessary changes 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, Section 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, Sections 5.1.2 through 5.1.5, is to ensure that, for load handling systems in areas where their failure might result in significant consequences, either (1) features are provided, in addition to those required for all load handling systems, to ensure that the potential for a load drop is extremely small (e.g., a single-failure-proof crane) or (2) conservative evaluations of load handling accidents indicate that the potential consequences of any load drop are acceptably small. Acceptability of accident consequences is quantified in NUREG-0612 into four accident analysis evaluation criteria.

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

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

2. define safe load travel paths through procedures and operator training so that, to the extent practical, heavy loads are not carried over or near irradiated fuel or safe shutdown equipment

3. provide mechanical stops or electrical interlocks to prevent movement of heavy loads over irradiated fuel or in proximity to equipment associated with redundant shutdown paths.

Staff guidelines resulting from the foregoing are tabulated in Section 5 of NUREG-0612. Section 6 of NUREG-0612 recommended that a program be initiated to ensure that these guidelines are implemented at operating plants.

1.3 PLANT-SPECIFIC BACKGROUND

On December 22, 1980, the NRC issued a letter [3] to Vermont Yankee Nuclear Power Corporation (VYNPC), the Licensee for the Vermont Yankee plant, requesting that the Licensee review provisions for handling and control of heavy loads, evaluate these provisions with respect to the guidelines of

NUREG-0612, and provide certain additional information to be used for an independent determination of conformance to these guidelines. On September 11, 1981, VYNPC provided the initial response [4] to this request. A draft technical evaluation report was prepared based upon this submittal and was informally transmitted to the Licensee for review and comment. On March 15, 1982, a telephone conference call was conducted with representatives of the NRC, FRC, and VYNPC to discuss unresolved issues. As a result of this call, additional information was forwarded by VYNPC on April 1, 1982 [5], and was incorporated into this technical evaluation.

2. EVALUATION

This section presents a point-by-point evaluation of load handling provisions at the Vermont Yankee plant 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 guideline 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:

- Guideline 1 - Safe Load Paths
- Guideline 2 - Load Handling Procedures
- Guideline 3 - Crane Operator Training
- Guideline 4 - Special Lifting Devices
- Guideline 5 - Lifting Devices (Not Specially Designed)
- Guideline 6 - Cranes (Inspection, Testing, and Maintenance)
- 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 the evaluation of this verification are contained in the succeeding paragraphs.

Table 2.1. Vermont Yankee/NUREG-0612 Compliance Matrix

Heavy Loads	Weight or Capacity (tons)	Guideline 1 Safe Load Paths	Guideline 2 Procedures	Guideline 3 Crane Operator Training	Guideline 4 Special Lifting Devices	Guideline 5 Slings	Guideline 6 Crane - Test and Inspection	Guideline 7 Crane Design	Interim Measure 1 Technical Specifications	Interim Measure 6 Special Attention
1. Reactor Building Cranes	110/7	--	--	C	--	--	C	C	C	--
Reactor Vessel Head	54	NC	C	--	P	--	--	--	--	C
Drywell Head	44	NC	C	--	P	--	--	--	--	C
Dryer	22	NC	C	--	P	--	--	--	--	C
Shroud Head/ Steam Separator	33	NC	C	--	P	--	--	--	--	C
Shield Blocks	21.5	NC	C	--	--	P	--	--	--	--
New Fuel Storage Vault Plugs (3)	3	NC	C	--	--	P	--	--	--	--
Fuel Pool Gate	1	NC	C	--	--	P	--	--	--	--
Refueling Slot Plugs	6	NC	C	--	--	P	--	--	--	C
Vessel Head Insulation	4.5	NC	C	--	--	P	--	--	--	C
Spent Fuel Shipping Cask	110	NC	C	--	--	--	--	--	--	--

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.

Table 2.1 (Cont.)

Heavy Loads	Weight or Capacity (tons)	Guideline 1 Safe Load Paths	Guideline 2 Procedures	Guideline 3 Crane Operator Training	Guideline 4 Special Lifting Devices	Guideline 5 Slings	Guideline 6 Crane - Test and Inspection	Guideline 7 Crane Design	Interim Measure 1 Technical Specifications	Interim Measure 6 Special Attention
Filter-Demineralizer Hatch	8	NC	C	--	--	P	--	--	--	--
Contaminated Eqmt. Storage Area Hatches	2.5	NC	C	--	--	P	--	--	--	--
Head Strongback	4	NC	C	--	--	P	--	--	--	C
Stud Tensioner Monorail	3.5	NC	C	--	--	P	--	--	--	C
Cattle Chute	14	NC	C	--	-	P	--	--	--	--
Dryer/Seperator Storage Pool Plugs	43.5	NC	C	--	P	--	--	--	--	--
Load Block	6	NC	C	--	--	--	--	--	--	--
HP Water Blaster	2.5	NC	C	--	--	P	--	--	--	--
Vessel Service Platform	5	NC	C	--	--	P	--	--	--	C

2.1.1 Heavy Load Overhead Handling Systems

a. Summary of Licensee Statements and Conclusions

The Licensee's review of overhead handling systems identified the reactor building crane as the only crane to handle heavy loads in the vicinity of irradiated fuel or safe shutdown equipment and therefore be subject to the criteria of NUREG-0612.

The Licensee has also identified numerous other cranes and hoists that have been excluded from compliance with the criteria of NUREG-0612 general guidelines. These handling systems include the following:

1. reactor recirculation pump monorail
2. CRD pump monorails
3. refueling platform hoist and refueling floor jib crane
4. turbine building bridge crane
5. reactor feedwater pump monorails
6. diesel generator monorails
7. HPCI equipment monorail
8. RCIC equipment monorail
9. recirculation motor generator sets monorail
10. various maintenance monorail hoists.

The Licensee states that the reactor recirculation pump monorail (1), located over the recirculation pumps and motors, can be used only when the plant is shut down and operating in the decay heat removal mode. This monorail is used only for removing and reinstalling recirculation pump motors and pump parts and can not impact on piping, cabling, or instrument lines associated with safe shutdown functions. Similarly, separate CRD pump monorails (2), located over each CRD pump, service a CRD pump which has previously been removed from service. There is no other safe shutdown equipment which may be affected and sufficient separation exists between CRD pumps to prevent any damage resulting from a load drop.

The refueling platform hoist and refueling floor jib crane (3) are being downgraded by the Licensee from a capacity of 1000 lb to the weight of a single fuel assembly (700 lb) and are being clearly marked to so indicate. In the event that loads greater than 700 lb must be lifted, the Licensee states that a safety evaluation will be prepared to assure that NUREG-0612 criteria

are complied with, although the reactor building crane auxiliary hook could be used for such a lift.

The turbine building crane (4), used primarily for moving large turbine generator components during maintenance or overhaul, has been excluded from compliance with NUREG-0612 on the basis that there is no safety-related equipment within the travel limits of this crane, with the exception of a portion of a diesel generator room. The Licensee states that this room has been designated as a storage area and heavy loads are not permitted to be carried over this area.

Several handling systems (5 through 9), each located over its designated machinery component, have been excluded by the Licensee on the basis that either no safety-related equipment would be damaged or no safe shutdown functions would be lost as a result of a load drop.

For remaining handling systems (10), the Licensee states that sufficient physical separation exists between load impact points and safety-related components so that a load drop would be of no consequence to safe shutdown.

b. Evaluation

The Licensee's response has been evaluated with respect to the NRC's objective as discussed in Section 1.2 of this evaluation, which is to achieve a defense-in-depth approach to the handling of heavy loads. Two distinct phases of implementation are to be accomplished to achieve this defense-in-depth:

- o first phase - overall improvement of procedures, training, maintenance, and crane and lifting device design, as well as establishment of safe travel paths which avoid irradiated fuel and safe shutdown equipment, as means to assure reliable operation of handling systems
- o second phase - implementation of additional safeguards by satisfying single-failure-proof crane criteria; or installation of mechanical or electrical interlocks; or performance of analyses that substantiate the Licensee's contentions that damage to irradiated fuel will not exceed limits for criticality or release of radioactivity, or that damage to redundant of dual safe shutdown systems will not result in loss of required safety functions.

The intent of the first phase of NUREG-0612 is to ensure that all cranes operating in the vicinity of irradiated fuel or safe shutdown equipment meet the requirements of the general guidelines (Section 5.1.1) with no regard or credit given to system redundancy, mechanical or electrical interlocks, administrative procedures, or single-failure-proof cranes.

On this basis, the Licensee's response has been evaluated for those cranes which have been excluded from compliance with NUREG-0612. For the reactor recirculation pump (1) and CRD pump monorails (2), it is not considered necessary that safe load paths or procedures be developed, since these monorails are sole-purpose handling systems used exclusively for maintenance and repair of their respective components, and do not routinely serve as load paths for other heavy loads not associated with these components.

The Licensee's exclusion of the refueling floor jib crane and refueling platform hoist (3) meets the intent of NUREG-0612 on the basis of Licensee actions to: (a) downgrade the capacity of both systems, including suitable marking of each, and (b) perform an independent safety evaluation in the event that a lift of greater than 700 lb is required. Exclusion of the turbine crane (4) is also acceptable on the basis of the Licensee's verification that no safety-related equipment (other than a single diesel generator room) is located in the turbine building. It is not necessary for the Licensee to develop extensive load paths and procedures for turbine building components or to adhere to the remaining guidelines solely for the diesel generator room room; however, the Licensee should insure that suitable administrative measures or interlocks are invoked to prevent crane movement over this area, since none have been noted to exist in the response.

For remaining handling systems, (5) through (9), insufficient information has been provided to verify that equipment, in commission at the time of a heavy load lift and provided for safe shutdown or decay heat removal, would not be damaged. Each handling system carries loads over its respective component (i.e., reactor feedwater pumps, diesel generators, HPCI, RCIC, etc.), each of which is safety-related. Licensee exclusion of these systems, if based upon system redundancy, is not in keeping with the underlying philosophy of the first phase of NUREG-0612: to apply criteria of the general

guidelines to all cranes operating over safe shutdown equipment without consideration of system redundancy. However, as noted previously for the recirculation pump and CRD pump monorails, exclusion of remaining handling systems (5) through (9) may be acceptable if additional information can be provided by the Licensee, including the following:

1. handling systems are sole-purpose, used exclusively during maintenance or equipment repairs when the respective components have been placed out of service in accordance with plant procedures or technical specifications

2. handling systems are not used as a routine load path for other non-related heavy loads.

c. Conclusion and Recommendations

As noted by the Licensee, the reactor building polar crane should comply with NUREG-0612 criteria. Additional information is needed to ascertain the validity of exclusion from compliance for several other hoisting systems identified by the Licensee, including the following:

- reactor feedwater pump monorails
- diesel generator monorails
- HPCI equipment monorail
- RCIC equipment monorail
- recirculation motor generator sets monorail

The Licensee should provide the information identified in the evaluation of these handling 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 states, "It is Vermont Yankee's position that our present plant policy of handling heavy loads with the Reactor Building Crane is sufficient." Further, it is added that loads are lifted and moved directly to intended destinations carefully and expeditiously, handling time is minimized, and pick heights are within reasonable limits.

b. Evaluation

While acknowledging that the Licensee's "present plant policy" may be adequate, such a position does not allow an independent evaluation to be made to determine the adequacy of this policy or to determine if the intent of this guideline has been satisfied at the Vermont Yankee plant. NUREG-0612 was developed to establish uniform standards for load handling system design and operation at nuclear power plants; a determination whether these minimum uniform standards have been met at the Vermont Yankee plant cannot be made on the basis of the Licensee's brief statements. Employment of these standards is intended to reduce the risk associated with the handling of heavy loads in the vicinity of irradiated fuel or equipment required for safe shutdown and decay heat removal. The Licensee's proposed actions regarding movements of loads by the most direct path and the use of pick heights, while providing some degree of load handling safety, do not provide adequate assurance that the Licensee has complied with NRC standards established in NUREG-0612. It is noted that loads are lifted and moved directly to intended destinations; the Licensee should verify that these routes have been reviewed and approved by the engineering support staff so that the direction of movement for major loads is not a decision left to the discretion of the crane operator at the time of movement. Following review and approval by plant engineering staff, these most-direct load paths should be formalized in drawings and included in appropriate load handling procedures. To ensure that these paths are followed at the time of the move, suitable visual aids should be implemented by the Licensee. These may include, but are not limited to, permanent or temporary floor markings (paint, stanchions, pylons, or tape) or use of a floor supervisor/signalman, who uses the procedure and load path drawing to direct

the load handling evolution (duties of this individual should be formally delineated in appropriate procedures). Deviations from these formalized load paths should require approval of the plant safety review committee or its equivalent.

c. Conclusion and Recommendation

The Licensee does not comply with Guideline 1. Although it is indicated that loads are moved by the most direct route, the following actions are needed to provide full compliance:

1. Review, approve, and include in procedures those load paths for major items lifted and moved at the Vermont Yankee plant.

2. Provide suitable visual aids for the operator to ensure adherence to established load paths.

3. Verify that deviations to load paths require approval by the plant safety review committee or its equivalent.

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

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

a. Summary of Licensee Statements and Conclusions

A detailed list of heavy loads and the procedures governing the handling of each load has been supplied by the Licensee, who further states that these handling procedures (O.P.'s 1200, 1201, and 2200) presently contain the following:

- precautions and prerequisites
- identification of proper handling equipment
- training and qualification requirements for crane operators
- sling selection criteria
- required crane inspections prior to load handling

- o supervision of lift by a designated individual
- o steps in order to perform the lift

In addition, the Licensee states that other procedures will be revised to more explicitly define those items listed above. It is noted that safe load paths are not defined in these procedures based upon their conclusions contained in Section 2.1.2 of this report.

b. Evaluation

The 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.

As previously noted in the evaluation of overhead handling systems at the Vermont Yankee plant, detailed procedures need not be developed for those sole-purpose hoists used for maintenance and repair of components which have been removed from service.

c. Conclusion and Recommendation

The Vermont Yankee plant complies with the criteria of Guideline 2. The Licensee should, however, incorporate safe load path definitions into established procedures; when completed, these procedures should be made readily available for review and inspection by the NRC staff.

2.1.4 Crane Operator Training [Guideline 32, 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' [6]."

a. Summary of Licensee Statements and Conclusions

Current procedures were reviewed by the Licensee against the provisions of ANSI B30.2-1976, Chapter 2-3. A number of minor changes were found necessary for the current Vermont Yankee program to satisfy the requirements of the standard. In addition, the Licensee states that a new procedure with

qualification records has been developed in order to formalize the program for crane operator training.

b. Evaluation

The Vermont Yankee plant satisfies this guideline on the basis of their comparison of current operator training with requirements and identification of necessary revisions in order to comply with Chapter 2-3 of ANSI B30.2-1976.

c. Conclusion and Recommendation

The Vermont Yankee plant complies with Guideline 3 on the basis of the Licensee's verification that when minor revisions are completed, the operator training program will comply with ANSI B30.2-1976, Chapter 2-3.

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' [7]. 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 base 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

Two special lifting devices identified by the Licensee have been evaluated in accordance with the criteria of ANSI N14.6-1978. These special lifting devices are (1) the dryer and separator sling assembly and (2) the head strongback. The spent fuel shipping cask lifting yokes are the only other lifting devices of concern; however, details of each yoke lifting device design must be submitted to the NRC prior to any cask handling operations and are therefore not addressed in this response.

The Licensee states that the two special lifting devices of concern were designed by General Electric Company (GE) prior to the existence of ANSI N14.6-1978; therefore, a number of sections are difficult to apply in retrospect, and insufficient documentation is available to assure that all subparts of these sections were met. These sections include the following:

- o Designers Responsibilities (3.1)
- o Design Considerations (3.3)
- o Fabrication (4)

However, information that is available indicates that sound engineering practices by the fabricator and inspector were enforced by the designer to ensure that the designer's intent was accomplished. Further, the Licensee states that several other sections of ANSI N14.6-1978 are not pertinent to load handling reliability of the devices and have not been addressed, including the following sections:

- o Scope and Definitions (1 and 2)
- o Design Consideration to Minimize Decontamination Efforts (3.4)
- o Coatings (3.5)
- o Lubricants (3.6)

Section 6 (Special Lifting Devices for Critical Loads) has not been evaluated by the Licensee since none of the loads lifted have been determined to be "critical loads."

Based upon the above considerations, detailed evaluation by the Licensee of the two designated special lifting devices was limited to Sections 3.1.3, 3.2.1.1, 3.2.3, and 5 of the ANSI standard. The head strongback and the dryer/separator sling assembly were both evaluated in accordance with ANSI N14.6-1978 critical design criteria and were subjected to stress analyses since the designer had not supplied such analyses for these devices. The lifting devices were also evaluated in accordance with American Institute of Steel Construction (AISC) specifications to determine compliance with the most widely used structural code as well as with ANSI criteria. Loads used were static loads of the major components increased by an impact factor of 15%. Results of these analyses are summarized in Tables 2.2 and 2.3.

Table 2.2. Head Strongback - Factors of Safety

Component	AISC	ANSI (Yield)	ANSI (Ultimate)
Minimum Requirement	1.00	3.00	5.00
Lifting Arms (Bending)	2.12	3.18	6.15
Lifting Arms (Shear)	4.06	5.25	5.85
Weld Flange to Web	2.81	-	9.37
Anchor Shackles	3.54*	-	21.20
2-1/2" Turnbuckles	2.37*	-	11.90
2-3/4" Turnbuckles	2.41*	-	12.10
Lifting Lugs (Tension)	9.30	13.50	(large)
Hook Pin (Bending)	12.70	21.20	(large)

*Denotes factor of safety with respect to manufacturer's Safety Working Load.

Table 2.3. Dryer and Separator Sling - Factors of Safety

Component	AISC	ANSI (Yield)	ANSI (Ultimate)
Minimum Requirement	1.00	3.00	5.00
Socket Pin (Bending)	2.71	3.61	5.76
Bell Housing (Bending in 3/8" Plate)	2.33	3.81	5.72
Bell Housing (Bending in 1" Plate over W6x15)	2.39	3.90	5.86
Cross Beam W5x16 (Axial Compression)	10.40	(large)	(large)
Cross Beam W5x16 (Bending)	3.90	6.38	7.19
Lifting Lugs (Bending Extensions)	5.59	9.10	(large)
2-1/2" Turnbuckles	2.99*	-	14.90
1-1/2" Wire Rope	-	-	8.20
Hook Box (Bending in Cross Plates)	6.94	11.36	(large)
Hook Box (Tension)	9.82	16.10	(large)
Hook Pin (Bending)	10.40	17.30	(large)

*Denotes factor of safety with respect to manufacturer's Safety Working Load.

The Licensee notes that the exact wire rope used was not specified in drawings; research performed indicates that galvanized wire rope with a fiber core was used on the dryer/separator sling. This rope has been used to conservatively determine the wire rope safety factors in Table 2.3.

Comparison of both devices with Section 5 identified the need for certain changes in Vermont Yankee plant procedures to meet the intent of ANSI inspection and testing requirements. Specifically, Section 5.3 (Testing to Verify Continuing Compliance) states that an annual load test to 150% be performed or, as an alternative, the lifting device be subjected to dimensional testing and visual and nondestructive inspection of major load carrying welds and critical areas. Since a load test to 150% of the maximum capacity may not be practical for an operating plant, a detailed program of inspections and examinations has been prepared and will be conducted on a one-time basis. Following that inspection, the test and inspection program will be modified accordingly. In addition, operating personnel will conduct a thorough visual examination of the devices prior to each use for indications of damage or deformation. If major repairs or alterations are performed, the device will be subjected to the 150% load, followed by inspections specified in Section 5.3.2 of ANSI N14.6-1978.

b. Evaluation

It is acknowledged that a strict interpretation of compliance of existing special lifting devices with the criteria of ANSI N14.6-1978 cannot be made. Therefore, the Licensee's response is consistent with the intent of this guideline in addressing only those sections which are directly related to load handling reliability of the lifting devices. Further, the following sections are neither pertinent nor contain requirements which affect load handling reliability, including Scope (Section 1), Definitions (2), Design Considerations to Minimize Decontamination Efforts (3.4), Coatings (3.5), Lubrication (3.6), Inspector's Responsibilities (4.2), and Fabrication Considerations (4.3). In addition, Section 6 (Special Lifting Devices for Critical Loads) need not be included in this review since none of the loads identified by the Licensee has been determined to be a "critical load."

The Licensee states that detailed comparison of the dryer/separator sling assembly and the head strongback was limited to Sections 3.1.3, 3.2.1.1, 3.2.3, and 5 of ANSI N14.6-1978. A review of design information provided indicates that both lifting devices satisfy the design criteria of ANSI N14.6-1978 in that all stress design factors are greater than 3 for yield strength and greater than 5 for ultimate strength. The Licensee has also demonstrated that these special lifting devices satisfactorily accommodate dynamic loads while maintaining acceptable stress design margins.

Proposed Licensee inspections are acceptable to verify continuing compliance in accordance with Section 5.3.1(2). Programs to verify continuing compliance at the Vermont Yankee plant are consistent with this guideline on the basis of the Licensee's commitment to revise existing inspection and test requirements to conform to Section 5 of ANSI N14.6-1978. However, the Licensee's intention to perform a detailed one-time inspection program in lieu of a 150% load test is not equivalent to the requirements of the ANSI standard. Performance of a load test in excess of rated load is judged to be necessary in order to substantiate minimum design safety margins as well as to verify the actual workmanship and structural integrity of the lifting device; performance of visual inspections and nondestructive examination (NDE) alone cannot accomplish these goals. The Licensee may opt to use the guidance of ANSI B30.2-1976, Section 2-2.2.2 as criteria for the performance of this test. ANSI B30.2-1976 specifies a load test (for cranes) to not more than 125% of rated load; load tests in this range of overload have previously been found acceptable to meet the intent of this guideline. Substantiation of an initial load test or lift of any load sufficiently in excess of the maximum load currently lifted by each device would justify use of this detailed one-time inspection program.

c. Conclusion and Recommendation

Special lifting devices evaluated by VPNPC (head strongback and the dryer and separator sling assembly) substantially comply with Guideline 4 on the basis of the Licensee's verification of critical design safety margins and commitment to revise programs for continuing testing and inspection. In order

to provide special lifting devices with load handling reliability consistent with this guideline, the Licensee should perform a load test of each lifting device sufficiently in excess of the maximum load lifted or document the previous performance of such a lift.

2.1.6 Lifting Devices (Not Specially Designed) [Guideline 5, NUREG-0612, Section 5.1.1(5)]

"Lifting devices that are not specially designed should be installed and used in accordance with the guidelines of ANSI B30.9-1971, 'Slings' [8]. 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 special and general purpose slings are covered by criteria, added to load handling procedures, that meet the intent of ANSI B30.9-1971 for sling selection and use as well as inspection and maintenance. VYNPC also identified the service platform sling, which is a 3-leg wire rope sling used to hoist the service platform into place over the reactor vessel flange. This sling has also been evaluated against the criteria of ANSI B30.9-1971 for design, inspection, and maintenance and found to comply with no deviations or exceptions.

b. Evaluation

Procedures containing criteria for selection and use of slings at the Vermont Yankee plant, including the service platform sling, are acceptable on the basis of the Licensee's statement that these procedures meet the intent of ANSI B30.9-1971.

Review of available information (Whiting Corp. Drawing No. U70921) indicates that the maximum hoist speeds of the reactor building cranes are relatively slow (main hoist-5.5 fpm; auxiliary hoist-17 fpm). Therefore,

dynamic loads which are imparted to the slings are reasonably small and need not be included with the static load or in selection and use of the slings.

c. Conclusion

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

a. Summary of Licensee Statements and Conclusions

The Licensee states that a new procedure, "Maintenance and Inspection Procedure for the Reactor Building Crane" has been developed which contains requirements for inspection, testing, and maintenance. In addition, modifications were made to the crane operation procedure, R.P. 2200 "Operation of the Reactor Building and Turbine Building Bridge Cranes," to include appropriate operator inspections prior to movement. Therefore, the Licensee states that, with these revisions and modifications, plant procedures meet the intent of ANSI B30.2-1976, Chapter 2-2.

b. Evaluation

The Licensee satisfies the criteria of this guideline on the basis that crane inspection, testing, and maintenance programs at the Vermont Yankee plant comply with ANSI B30.2-1976.

c. Conclusion and Recommendation

The Vermont Yankee plant complies with Guideline 6.

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' [9]. 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 reactor building crane was modified in 1976 to satisfy the requirements of APCSB BTP 9-1 which subsequently became NUREG-0554. The modifications included replacement of the trolley with one that had dual load paths on the main hoist. The criteria in BTP 9-1 called for the crane to be designed and fabricated to a number of industry standards, including ANSI B30.2 and CMAA-70. On December 30 1975, Vermont Yankee submitted to the NRC a report entitled, "Reactor Building Crane Modification," that described how the criteria of BTP 9-1 were satisfied for this crane. This information was reviewed and approved by the NRC, as described in the staff's safety evaluation report transmitted by letter of January 28, 1977 from R. Reid (NRC) to R. Groce (Yankee Atomic). Based on this previous review, we believe that for the Vermont Yankee Reactor Building Crane it is not necessary to reevaluate the crane design since conformance with the criteria of ANSI B30.2, CMAA-70, and other provisions of BTP 9-1 was addressed in the previous review."

b. Evaluation

The Vermont Yankee plant satisfies the criteria of this guideline on the basis that current crane design satisfies ANSI B30.2-1976 and CMAA-70 standards and has been previously found by the NRC staff to satisfy APCSB Branch Technical Position 9-1.

c. Conclusion and Recommendation

The Vermont Yankee plant complies with Guideline 7.

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 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 is 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. Evaluation

As noted in VYNPC's response to Guideline 7 (2.1.8), the reactor building crane is a single-failure-proof crane which has been previously approved by the NRC. Therefore, no action is required for the Licensee to satisfy this interim protection measure.

b. Conclusion

The Vermont Yankee plant complies with Interim Protection Measure 1.

2.2.2 Administrative Controls [Interim Protection Measures 2, 3, 4, and 5, NUREG-0612, Sections 5.3(2)-5.3(5)]

"Procedural or administrative measures [including safe load paths, load handling procedures, crane operator training, and crane inspection]... can be accomplished in a short time period and need not be delayed for completion of evaluations and modifications to satisfy the guidelines of Section 5.1 of [NUREG-0612]."

a. Summary of Licensee Statements and Conclusions

Summaries of Licensee statements and conclusions are contained in discussions of the respective general guidelines in Sections 2.1.2, 2.1.3, 2.1.4, and 2.1.7.

b. Evaluations, Conclusions, and Recommendations

Evaluations, conclusions, and recommendations are contained in discussions of the respective general guidelines in Sections 2.1.2, 2.1.3, 2.1.4, and 2.1.7.

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

a. Summary of Licensee Statements and Conclusions

The Licensee states that upon receipt of NRC Generic Letter 81-07[2], special attention was given to procedures, equipment, and personnel for the handling of heavy loads over the core. Deficiencies noted, primarily in the

area of operator qualification, were corrected by training conducted in May, 1981.

b. Evaluation and Conclusion

The Vermont Yankee plant complies with Interim Protection Measure 6.

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 Vermont Yankee Nuclear Power 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 the Vermont Yankee plant can be expected to be conducted in a highly reliable manner consistent with the staff's objectives as expressed in these guidelines. A need for further Licensee action was identified in the following areas:

- VYNPC should develop and implement safe load paths for major heavy loads which have been identified by the Licensee. Development of such a program should consist of determination by engineering staff review the optimum load path or corridor, formalization in drawings and inclusion in appropriate procedures, development of suitable visual aids to aid the crane operator and assure compliance, and provisions for formal review and approval of deviations to these pathways.
- VYNPC should conduct a load test of special lifting devices to a weight sufficiently in excess of the maximum load currently lifted.

In addition, the Licensee should provide appropriate information identified in Section 2.1.1 to support exclusion of the following handling systems from compliance with NUREG-0612:

- o reactor feedwater pump monorails
- o diesel generator monorails
- o HPCI equipment monorail
- o RCIC equipment monorail
- o recirculation motor generator sets monorail.

3.2 INTERIM PROTECTION MEASURES

The NRC staff has established (NUREG-0612, Section 5.3) that certain measures should be initiated to provide reasonable assurance that handling of heavy loads will be performed in a safe manner until final implementation of the general guidelines of NUREG-0612, 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 measures have been properly implemented which ensure compliance with the staff's measures for interim protection at the Vermont Yankee plant, with one exception, safe load paths, which has been previously addressed in Section 3.1 of this evaluation.

4. REFERENCES

1. NUREG-0612
   Control of Heavy Loads at Nuclear Power Plants
   NRC, July 1980

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

3. NRC
   Letter to Vermont Yankee Nuclear Power Corporation. Subject: NRC Request for Additional Information on Control of Heavy Loads Near Spent Fuel
   22 December 1980

4. E. W. Jackson (VYNPC)
   Letter to D. G. Eisenhut (NRC). Subject: Control of Heavy Loads
   11 September 1981

5. E. W. Jackson (VYNPC)
   Letter to D. G. Eisenhut (NRC). Subject: Control of Heavy Loads
   1 April 1982

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

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

8. ANSI B30.11-1971
   "Slings"

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

ADDITIONAL INFORMATION REQUIRED FROM VERMONT YANKEE

1.a. RECOMMENDATION/OPEN ITEM

Vermont Yankee Nuclear Power Corporation should provide appropriate information to support exclusion of the following load handling systems from compliance with NUREG-0612:

- o reactor feedwater pump monorails
- o diesel generator monorails
- o HPCI equipment monorails
- o RCIC equipment monorail
- o recirculation motor generator sets monorail.

b. EVALUATION CRITERIA

Licensees were requested to evaluate all load handling systems in use and determine those systems which should comply with the general guidelines of NUREG-0612. Any handling systems capable of carrying heavy loads, as defined by NUREG-0612, over irradiated fuel or safe shutdown equipment should comply with NUREG-0612 general guidelines, regardless of system redundancy, mechanical or electrical interlocks, intervening floors, or administrative controls. Exclusion of certain handling systems normally subject to NUREG-0612 compliance has been found acceptable if the Licensee can demonstrate that the following conditions have been met:

- o The handling system is sole-purpose, used only to handle components of the respective plant system, and does not serve as a routine pathway for other heavy loads or over other redundant trains of the same safe shutdown system.
- o Safe shutdown system components are handled by the handling system after the plant system has been placed out of service in accordance with appropriate technical specifications or administrative procedures.

c. DISCUSSION

Information provided to date by the Licensee is insufficient to make an independent determination as to whether several monorails should satisfy the

general guidelines of NUREG-0612. The following is a listing of the monorails in question and reasons for exclusion by the Licensee:

- o reactor feedwater pump monorail - no safety-related equipment
- o diesel generator monorail - no loss of safe shutdown functions
- o HPCI equipment monorail - no loss of safe shutdown functions
- o recirculation motor generator set monorails - no loss of safe shutdown decay heat removal functions.

In addition, the Licensee states that each monorail is located over its respective component, which implies that, were a load drop to occur, the particular component or system would be damaged. Therefore, additional information is required to verify that the Licensee has not relied on system redundancy to ensure the safe shutdown functions. Availability of redundant equipment or features has not been found to be sufficient justification for exclusion of a handling system from satisfying the general guidelines of NUREG-0612.

2.a. RECOMMENDATION/OPEN ITEM

To ensure that loads are safely handled at Vermont Yankee Atomic Power Station, the Licensee should perform the following actions:

- o perform an engineering review of load paths currently in use, and formally approve and incorporate into procedures and drawings those load paths for major loads lifted at the Vermont Yankee plant
- o provide suitable visual aids for the crane operator to ensure adherence to established load paths
- o verify that deviations from these load paths require approval by the plant safety review committee or its equivalent.

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 incorporate these paths into plant procedures and drawings. Determining the load path in this manner would avoid ad-hoc load path decisions made on the handling floor by the crane operators who may not be familiar with plant equipment or system functions. Deviations from these load paths would then require a level of approval similar to that of that originally required. 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 marking; it has been found previously 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

The Licensee states, "It is Vermont Yankee's position that our present plant policy of handling heavy loads with the Reactor Building Crane is sufficient." Further, it is added that loads are lifted and moved directly to intended destinations carefully and expeditiously, handling time is minimized, and pick heights are within reasonable limits.

While acknowledging that the Licensee's "present plant policy" may be adequate, such a position does not allow an independent evaluation to be made to determine the adequacy of this policy or to determine whether the intent of this guideline has been satisfied at the Vermont Yankee plant. NUREG-0612 was developed to establish uniform standards for load handling system design and operation at nuclear power plants; a determination of whether these minimum uniform standards have been met at the Vermont Yankee plant cannot be made on the basis of the Licensee's brief statements. Employment of these standards is intended to reduce the risk associated with the handling of heavy loads in the vicinity of irradiated fuel or equipment required for safe shutdown and decay heat removal. The Licensee's proposed actions regarding movements of loads by the most direct path and the use of pick heights, while providing some degree of load handling safety, do not provide adequate assurance that the Licensee has complied with NRC standards established in NUREG-0612. It is noted that loads are lifted and moved directly to intended destinations; the Licensee should verify that these routes have been reviewed and approved by the engineering support staff so that the direction of movement for major loads is not a decision left to the discretion of the crane operator at the time of movement. Following review and approval by plant engineering staff, these most direct load paths should be formalized in drawings and included in appropriate load handling procedures. To ensure that these paths are followed at the time of the move, suitable visual aids should be implemented by the Licensee. These may include, but are not limited to, permanent or temporary floor markings (paint, stanchions, pylons, or tape) or use of a floor supervisor/signalman, who uses the procedure and load path drawing to direct the load handling evolution (duties of this individual should be formally delineated in appropriate procedures). Deviations from these formalized load

paths should require approval of the plant safety review committee or its equivalent.

3.a. RECOMMENDATION/OPEN ITEM

The Vermont Yankee plant should perform a load test of special lifting devices subject to compliance with NUREG-0612.

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 actual compliance or equivalence with the standard, the licensee, as a minimum, should demonstrate that the following issues have been adequately addressed for each special lifting device identified:

- o adequacy of design (stress design factors, quality assurance, fabrication controls)
- o proof of workmanship and mechanical integrity (initial load test)
- o programs to ensure continuing compliance (test and inspection program)

c. DISCUSSION

Two special lifting devices have been identified by the Vermont Yankee plant to require compliance with NUREG-0612: (1) the reactor head strongback and the (2) dryer and separator sling assembly. Sufficient information has been provided by the Licensee to demonstrate the adequacy of design of both devices and provide assurances that the program for continuing compliance is satisfactory.

For proof of workmanship, however, the Licensee has proposed performance of a detailed, one-time program of inspections and examinations to be performed in lieu of the required load test, since a load test to 150% of maximum capacity may not be practical for an operating plant.

It is recognized that performance of such a load test may be difficult, depending upon load-test capabilities of the plant and contamination of the

lifting device, as well as 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 The device is of simple design. Simplicity of design eliminates complex, and therefore difficult to analyze, components. Simplicity also reduces the fabrication requirements and consequent potential for inadequate workmanship.

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

- o A conservative design was used. 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.