TECHNICAL EVALUATION REPORT

CONTROL OF HEAVY LOADS

DUQUESNE LIGHT COMPANY

BEAVER VALLEY POWER STATION UNIT 1

NRC DOCKET NO. 50-334

NRC TAC NO. 07972

NRC CONTRACT NO. NRC-03-81-130

FRC PROJECT C5506

FRC ASSIGNMENT 13

FRC TASK 334

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: A. Singh

November 27, 1984

FRANKLIN RESEARCH CENTER
DIVISION OF ARVIN/CALSPAN

20th and Race Streets, Phila., Pa. 19103 (215) 448-1000

TECHNICAL EVALUATION REPORT

CONTROL OF HEAVY LOADS

DUQUESNE LIGHT COMPANY

BEAVER VALLEY POWER STATION UNIT 1

NRC DOCKET NO. 50-334

NRC TAC NO. 07972

NRC CONTRACT NO. NRC-03-81-130

FRC PROJECT C5506

FRC ASSIGNMENT 13

FRC TASK 334

Prepared by

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

Prepared for

Nuclear Regulatory Commission
Washington, D.C. 20555

Author: C. Bomberger

FRC Group Leader: I. H. Sargent

Lead NRC Engineer: A. Singh

November 27, 1984

Prepared by:	Reviewed by:	Approved by:
Charles Bomberger	[signature]	D P Carfagno
Principal Author	Group Leader	Department Director
Date: 11/16/84	Date: 11/21/84	Date: 11-27-84

FRANKLIN RESEARCH CENTER
DIVISION OF ARVIN/CALSPAN

20th and Race Streets, Phila., Pa. 19103 (215) 448-1000

CONTENTS

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. 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 Duquesne Light Company's (DLC's) Beaver Valley Power Station Unit 1. This evaluation was performed with the following objectives:

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

1.2 GENERIC BACKGROUND

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

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

In order to upgrade measures provided to control the handling of heavy loads, the staff developed a series of guidelines designed to achieve a two-part objective using an accepted approach or protection philosophy. The first part of the objective, achieved through a set of general guidelines identified in NUREG-0612, Section 5.1.1, is to ensure that all load handling systems at nuclear power plants are designed and operated so that their

probability of failure is uniformly small and appropriate for the critical tasks in which they are employed. The second part of the staff's objective, achieved through guidelines identified in NUREG-0612, Sections 5.1.2 through 5.1.5, is to ensure that, for load handling systems 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.

A defense-in-depth approach was used to develop the staff guidelines to ensure that all load handling systems are designed and operated so that their probabilities of failure are appropriately small. The intent of the guidelines is to ensure that licensees of all operating nuclear power plants perform the following:

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

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 DLC, the Licensee for Beaver Valley Unit 1, requesting that the Licensee review provisions for handling and control of heavy loads at Beaver Valley Unit 1, 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 June 23, 1981, DLC made an initial response [4] to this request.

Following completion of an evaluation based on the information provided in this formal response, a draft technical evaluation report (TER) was prepared and forwarded via the NRC staff to DLC for review. A site visit was conducted by NRC and FRC engineers on November 23 and 24, 1981 [5] to discuss specific issues noted in this review and to resolve, where possible, any apparent open items. Additional information was subsequently submitted in responses dated April 26, 1982 [6] and October 9, 1984 [7]. All information received has been incorporated into this final evaluation.

2. EVALUATION

This section presents a point-by-point evaluation of load handling provisions at Beaver Valley Unit 1 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 by all overhead handling systems and procedures used to handle heavy loads in the vicinity of the reactor vessel, near spent fuel in the spent fuel pool, or in other areas where a load drop may damage safe shutdown systems. The Licensee's verification of the extent to which these guidelines have been satisfied and FRC's evaluation of this verification are contained in the succeeding paragraphs.

2.1.1 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

Table 2.1. Beaver Valley Power Station Unit 1/NUREG-0612 Compliance Matrix

Heavy Loads	Weight or Capacity (tons)	Guideline 1 Safe Load Paths	Guideline 2 Procedures	Guideline 3 Crane Operator Training	Guideline 4 Special Lifting Devices	Guideline 5 Slings	Guideline 6 Crane - Test and Inspection	Guideline 7 Crane Design	Interim Measure 1 Technical Specifications	Interim Measure 6 Special Attention
1. Polar Crane (CR-1) Bridge Trolley #1 Trolley #2	200 130/15 130	--	--	C	--	--	R	R	--	--
Reactor Vessel Head and Attachments	117.3	C	C	--	R	--	--	--	--	R
Reactor Vessel Internals Package	64.8	C	C	--	R	--	--	--	--	R
Reactor Core Barrel Assembly	124	C	C	--	--	R	--	--	--	--
Reactor Coolant Pump - Motor	41.1	C	C	--	R	R	--	--	--	--
Reactor Vessel Seal Ring - 4 Segments (each)	1.5	C	C	--	--	R	--	--	--	R
Recirculation Spray Coolers	7.4	C	C	--	--	R	--	--	--	--
Recirculation Spray Pump Motor	1.2	C	C	--	--	R	--	--	--	--

C = Licensee action complies with NUREG-0612 Guideline.
R = Licensee has proposed revisions/modifications designed to comply with NUREG-0612 Guideline.
-- = Not applicable.

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
CRDM Missile Shield	38.6	C	C	--	--	R	--	--	--	R
Ventilation Supply Ducting (to CRDM)	3.0	C	C	--	--	R	--	--	--	R
Ventilation Ring Duct (to CRDM)	5.0	C	C	--	--	R	--	--	--	R
Ventilation Fans	3.1	C	C	--	--	R	--	--	--	R
Stud Carriers (full)	3.8	C	C	--	--	R	--	--	--	R
Residual Heat Removal Exchanger	12.5	C	C	--	--	R	--	--	--	--
Residual Heat Removal Pump - Motor	1.5	C	C	--	--	R	--	--	--	--
Regenerative Heat Exchangers	3.1	C	C	--	--	R	--	--	--	--
Polar Cranes - Bottom Block and Hook	5.4	C	C	--	--	--	--	--	--	R

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
R. C. Operating Floor Removable Plugs (20) - Heaviest Plug	14.9	C	C	--	--	R	--	--	--	--
2. Fuel Cask Crane (CR-15)	125.0		--	C	--	--	R	C	R	--
Spent Fuel Shipping Cask	21.5	--	C	--	--	R	--	--	--	--
3. Screenwell Crane (CR-17)	15		--	C	--	--	R	R	--	--
River Water Pumps	6.5	C	C	--	--	R	--	--	--	--
River Water Motors	2.7	C	C	--	--	R	--	--	--	--
Raw Water Pumps	9.3	C	C	--	--	R	--	--	--	--
Raw Water Motors	3.8	C	C	--	--	R	--	--	--	--
Electrical Fire Pump	3.0	C	C	--	--	R	--	--	--	--
Electrical Fire Pump Motor	2.0	C	C	--	--	R	--	--	--	--
Diesel Fire Pump	3.0	C	C	--	--	R	--	--	--	--

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
Diesel Engine	1.9	C	C	--	--	R	--	--	--	--
Hydro-Pneumatic Tank	1.2	C	C	--	--	R	--	--	--	--
Removable Covers (largest)	4.3	C	C	--	--	R	--	--	--	--
Unit 2 Service Water Pumps and Motors	13.8	C	C	--	--	R	--	--	--	--
Traveling Water Screens (heaviest section)	10.4	C	C	--	--	R	--	--	--	--
Stoplogs	10.0	C	C	--	--	R	--	--	--	--
4. 7.5-Ton Monorail System (CR-9)	7.5	--	C	C	--	--	R	R	--	--
5. PCA Shop Crane (CR-19)	15.0	--	C	C	--	--	R	R	--	--
6. 10-Ton Monorail System (CR-20)	10.0	--	--	C	--	--	R	R	--	--
Charging Pumps - Pump	3.8	--	C	--	--	R	--	--	--	--

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
Charging Pumps - Motor	2.0	--	C	--	--	R	--	--	--	--
Cubicle Covers (largest)	5.0	--	C	--	--	R	--	--	--	--
7. 6-Ton Monorail System (CR-21)	6.0	--	--	C	--	--	R	R	--	--
Component Cooling Water Pump	1.5	--	C	--	--	R	--	--	--	--
Component Cooling Water Motor	1.7	--	C	--	--	R	--	--	--	--
8. 10-Ton Monorail System (CR-23)	10.0	--	--	C	--	--	R	R	--	--
Seal Water Heat Exchanger	1.1	--	C	--	--	R	--	--	--	--
Nonregenerative Heat Exchanger	4.3	--	C	--	--	R	--	--	--	--
Deborating Demineralizer	1.0	--	C	--	--	R	--	--	--	--
Cesium Removal Ion Exchanger	1.0	--	C	--	--	R	--	--	--	--
Fuel Pool Ion Exchanger	1.0	--	C	--	--	R	--	--	--	--

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
Removal Covers (largest)	8.5	--	C	--	--	R	--	--	--	--
9. 6-Ton Monorail System (CR-24A &B)	6.0	--	--	C	--	--	R	R	--	--
Removable Covers	3.0	--	C	--	--	R	--	--	--	--
10 Movable Platform and Hoist (CR-27)	5.0	--	--	C	--	--	R	C	R	--
New Fuel Shipping Container (fully loaded)	2.5	--	C	--	--	--	--	--	--	--
Failed Fuel Assembly Storage Can (full)	1.5	--	C	--	--	--	--	--	--	--

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."

2.1.1.1 Licensee Statements and Conclusions

Safe load travel paths have been defined which will minimize adverse effects of a load drop for those handling systems identified. The Licensee identified and provided drawings of safe load paths at Beaver Valley Power Station. These load paths have been defined so as to minimize the adverse affects of a load drop for the handling systems identified in the vicinity of irradiated fuel and safe shutdown equipment. The drawings have been incorporated into plant procedures. It has been verified that these load paths follow, to the extent practical, structural floor members. These load paths have not been permanently marked on the plant floors since the Licensee has determined that such markings would not further strengthen this program with regard to handling heavy loads. In lieu of permanent floor markings, a signalman equipped with the load handling procedure is used to direct the movements of the crane operator.

In the event that deviations from approved load paths are found necessary or a determination of the applicability of this procedure on a special case basis is required, a decision will be made by the Onsite Safety Committee, with a supporting safety analysis performed by the Station Engineering Group, as to whether or not approval should be granted for the activity in question.

2.1.1.2 Evaluation

DLC has identified safe load paths which will minimize the potential for heavy loads to impact irradiated fuel in the reactor vessel and in the spent fuel pool and to impact safe shutdown equipment. Review of load path drawings provided by the Licensee reveals that the load paths have been selected to minimize the time the heavy load is over irradiated spent fuel and to shorten

the distance the heavy load has to travel while still avoiding safe shutdown equipment as much as practical. DLC's stated intentions concerning identification of the safe load paths in procedures and on equipment layout figures are acceptable.

The Licensee has addressed the need for review and approval of deviations from defined safe load paths by requiring that deviations from defined safe load paths be reviewed and approved as part of the administrative procedures for processing a field change. This approach meets the intent of Guideline 1 in that responsible and knowledgeable personnel would review deviations from the defined safe load paths with respect to concerns addressed in NUREG-0612.

Although no physical indication (e.g., floor markings) has been provided for safe load paths, the Licensee's proposed alternative (use of signalman) has previously been found acceptable on the basis that such an individual provides a suitable visual aid to ensure that approved load paths are followed.

2.1.1.3 Conclusion

Development of safe load paths at Beaver Valley Power Station is consistent with the guidance provided by Guideline 1.

2.1.2 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....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."

2.1.2.1 Licensee Statements and Conclusions

The Licensee stated that existing maintenance procedures generally follow the guidance of NUREG-0612. Trigger statements will be added to existing procedures requiring an evaluation to the requirements of NUREG-0612 before making the lift. A general heavy load handling procedure (CMP-1-75-212) has been implemented which contains the information specified in Guideline 2 of NUREG-0612.

2.1.2.2 Evaluation and Conclusion

DLC's approach to ensuring that load handling procedures satisfying Guideline 2 are to be invoked for individual lifts is reasonable and acceptable.

2.1.3 Crane Operator Training [Guideline 3, NUREG-0612, Section 5.1.1(3)]

> "Crane operators should be trained, qualified, and conduct themselves in accordance with Chapter 2-3 of ANSI B30.2-1976, 'Overhead and Gantry Cranes'[8]."

2.1.3.1 Summary of Licensee Statements and Conclusions

The Licensee has stated that operator training is in accordance with ANSI B30.2-1976. Further, DLC staff noted that operator selection and performance monitoring procedures also comply with this standard.

2.1.3.2 Evaluation and Conclusion

Crane operator training at Beaver Valley Unit 1 is considered to satisfy the NRC staff guidelines, on the basis of DLC's verification that related programs are based on ANSI B30.2-1976.

2.1.4 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' [9]. This standard should apply to all special lifting devices which carry heavy loads in areas as defined above. For operating plants, certain inspections and load tests may be accepted in lieu of certain material requirements in the standard. In addition, the stress design factor stated in Section 3.2.1.1 of ANSI N14.6 should be based on the combined maximum static and dynamic loads that could be imparted on the handling device based on characteristics of the crane which will be used. This is in lieu of the guideline in Section 3.2.1.1 of ANSI N14.6 which bases the stress design factor on only the weight (static load) of the load and of the intervening components of the special handling device [NUREG-0612, Guideline 5.1.1(4)]."

2.1.4.1 Summary of Licensee Statements and Conclusions

The following special lifting devices have been identified to require compliance with the criteria of NUREG-0612, Guideline 4:

- o head lift rig
- o internals lift rig
- o reactor coolant pump (RCP) motor lift sling spreader assembly.

The Licensee stated that these devices were designed and built prior to the existence of ANSI N14.6-1978. The design criteria used were based upon stresses in load-bearing members not exceeding one-fifth of the material's ultimate strength. A detailed comparison with the criteria of ANSI N146.1978 has been performed, and the results demonstrate that the intent of the ANSI standard has been met for design, fabrication, and quality assurance. Although design specifications were not written, detailed manufacturing drawings and purchase orders contain equivalent information. A stress report has been performed on these devices which demonstrates that design criteria are satisfied. The devices were manufactured under Westinghouse surveillance, procedural review, and personnel qualification, which adequately meet ANSI quality assurance requirements.

The Licensee noted, however, that these devices are not in strict agreement with the ANSI criteria for acceptance testing, maintenance, and verification of continuing compliance. An initial load test of 125% of rated load (in lieu of a 150% load test) was performed on all three devices followed by nondestructive testing (NDE) of all critical welds. In order to demonstrate continuing compliance, a visual examination by qualified personnel of critical welds and parts will be conducted prior to lifting. In addition, NDE of all major load-carrying welds will be performed as part of the 10-year inservice inspection outage. Relaxation of the NDE interval is believed to be justified based upon low usage of these devices.

2.1.4.1 Evaluation

Although not built in strict compliance with the design and fabrication requirements of ANSI N14.6-1978, it is apparent from the Licensee's response

that adequate documentation exists from original design and fabrication and that analyses have subsequently been performed which demonstrate the design adequacy of these devices, as well as provide assurance that the devices were fabricated using suitable quality controls. Such documentation satisfactorily demonstrates that these devices should possess a load handling reliability comparable to that of a device originally designed to ANSI N14.6-1978.

Similarly, a load test of 125% provides sufficient overstress to provide proof of workmanship of the devices and was followed by appropriate NDE of load-bearing welds.

The Licensee's commitment to perform visual inspections prior to use, as well as NDE of all load-bearing welds during the inservice inspection outage, provides assurances that these devices will be maintained in a manner which ensures adequate load handling reliability.

2.1.4.3 Conclusion

Design of special lifting devices at Beaver Valley Power Station, as well as implementation of inspection programs to ensure continuing compliance, is performed in a manner consistent with Guideline 4.

2.1.5 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' [10]. However, in selecting the proper sling, the load used should be the sum of the static and maximum dynamic load.* The rating identified on the sling should be in terms of the 'static load' that produces the maximum static and dynamic load. Where this restricts slings to use on only certain cranes, the slings should be clearly marked as to the cranes with which they may be used."

2.1.5.1 Summary of Licensee Statements and Conclusions

The Licensee stated that plant procedures have been revised to comply with ANSI B30.9-1971. Dynamic load considerations have also been incorporated in selection of slings; sling ratings have been downrated based upon dynamic

loads (approximated by 1/2% of rated load times the maximum hoist speed for those cranes subject to NUREG-0612 guidelines).

2.1.5.2 Evaluation and Conclusion

Selection and use of slings at Beaver Valley Unit 1 are consistent with the requirements of this guideline.

2.1.6 Cranes (Inspection, Testing, and Maintenance) [Guideline 6, NUREG-0612, Section 5.1.1(6)]

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

2.1.6.1 Licensee Statements and Conclusions

Preventive maintenance procedures are being reviewed for compliance to ANSI B30.2-1976 and will be revised as necessary. Contractors are presently used to perform crane inspections and testing. Purchase orders will be revised to require inspectors to be qualified and inspections conducted in accordance with ANSI B30.2-1976.

2.1.6.2 Evaluation

DLC's crane inspection, testing, and maintenance program, which is being reviewed and revised at Beaver Valley Unit 1, is considered to satisfy the intent of Guideline 6 criteria, on the basis of the Licensee's statement that the program is being revised in accordance with ANSI B30.2.

2.1.6.3 Conclusion and Recommendation

Inspection, maintenance, and testing of cranes at Beaver Valley Unit 1 satisfy Guideline 6 of NUREG-0612.

2.1.7 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 Travelling Cranes' [11]. 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."

2.1.7.1 Licensee Statements and Conclusions

"CMAA Specification 70 and ANSI B30.2-1976 apply to cranes CR-1, 15, 17, 19, and 27. Cranes CR-15 and CR-27 have been designed to comply with CMAA 70.

"Cranes CR-1, CR-17, and CR-19 were designed to comply with EOCI Specification 61 which was superseded by CMAA-70. The differences between these two specifications which impact the evaluation of the safe handling of heavy loads are addressed below with respect to the significant cranes.

a) CMAA-70 requires the hoist rope safety factor be calculated on the combined weight of the bottom block assembly and the rated load. This requirement is met by all of the above listed cranes except CR-19 which will be administratively limited to a 13.9 ton load to meet this safety requirement while the remainder of this study is in progress.

b) CMAA-70 requires ASTM-A36 structural steel; all of the above cranes are built of this material.

c) Though the specification requirements differ, the stress requirements of CMAA-70 for bridge girders, end trucks and trolley frames are met by the cranes.

ANSI B30.2-1976 adds the additional requirement applicable to safe heavy load handling that crane hooks have latches if practical in that application. This requirement is met by the above listed cranes."

In addition to the above requirements, the Licensee has performed a detailed comparison of existing crane design with the more restrictive

requirements of CMAA-70. Results, summarized above and in the following paragraphs, indicate that these cranes satisfy the design requirements of CMAA-70.

1. Impact allowance. CMAA-70, Article 3.3.2.1.1.3 requires that crane design calculations include an impact allowance of 0.5% of the load per foot per minute of hoisting speed but not less than 15%. EOCI-61 specifies only a minimum allowance of 15%. Consequently, for cranes with hoist speeds in excess of 30 feet per minute, it is possible that the impact allowance applied under EOCI-61 will be less than that required by CMAA-70. Hoist speeds for Beaver Valley cranes do not exceed 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. Bridge griders for the Beaver Valley cranes are constructed of box griders which are symmetrical about each principal central axis (e.g., box section or I-beam girders commonly used in crane subject to this review), the shear center coincides with the centroid of the girder section, and there is no difference between the two requirements.

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. Original design of the cranes is in accordance with the revised requirements of CMAA-70 for stiffeners.

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 stresses except that the allowable stress decreases from approximately 50% of yield only after the b/c ratio exceeds 41. Consequently, structural members with b/c ratios in the general range of 38 to 52 designed under EOCI-61 will allow a slightly higher compressive stress than those designed under CMAA-70. Ratios for b/c are less than 38 for both the polar crane and the PLA shop crane; b/c ratio for the screenwell crane is 40.

This is not anticipated to be a problem since a 15-ton trolley is installed on girders designed for 25 tons.

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. Since these cranes are expected to handle a limited number of lifts near rated load throughout the life of the plant, fatigue failure is not expected to be of consequence for these cranes.

6. 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. Drum designs for all cranes were based on the combination of crushing and bending loads.

7. Drum design. CMAA-70, Article 4.4.3 provides recommended drum groove depth and pitch. EOCI-61 provides no similar guidance. Drum groove depth and pitch on all cranes comply with CMAA-70 requirements.

8. 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. Crane gear horsepower ratings were based upon referenced AGMA standards.

9. 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 was not used in any crane desgin.

10. 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. Holding brakes are rated at 150% of motor torque for all cranes.

11. 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. No similar guidance is provided in EOCI-61. All installed bumpers meet the deceleration requirements and energy absorbing requirements of CMAA-70.

12. 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. Static control systems were not used on the subject cranes.

13. 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. The cranes were designed with spring-return controllers or momentary-contract push buttons.

2.1.7.2 Evaluation

Cranes CR-15 (fuel cask crane) and CR-27 (movable platform and hoist) satisfy the requirements of this guideline on the basis that they were originally designed and fabricated in accordance with CMAA-70. Remaining cranes (polar crane, screenwell crane, and PCA shop crane) satisfy the requirements of this guideline to a large degree, based upon original design to EOCI-61. The Licensee has performed a detailed comparison between CMAA-70 and EOCI-61 to determine revisions which may affect load handling reliability and has evaluated each of these cranes with the more restrictive requirements of CMAA-70. Results of this evaluation indicate that all cranes at Beaver Valley Unit 1 satisfy the design requirements of this guideline.

2.1.7.3 Conclusion

Design of cranes at Beaver Valley Unit 1 is consistent with requirements of 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 or spent fuel pool. Four of the six interim measures of the report consist of general Guideline 1, Safe Load Paths; Guideline 2, Load Handling Procedures;

Guideline 3, Crane Operator Training; and Guideline 6, Cranes (Inspection, Testing, and Maintenance). The two remaining interim measures cover the following criteria:

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

Licensee implementation and evaluation of these interim protection measures are contained in the succeeding paragraphs of this section.

2.2.1 Technical Specifications [Interim Protection Measure 1, NUREG-0612, Section 5.3(1)]

> "Licenses for all operating reactors not having a single-failure-proof overhead crane in the fuel storage pool area should be revised to include a specification comparable to Standard Technical Specification 3.9.7, 'Crane Travel - Spent Fuel Storage 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 [of NUREG-0612]."

2.2.1.1 Summary of Licensee Statements and Conclusions

Beaver Valley Technical Specification 3.9.7 prohibits loads in excess of 3000 lb from travel over fuel assemblies in the storage pool. This weight (though in excess of the weight of a single fuel assembly - 1815 lb) is based upon the combined weight of a fuel assembly, the damaged fuel storage container, and the spent fuel handling tool.

The Licensee stated that plant procedures restrict the handling of heavy loads in the areas where fuel is located and where safety-related equipment is installed. It is the Licensee's opinion that these adminstrative controls, in addition to the existing technical specifications, provide the same degree of protection as would a revision to the existing technical specification.

2.2.1.2 Evaluation and Conclusion

Technical specifications and administrative controls which have been implemented to restrict movements of heavy loads over and in the immediate vicinity of stored spent fuel are consistent 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]."

2.2.2.1 Evaluation

The specific requirements for load handling administrative controls are contained in NUREG-0612, Section 5.1.1, Guidelines 1, 2, 3, and 6. Evaluation of the Licensee's compliance with respect to these guidelines is contained in Sections 2.1.1.2, 2.1.2.2, 2.1.3.2, and 2.1.6.2, respectively.

2.2.2.2 Conclusions

Conclusions and recommendations concerning the Licensee's compliance with these administrative controls are contained in Sections 2.1.1.3, 2.1.2.3, 2.1.3.3, and 2.1.6.3.

2.2.3 Special Review for Heavy Loads Handled Over the Core [Interim Protection Measure 6, NUREG-0612, Section 5.3(6)]

> "...special attention should be given to procedures, equipment, and personnel for the handling of heavy loads over the core, such as vessel internals or vessel inspection tools. This special review should include the following for these loads: (1) review of procedures for installation of rigging or lifting devices and movement of the load to assure that sufficient detail is provided and that instructions are clear and concise; (2) visual inspections of load bearing components of cranes, slings, and special lifting devices to identify flaws or deficiencies that could lead to failure of the component; (3) appropriate repair and replacement of defective components; and (4) verify that the crane operators have been properly trained and are familiar with specific procedures used in handling these loads, e.g., hand signals, conduct of operation, and content of procedures."

2.2.3.1 Summary of Licensee Statements

DLC has completed a review of its load handling procedures and its training and qualification program to verify that they conform to existing

standards and good engineering practice. No special inspection of load-bearing components in cranes, slings, or special lifting devices handling heavy loads over the core has been reported. DLC intends to perform such an inspection prior to the next reactor vessel head lift.

2.2.3.2 Evaluation and Conclusion

The Licensee's review of load handling procedures and operation at Beaver Valley Unit 1 indicates that DLC will satisfy this interim measure.

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 Beaver Valley Unit 1. Overall conclusions and recommended Licensee actions, where appropriate, are provided with respect to both general provisions for load handling (NUREG-0612, Section 5.1.1) 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 Beaver Valley Unit 1 can be expected to be conducted in a highly reliable manner consistent with the staff's objectives as expressed in these guidelines.

3.2 INTERIM PROTECTION

The NRC staff has established (NUREG-0612, Section 5.3) certain measures that should be initiated to provide reasonable assurance that handling of heavy loads will be performed in a safe manner until final implementation of the general guidelines of NUREG-0612, Section 5.1 is complete. Specified measures include: the implementation of a technical specification to prohibit the handling of heavy loads over fuel in the storage pool; compliance with

Guidelines 1, 2, 3, and 6 of NUREG-0612, Section 5.1.1; a review of load handling procedures and operator training; and a visual inspection program, including component repair or replacement as necessary of cranes, slings, and special lifting devices to eliminate deficiencies that could lead to component failure. The evaluation of information provided by the Licensee indicates that Beaver Valley Power Station complies with the staff's measures for interim protection.

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
   May 17, 1978

3. NRC
   Letter to Duquesne Light Company (DLC)
   December 22, 1980

4. J. J. Carey (DLC)
   Letter to S. A. Varga (NRC). Subject: Control of Heavy Loads
   June 23, 1981

5. Information received from S. Sovick (DLC) during site visit to BVPS by F. Clemenson (NRC) and I. H. Sargent (FRC)
   November 23-24, 1981

6. J. J. Carey (DLC)
   Letter to S. A. Varga (NRC). Subject: Control of Heavy Loads
   April 26, 1982

7. J. J. Carey (DLC)
   Letter to S. A. Varga (NRC). Subject: Control of Heavy Loads
   October 9, 1984

8. ANSI B30.2-1976
   Overhead and Gantry Cranes

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

10. ANSI B30.9-1971
    Slings

11. CMAA-70
    Specifications for Electric Overhead Travelling Cranes