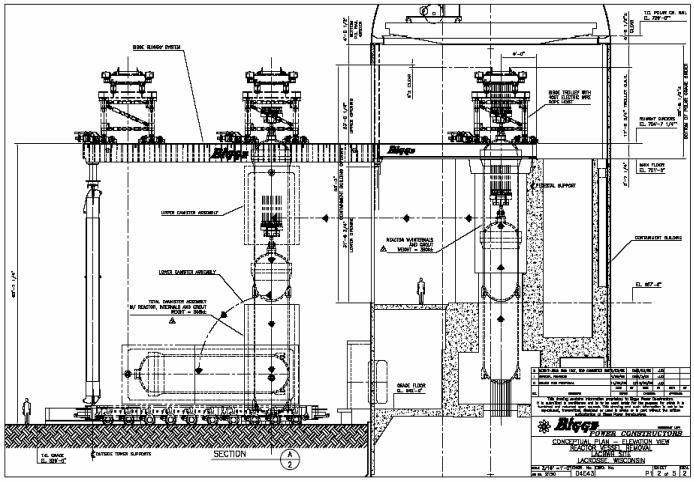
La Crosse Boiling Water Reactor - Reactor Pressure Vessel (RPV) Removal – NUREG 0612 Compliance

This paper addresses the planned approach to be used by Duratek / Bigge for compliance with NUREG 0612, "*Control of Heavy Loads at Nuclear Power Plants*" for the lifting / rigging activities associated with the removal of the La Crosse Boiling Water Reactor (LACBWR) Reactor Pressure Vessel (RPV).

Background

Duratek / Bigge have completed the planning stage of work for the removal of the LACBWR RPV.

A plan has been developed and initially engineered to execute this removal. The plan is to utilize a Temporary (or as called in NUREG 0612 – a *Special*) Lifting Device (TLD) to remove the RPV. The TLD is a hoisting system consisting of a trolley running on runway girder rails with bottom of rails being approximately at the elevation of the operating floor. The RPV will then be lifted approximately 20 feet vertically, such that the bottom of the RPV clears the elevation of the 667'-0" floor. The RPV will then trolley on the girder approximately 80 feet to Plant north, exiting the RB at a point that the RPV can be lowered northeast of the Machine Shop into the bottom portion of the shipping canister. The horizontal removal path will require all structures and components to be cleared above the 667'-0" floor north of the reactor cavity approximately 11' wide and for approximately 59' above the floor.



Once outside the Reactor Building, the RPV will be lowered into the bottom portion of the shipping container. The top portion of the container will then be rigged into place using the same hoisting system and once the packaging is completed, the complete package will be downended using the hoisting system.

NUREG 0612 Compliance

Section 5.0 of NUREG 0612 provides "Guidelines For Control Of Heavy Loads". The recommended Guidelines in Section 5.1 of NUREG 0612 are based upon a "defense-in-depth approach" for controlling the handling of heavy loads. Per the NUREG, this "*defense-in-depth approach*" is summarized in the first column on the following table:

NUREG 0612 Requirement	Bigge/ Duratek Compliance Plan	Comment
5.1.(1) Provide Sufficient operator training, handling system design, load handling instructions, and equipment inspection to assure reliable operation of the handling system; and	Detailed operator training, handling system design, load handling instructions, and equipment inspection will be conducted to assure reliable operation of the handling system; and	No deficiencies in compliance
5.1.(2) Define safe load travel paths through procedures and operator training so that to the extent practical heavy loads avoid being carried over or near irradiated fuel of safe shutdown equipment; and	The safe load travel path will be in procedures and be part of operator training. The engineered load path is such that the RPV will not be carried over or near irradiated fuel or safe shutdown equipment; and	No deficiencies in compliance
5.1.(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.	Mechanical stops will be provided to prevent movement of heavy loads over irradiated fuel or in proximity to equipment associated with redundant shutdown paths	No deficiencies in compliance

The Guidance in Section 5.1 then goes on to allow for certain deficiencies in items (2) and (3) (which there are none in the Bigge / Duratek Compliance Plan) to have alternate compensatory measures taken credit for; these alternate compensatory measures include increasing crane reliability by providing dual load paths in certain components, increased factors of safety, increased inspections, and delaying operations in the spent fuel area till fuel decay has occurred or by analyzing the effects of a postulated load drop to demonstrate that the consequences are within acceptable limits. The guidance states that items

(1) and (2) should still be satisfied to provide the “defense-in-depth” even if one of the alternate measures is selected.

Although as discussed below, the compliance plan is to fully meet the “defense in depth” approach and all criteria - there are no deficiencies in items (2) and (3) – but in addition there are certain additional alternate compensatory measures that can be taken credit for; these alternate compensatory measures include increasing hoisting system reliability by providing increased factors of safety, increased inspections, and by virtue of the fact that the RPV removal operation has been delayed in time to a point where significant spent fuel decay has occurred.

Section 5.1.1 (General) of NUREG 0612 defines 7 criteria to be met for overhead handling systems that are used to handle heavy loads in the area of the reactor vessel or spent fuel in the spent fuel pool. These criteria are:

NUREG 0612 Requirement	Bigge/ Duratek Compliance Plan
5.1.1 (1) Safe load Paths should be defined for the movement of heavy loads to minimize the potential of heavy load, if dropped, to impact irradiated fuel or impact safe shutdown equipment. The path should follow structure, which is likely to withstand the impact if the load is dropped and the load path should be defined in procedures, shown on drawings and marked on the building floor. Deviations to this load path should require written alternate procedures approved by the plant safety review committee.	Safe load Paths will be defined for the movement of the LACBWR RPV to minimize the potential of the load, if dropped, impacting irradiated fuel or important to safety equipment. The selected load path is created through robust structure, which is likely to withstand the impact if the load is dropped. The load path and equipment was chosen to limit the lift height of the RPV as to not be in a physical position that it could fall on irradiated spent fuel. The load path will be defined in procedures, shown on drawings and marked on the building floor. Deviations to this load path will not occur.

5.1.1 (2) Procedures should be developed to cover load handling operations. The procedures should include; identification of required equipment, inspections and acceptance criteria required prior to load movement, the steps and sequence to be used in handling the load, definition of the safe load path, and any other special precautions	Procedures will be developed to cover load handling operations. The procedures will include; identification of required equipment, inspections and acceptance criteria required prior to load movement, the steps and sequence to be used in handling the load, definition of the safe load path, and any other special precautions
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".	Crane Operators (lifting equipment operators) will be trained, qualified and conduct themselves in accordance with chapter 2-3 of ANSI B30.2-1976" Overhead and Gantry Cranes". The Lift Supervisor will also be (CCO) certified by the National Commission For The Certification Of Crane Operators (NCCCO) and the Lift Supervisor and Crew will be trained by DairyLand Power to site specific aspects of NUREG 0612.
5.1.1(4) Special lifting devices should follow the guidelines of ANSI N14.6-1978. In addition the stress design factor stated in Section 3.2.1.1 of ANSI N14.6 should be based upon the combined maximum static and dynamic load (not including the loads imposed by an (SSE)) based upon the characteristics of the crane being used.	Special lifting devices will follow the guidelines of ANSI N14.6-1978. In addition the stress design factor stated in Section 3.2.1.1 of ANSI N14.6 will be based upon the combined maximum static and dynamic load (not including the loads imposed by an SSE) based upon the characteristics of the crane being used. For all lifts inside the Reactor Building, the special lifting device will have twice (2 X) the design safety factor per the requirements of 5.1.6(1)
5.1.1(5)Lifting devices that are not specifically designed should be used in accordance with the guidelines of ANSI B30.9-1971 "Slings". In addition the rating identified on the sling should be based upon the combined maximum static and dynamic load (not including	Lifting devices that are not specifically designed will be used in accordance with the guidelines of ANSI B30.9-1971 "Slings". In addition the rating identified on the sling will be based upon the combined maximum static and dynamic load (not including the

the loads imposed by an SSE) based upon the characteristics of the crane being used	loads imposed by an SSE) based upon the characteristics of the crane being used and either dual load paths or factors of safety of twice (2 X) will be used, per the requirements of 5.1.6(1)(b).
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". The crane testing shall meet the testing intervals defined in ANSI B30.2 or be inspected, tested and maintained prior to the heavy load use.	The TLD will be assembled for this one lift and will be inspected and tested after assembly and prior to the lifting of the RPV. Inspection and testing of the TLD will be done to the applicable requirements of AISC, NQA-1, and ANSI N14.6.
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 and CMAA-70.	The TLD will be designed to meet the applicable requirements of ANSI N14.6, AISC, and ANSI B30.1.

Section 5.1.4 of NUREG 0612 discusses the Reactor Building in Boiling Water Reactors (BWR's). This section (5.1.4) appears to be drafted with focus toward operating BWR's and does not address the RPV as a potential heavy load. Nevertheless, it says that in addition to meeting the general guidelines of Section 5.1.1; either the lifting devices should meet (1) the guidelines in Section 5.1.6 or (2) that the effects of a heavy load drop be analyzed.

The planned compliance plan is to meet the requirements of Section 5.1.6.

In order to meet Section 5.1.6, the TLD will be designed to meet Section 6 of ANSI N14.6. A single lifting device will be provided instead of a dual device.

The below the hook lifting devices will be designed to twice (2x) the design safety factor to meet the requirements Section 7 of ANSI N14.6, the runway and structural steel to twice (2x) the design safety factor to meet the requirements of AISC and the jacking components to twice (2x) the design safety factor to meet the requirements of ANSI B30.1. Therefore, all items in the TLD load path will be designed to provide twice (2x) the design safety factor to meet the requirement of 5.1.6(1)(a).

The components of the lifting device that are not specifically designed will be used in accordance with the guidelines of ANSI B30.9-1971"Slings, except either dual load paths or factors of safety will be twice (2X) to meet the requirement of 5.1.6(1)(b).

Lastly NUREG 0612 requires in Section 5.1.6 (3) that interfacing lift points such as lifting lugs or trunions provide either a dual load path such that a single failure would not result in an uncontrolled lowering of the load with a factor of safety with respect to ultimate strength of five (5) times the combined static plus dynamic load or non-redundant or non-dual lift point systems have a design safety factor of ten (10) times the maximum static plus dynamic load. The Bigge/ Duratek compliance plan is such that all Interfacing lift points such as lifting lugs or trunions will either have a dual load path such that a single failure would not result in an uncontrolled lowering of the load with a factor of safety with respect to ultimate strength of five (5) times the combined static plus dynamic load or non-redundant or non-dual lift point systems will have a design safety factor of ten (10) times the maximum static plus dynamic load.

Conclusion:

The compliance plan therefore meets the "defense in depth" approach and that all criteria are met. In addition, although there are no deficiencies in items (2) and (3), certain additional measures can be taken credit for. These additional measures include; increasing hoisting system reliability by providing increased factors of safety, increased inspections, and by virtue of the fact that the RPV removal operation has been delayed in time to a point where significant spent fuel decay has occurred.

The planned TLD is to be used solely for the lifting and removal of the RPV. The compliance to the NUREG is in the context that it is not planned as new permanent plant equipment or replacing the existing polar crane, but used as a Temporary (or Special) Lifting Device to lift the RPV.

The compliance plans meets the requirements of "Reactor Building BWR" (NUREG Section 5.1.4) in that the TLD meets all the augmented requirements for "Special Lifting Devices" defined in NUREG 0612 Section 5.1.6.