Tennessee Valley Authority, Post Office Box 2000, Spring City, Tennessee 37381-2000

MAY 2 1 2002

10 CFR 50.90

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D. C. 20555

Gentlemen:

In the Matter of) Docket No.50-390
Tennessee Valley Authority)

WATTS BAR NUCLEAR PLANT - REQUEST FOR ADDITIONAL INFORMATION (RAI) REGARDING TRITIUM PRODUCTION - INTERFACE ISSUE NUMBER 7 - LIGHT LOAD HANDLING SYSTEMS (TAC NO. MB1884)

The purpose of this letter is to provide information regarding NUREG1672, Interface Issue Number 7, "Light Loads Handling Systems," that was requested by NRC letter dated April 25, 2002.

Initial information related to this interface issue was supplied by TVA on May 1, 2001, and with the license amendment request dated August 20, 2001. The enclosure to this letter provide both the RAI and the TVA response.

A003

There are no regulatory commitments made by this letter. If you have any questions, please contact me at (423) 365-1824.

Sincerely,

Rebecca N. Mays

for P. L. Pace
Manager, Site Licensing
and Industry Affairs

Enclosures
cc: See page 3

Subscribed and sworn to before me
on this 21st day of May 2002

E. Jeannette Long
E. Jeannette Long
Notary Public

My Commission expires May 21, 2005

cc (Enclosure):

NRC Resident Inspector
Watts Bar Nuclear Plant
1260 Nuclear Plant Road
Spring City, Tennessee 37381

Mr. L. Mark Padovan, Senior Project Manager
U.S. Nuclear Regulatory Commission
MS 08G9
One White Flint North
11555 Rockville Pike
Rockville, Maryland 20852-2738

U.S. Nuclear Regulatory Commission
Region II
Sam Nunn Atlanta Federal Center
61 Forsyth St., SW, Suite 23T85
Atlanta, Georgia 30303

ENCLOSURE
TENNESSEE VALLEY AUTHORITY
WATTS NUCLEAR PLANT (WBN)
UNIT 1
DOCKET NO. 390
INTERFACE ITEM NUMBER 7
LIGHT LOAD HANDLING SYSTEMS

NRC REQUEST

Enclosures 1 and 4 to Tennessee Valley Authority's (TVA's) letter of August 20, 2001, TVA stated that no more than 24 TPBARs would be damaged for all credible impact scenarios involving a fully-loaded (300 TPBARs) consolidation canister. In response to a question regarding the basis for this statement, TVA stated that a Pacific Northwest National Laboratories analysis showed no TPBAR cladding failures for a canister impact with a rigid surface at a speed of 40 feet per minute. This speed is based on the maximum uncontrolled lowering hook speed of the spent fuel pool hoist. Also, using this speed as a limiting value was based on design features and operating practices that would be applied to handling of consolidation canisters. Using these conditions resulted in the previously-evaluated consequences from a fuel handling accident (involving a fuel assembly containing an inventory of 24 TPBARs) bounding fuel handling accidents involving a consolidation canister.

This approach appears to be neither consistent with regulatory guidance for review of fuel handling facilities and single-failure-proof load handing systems:

- Regulatory Guide 1.13, "Spent Fuel Storage Facility Design Basis"

- Safety Guide 25, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors"

- Standard Review Plan Sections 9.1.4, 9.4.2, and 15.4.7

- NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants"

- The regulatory guidance for fuel handling facilities specifies that the maximum potential release due to an unrestrained drop of a light load from its maximum potential height be evaluated, and the resultant consequences be within regulatory limits. The regulatory guidance for review of single-failure-proof load handling systems specifies a complete set of design features and operational controls to ensure reliable performance of the load handling system in preventing damage to important structures, systems, and components. The information in Enclosures 1 and 4 to TVA's letter of August 20, 2001, does not address the maximum potential release from a consolidation canister. Further, it does not describe TVA's implementation of a complete set of design features and operational controls to ensure reliable performance of the load handling system in preventing damage to important structures, systems, and components.

NRC REQUEST

In order to complete our review, please provide either of the following evaluations:

1. An evaluation of the maximum potential radiological consequences from a fuel handling accident involving a consolidation canister. This evaluation should consider potential releases resulting from an unrestrained drop of a light load from its maximum potential height and should address all potential impact combinations involving fuel assemblies and loaded consolidation canisters.

2. An evaluation comparing design features, operational controls, and analyses planned for implementation to those specified in the applicable section of NUREG-0612. This evaluation should address each specified item separately by describing what is planned for implementation and the basis for any difference in scope or depth relative to what is specified in NUREG-0612.

TVA RESPONSE

TVA has chosen to respond to Item 2 above and provides the following evaluation:

NUREG-0612

NUREG-0612 provides guidelines to assure that a Heavy Load drop (Heavy Load is defined as a load that weighs more than a single spent fuel assembly and its associated handling tool) would not result in a release of radioactive material that could result in off-site doses exceeding 10 CFR Part 100 limits. A heavy load at Watts Bar Nuclear Plant (WBN) is 2059 pounds (lbs.). Lifting the TPBAR canister loaded with up to 300 TPBARs is not a heavy load (calculated at approximately 750 lbs. buoyant weight), therefore it is not specifically addressed by NUREG-0612. However, in order to provide added assurance that the crane and lifting device used to lift the TPBAR canisters are safe, they will be evaluated against the requirements of NUREG-0612.

The Spent Fuel Bridge Crane will be the only crane designated to lift the TPBAR canister while loaded with TPBARs. The bridge itself is designed specifically by Dwight Foote, Inc. for the provided hoist (4000 lb. capacity hoist). Any reference to crane or crane attributes such as trolley, bridge, hoist, etc. pertain specifically to the Spent Fuel Bridge Crane unless otherwise indicated.

In Section 5.1.1 of NUREG-0612, general requirements are outlined for handling of heavy loads. These requirements and TVA's response are as follows:

1. **<u>Safe load paths</u> - a defined path should be established for movement of heavy loads that minimizes the potential for heavy loads, if dropped, to impact irradiated fuel in the reactor vessel or spent fuel pool, or to impact safe shutdown equipment.**

   TPBAR canister has been evaluated for uncontrolled (40 feet per minute (fpm) maximum lowering and no damage to TPBARs will occur as demonstrated by impact analysis as previously discussed in TVA letter dated February 21, 2002. The loaded canister weighs less than a fuel assembly and therefore, damage to stored spent fuel from an uncontrolled canister lowering is bounded by existing analysis of a fuel handling accident.

   Additionally, loaded canister movement is restricted to the area within the Spent Fuel Pool (SFP) and Cask Loading Pit which precludes interaction with safety related equipment. Loaded canisters will be stored in designated cells in the SFP away from anticipated fuel assembly movement. Additional administrative controls will be in place to prevent handling fuel assemblies over these cells while loaded canisters are present. Therefore, the load paths for this crane are considered safe and do not require designation.

2. **<u>Procedures</u> - 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.**

   Appropriate detailed procedures will be developed to address load handling operations of the Spent Fuel Bridge Hoist to lift the TPBAR canister.

3. **<u>Crane Operators</u> should be trained, qualified, and conduct themselves in accordance with Chapter 2-3 of ANSI B30.2-1976, "Overhead and Gantry Cranes".**

   Crane Operators are trained, qualified, and conduct themselves in accordance with ASME B30.2. Additionally, TPBAR consolidation operators will be required to have the same training needed to perform fuel handling activities.

4. **<u>Special Lifting Devices</u> should satisfy the guidelines of ANSI N14.6-1978, "Standard for Special Lifting Devices for Shipping Containers Weighing 10,000 lb. (4500 Kg) or More for Nuclear Materials.**

   The lifting device for the TPBAR canister will be designed to satisfy the guidelines of ANSI N14.6-1978, "Standard for Special Lifting Devices for Shipping Containers Weighing 10,000 lb. (4500 Kg) or More for Nuclear Materials." Specifically, either dual load paths or increased safety factors, in addition to fabrication and testing requirements, will be invoked in accordance with Sections 6 and 7 of ANSI N14.6.

5. **<u>Lifting Devices that are not specially designed</u> should be installed and used in accordance with the guidelines of ANSI B30.9-1971 "Slings".**

   No slings will be utilized to lift the TPBAR canister. However, a synthetic sling is utilized as a lanyard to limit canister tipping to prevent TPBAR spillage. This lanyard is designed to withstand the impulse/impact load to stop the tipping canister.

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 SFP crane is inspected, tested, and maintained prior to each refueling outage. The TPBAR consolidation activity will be performed, when necessary, following plant startup after each refueling outage. The SFP crane maintenance procedure prescribes inspection and maintenance required for this crane. Further, other site procedures govern operator conduct and load handling per ASME B30.2.

7. **The crane should be designed to meet the applicable criteria and guidelines of Chapter 1 of ANSI B30.2-1976, "Overhead and Gantry Cranes" of CMAA-70, "Specifications for Electric Overhead Traveling Cranes". 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.**

   The hoist was designed in accordance with ANSI B30.16 (Applicable Standard at the time of hoist design and fabrication). Note that the importance of the structural elements contained in the required specifications is diminished as the maximum critical load (MCL) is less than one half of the crane's capacity.

Additionally, the crane and lifting devices used for handling the TPBAR canister will be compared to single-failure proof guidelines to assure increased safety while performing this lift. Single Failure Proof Requirements for Nuclear Power Plant Cranes are contained in NUREG-0554 "Single Failure Proof Cranes for Nuclear Power Plants".

NUREG-0554 Evaluation of the Spent Fuel Bridge Crane and Hoist

Single failure proof guidelines are outlined in NUREG-0554. A comparison of the hoist and bridge crane and single failure proof requirements from the applicable section of NUREG-0554 is provided below. The section of NUREG-0554 used to document the requirement is also included:

2.0 SPECIFICATION AND DESIGN CRITERIA

2.1 Construction and Operating Periods

Requirement:

Separate performance specifications for a crane system may be needed to reflect the duty cycles and loading requirements for construction phase and operating plant phase.

The SFP Bridge Hoist was not used extensively during construction. The limited range of the crane (could only perform lifts within the spent fuel pit) and the availability of the 125/10 Ton Refuel Floor Bridge crane, which could cover the entire refuel floor, made it impractical for construction use. Therefore, construction phase duty and loading cycles are not a concern. The duty cycles and loading requirements for the operating phase are defined.

2.2 Maximum Critical Load

Requirement:

A single failure proof crane should be designed to handle the Maximum Critical Load (MCL) that will be imposed. Certain single failure proof cranes may be required to handle occasional non-critical loads greater than the MCL. The maximum non-critical load will be the design rated load (DRL). The DRL and the MCL ratings should be marked on the cranes separately.

The MCL that will be imposed consists of the TPBAR canister and up to 300 TPBARs, which will weigh approximately 750 lb. This is well within the capacity of the hoist including any dynamic loading (design rated load = 2 Tons). Since the consolidation canister is the only critical load and the DRL is the hoist capacity which is marked on the hoist, no additional markings are deemed necessary.

2.3 Operating Environment

Requirement:

The operating environment, including maximum and minimum pressure, maximum rate of pressure increase, temperature, humidity, and emergency corrosive or hazardous conditions, should be specified for the crane and lifting fixtures.

The normal range of maximum and minimum temperatures on the refuel floor is 60° F to 104° F. Pressure is maintained slightly below atmospheric. Relative humidity is maintained between 30 percent (%) and 90%. There are no emergency corrosive or hazardous conditions. Further, lifting devices are designed to withstand the aqueous conditions within the SFP.

2.4 Material Properties

Requirement:

Cranes are generally fabricated from structural shapes and plate rolled from carbon steel (no alloying elements except for 1% manganese in heavier section) or low alloy steel (less than 5% total alloy content). Some of these steel parts exceed 12 mm (1/2 inch) thickness and may have brittle-fracture tendencies when exposed to low operating temperatures so that testing of the material toughness becomes necessary. When low-alloy steels are used, weld metal toughness is of greater concern than the base metal. The crane and lifting fixtures for cranes already fabricated or operating may be subjected to a coldproof test...

This requirement is written concerning brittle fracture tendencies of structural steel that exceeds 1/2 inch thickness when exposed to lower operating temperatures. The crane is located indoors, in a controlled environment, and not subject to extremes in temperature. Therefore, is not considered necessary to perform a fracture analysis to determine the minimum operating temperature.

2.5 Seismic Design

Requirement:

The cranes should be designed to retain control of and hold the load, and the bridge and trolley should be designed to remain in place on their respective runways with their wheels prevented from leaving the tracks during a seismic event. If a seismic event comparable to a safe shutdown earthquake (SSE) occurs, the bridge should remain on the runway with

brakes applied, and the trolley should remain on the crane girders with brakes applied.

The bridge and hoist have been evaluated for seismic loading (with a fuel assembly which is heavier) and are acceptable.

2.5 Lamellar Tearing

Requirement:

All weld joints whose failure could result in the drop of a critical load should be nondestructively examined. If any of these weld joint geometrics would be susceptible to Lamellar tearing, the base metal at the joints should be nondestructively examined.

This hoist is rated for loads in excess of 2 1/2 x (Factor of Safety ~ 26) the MCL, and have not experienced problems with lifting heavier loads. An inspection is performed periodically on the crane (prior to refueling outages) to check for cracks or distortion, therefore, Lamellar tearing will not be a problem while lifting a MCL.

2.7 Structural Fatigue

Requirement:

Since each crane loading cycle will produce cyclic stress, it may be necessary to investigate the potential for failure of the metal due to fatigue. If a crane will be used during the construction period, it will experience additional cyclic loading, and these loads should be added to the expected cyclic loading for the permanent plant operation when performing the fatigue evaluation.

The SFP crane was used sparingly during construction because of its limited range (only can be used to make lifts in the spent fuel pool) as compared to the 125/10 ton overhead bridge crane, which can access almost all of the refuel floor. This crane is currently used to move fuel only a few times per year (usually for refueling outages), and has not and will not receive the volume of cyclic loading that might require a structural fatigue analysis.

2.8 Welding Procedures

Requirement:

Preheat temperatures and postweld heat-treatment (stress relief) temperatures for all weldments should be specified in the weld procedure. Welds described in the recommendations

of section 2.6 should be postweld heat treated in accordance with Subarticle 3.9 of AWS D1.1, "Structural Welding Code."

The SFP crane has been in use for several years with no identified welding problems, and are visually inspected periodically for problems with welds. Therefore it is acceptable to use for MCL lifts of less than half the crane's capacity.

3.0 SAFETY FEATURES

3.1 General

N/A

3.2 Auxiliary Systems

Requirement:

All auxiliary hoisting systems of the main crane handling system that are employed to lift or assist in handling critical loads should be single failure proof.

Auxiliary systems or dual components should be provided for the main hoisting mechanism so that, in case of subsystem or component failure, the load will be retained and held in a stable or immobile safe position.

The hoist on this crane has dual braking. If there is a loss of power, a mechanical brake will hold the load in place. The factors of safety for this hoist is in excess of 26 to 1. Therefore the SFP crane has a high factor of safety while lifting the MCL which assures safe handling of critical loads, and a dual braking system, which assures that the load will be retained in a stable and immobile safe position in case of a component failure.

3.3 Electric Control Systems

Requirement:

The automatic controls and limiting devices should be designed so that, when disorders due to inadvertent operator action, component malfunction, or disarrangement of subsystem control functions occur singly or in combination during the load handling, and assuming no components have failed in any subsystems, these disorders will not prevent the handling system from stopping and holding the load. An emergency stop button should be added at the control station to stop all motion.

There are redundant upper limit switches of different designs to stop the hoisting in the up direction and prevent two-blocking. Simultaneous hoist and bridge operation is precluded by interlocks. The trolley is manual. Therefore, uncontrolled lowering is considered the only plausible control failure consequence. Uncontrolled lowering of the TPBAR canister has been evaluated and demonstrates that no TPBAR damage occurs at a hoist speed of 40 fpm (currently maximum hoist speed is 26 fpm) for the potential impact scenarios. A lanyard is installed during hoisting to assure TPBARs are not spilled out of the canister in the event of canister tipping following impacting an obstruction. Further, the canister and its handling tool weighs less than a spent fuel assembly and its handling tool, therefore, consequences of this is bounded by existing FHA analysis.

3.4 Emergency Repairs

Requirement:

A crane that has been immobilized because of malfunction or failure of controls or components while holding a critical load should be able to hold the load or set the load down while repairs or adjustments are made. This can be accomplished by inclusion of features that will permit manual operation of the hoisting system and the bridge and trolley transfer mechanisms by means of appropriate emergency devices.

Means should be provided for using the devices required in repairing, adjusting, or replacing the failed components(s) or subsystem(s) when failure of an active component or subsystem has occurred and the load is supported and retained in the safe (temporary) position with the handling system immobile. As an alternative to repairing the crane in place, means may be provided for safely transferring the immobilized system with its load in a safe laydown area that has been designated to accept the load while the repairs are being made.

The design of the crane and its operating area should include provisions that will not impair the safe operation or safe shutdown of the reactor or cause unacceptable release of radioactivity when corrective repairs, replacements, and adjustments are being made to place the crane handling system back into service after component failure(s).

Access to the Spent Fuel Bridge Crane in order to repair the hoist and the ability to take measures to assure the load will be retained in a safe, temporary position will not be a concern because the Spent Fuel Bridge Crane is located on the refuel floor, with easy personnel access at any location in its travel. It would be relatively easy to take measures to retain the TPBAR canister in place (by using a sling or another hoist/crane such as the Auxiliary Building Bridge Crane) with a minimum factor of safety of 10-1) because of its accessibility to personnel and because the load is relatively light (750 lb.). The TPBAR canister must be in the spent fuel pool as long as it contains TPBARs; therefore a safe laydown area would be limited to the spent fuel racks.

If the hoist/load becomes immobilized due to a hoist malfunction, the load could be temporarily rigged and either suspended in place or placed in a spent fuel rack utilizing another hoist (with a factor of safety of 10 to 1 minimum) while the original hoist is being repaired. If the trolley or bridge travel is affected, the hoist will be able to retain the load while repairs are in progress.

4.1 Reeving System

Requirement:

Component parts of the vertical hoisting mechanism are important. Specifically, the rope reeving system deserves special consideration during design of the system. The load-carrying rope will suffer accelerated wear if it rubs exclusively on the sides of the grooves in the drum and sheaves because of improper alignment or large fleet angles between the grooves. The load-carrying rope will furthermore suffer excessive loading if it is partly held by friction on the groove wall and then suddenly released to enter the bottom of the groove. The rope can be protected by the selection of conservative fleet angles. Ropes may also suffer damage due to excessive strain developed if the rope construction and the pitch diameter of the sheaves are not properly selected. Fatigue stress in ropes can be minimized when the pitch diameter of the sheaves is selected large enough to produce only nominal stress levels. The pitch diameter of the sheaves should be larger for ropes moving at the highest velocity near the drum and can be smaller for sheaves used as equalizers where the rope is stationary. Protection against excessive wire rope wear and fatigue damage can be ensured through scheduled inspection and maintenance.

Design of the rope reeving system(s) should be dual with each system providing separately the load balance on the head and load blocks through configuration of ropes and rope equalizer(s). Selection of the hoisting rope or running rope should include consideration of the size, construction, lay, and means or type of lubrication, if required to maintain

efficient working of the individual wire strands when each section of rope passes over the individual sheaves during the hoisting operation. The effects of impact loadings, acceleration, and emergency stops should be included in selection of rope reeving systems. The maximum load (including static and inertia forces) on each individual wire rope in the dual reeving system with the MCL attached should not exceed 10% of the manufacturer's published breaking strength.

The ratio of wire rope yield strength to ultimate strength may vary sufficiently for different production runs to influence the wire rope rating in such a manner that the initial safety margin selected would be too small to prevent the critical load from straining the wire rope material beyond the yield point under abnormal conditions. It would, therefore, be prudent to consider the wire rope yield strength as well as the ultimate strength when specifying wire rope in order to ensure the desired margin on rope strength.

The maximum fleet angle from drum to the lead sheave in the load block or between individual sheaves should not exceed 0.061 Rad (3-1/2°) at any one point during hoisting except that for the last 1 m (3 ft) of maximum lift elevation the fleet angle may increase slightly. The use of reverse bends[7] for running wire ropes should be limited, and the use of larger sheaves should be considered for those applications where a disproportionate reduction in wire rope fatigue life would be expected from the use of standard sheave diameters for reverse bends.

The equalizer for stretch and load on the rope reeving system may be of either beam or sheave type or combinations thereof. A dual rope reeving system with individual attaching points and means for balancing or distributing the load between the two operating rope reeving systems will permit either rope system to hold the critical load and transfer the critical load without excessive shock in case of failure of the other rope system.

The pitch diameter of running sheaves and drums should be selected in accordance with the recommendations of CMAA Specification # 70. The dual reeving system may be a single rope from each end of a drum terminating at one of the blocks or equalizer with provisions for equalizing beam-type load and rope stretch, with each rope designed for the total load. Alternatively, a 2-rope system may be used from each drum or separate drums using a sheave equalizer or beam equalizer or

any other combination that provides two separate and complete reeving systems.

The wire rope on this hoist is regularly inspected in accordance with site procedures. Accordingly, excessive wire rope wear and fatigue damage are not a concern. The reeving system on this hoist is not dual; however the factor of safety while lifting the MCL will be approximately 26 to 1. With this high factor of safety, the reeving will have an acceptable breaking strength.

The hoist for the spent fuel pit bridge crane incorporates a sheave type equalizer to assure that the load in the reeving system will be equally distributed by compensating for rope stretch or swinging of the block.

4.2 Drum Support

Requirement:

The load hoisting drum should be provided with structural and mechanical safety devices to limit the drop of the drum and thereby prevent it from disengaging from its holding brake system if the drum shaft or bearings were to fail or fracture.

While the hoist does not meet these requirements, the increased factor of safety (26 to 1) while lifting the MCL, as well as the fuel handling activities which precede consolidation activities, makes it very unlikely that the load hoisting drum will fail.

4.3 Head and Load Blocks

Requirement:

The head and load blocks should be designed to maintain a vertical load balance about the center of lift from load block through head block and have a reeving system of dual design.

The load-block assembly should be provided with two load-attaching points (hooks or other means) so designed that each attaching point will be able to support a load of three times the load (static and dynamic) being handled without permanent deformation of any part of the load-block assembly other than local strain concentration in areas for which additional material has been provided for wear.

The individual component parts of the vertical hoisting system components, which include the head block, rope,

reeving system, load block, and dual load-attaching device, should each be designed to support a static load of 200% of the MCL. A 200% static type load test should be performed for each load-attaching hook. Measurements of the geometric configuration of the hooks should be made before and after the test and should be followed by a nondestructive examination that should consist of volumetric and surface examinations to verify the soundness of fabrication and ensure the integrity of the hooks. The load blocks should be nondestructively examined by surface and volumetric techniques. The results of the examinations should be documented and recorded.

While the hoist does not have a reeving system of dual design, and the load block assembly is not provided with two load-attaching points, the factor of safety of this hoisting system for the MCL is in excess of 26 to 1 and is deemed acceptable. The hoist and crane are visually inspected at regular intervals, and the results are documented in accordance with procedure.

4.4 Hoisting Speed

Requirement:

Maximum hoisting speed for the critical load should be limited to that given in the "slow" column of Figure 70-6 of CMAA Specification #70.

Selection of hoisting speed is influenced by such items as reaction time for corrective action for the hoisting movement and the potential behavior of a failed rope. To prevent or limit damaging effects that may result from dangerous rope spin-off in case of a rope break, the hoisting speed should be limited. The rope traveling speed at the drum is higher than at other points in the reeving system, and the potential for damage due to rope failing and interference with other parts of the system should be considered. Conservative industry practice limits the rope line speed to 1/4 m/s (50 fpm) at the drum.

Drum speed is less than 50 fpm. Additionally, adverse inertial affects are diminished due to the MCL being less than 1/2 of the rated load.

4.5 Design Against Two-Blocking

Requirement:

A potential failure of a hoist travel-limit switch could result in a "two-block" incident and in the cutting or crushing of the wire rope. In order to protect the wire rope, the reeving system should be designed to prevent the cutting or crushing of the wire rope if a two-blocking incident were to occur.

The mechanical and structural components of the complete hoisting system should have the required strength to resist failure if the hoisting system should "two-block" or if "load hang-up" should occur during hoisting. The designer should provide means within the reeving system located on the head or on the load-block combinations to absorb or control the kinetic energy of rotating machinery during the incident of two-blocking. As an alternative, the protective control system to prevent the hoisting system from two-blocking should include, as a minimum, two independent travel limit switches of different designs and activated by separate mechanical means. These devices should de-energize the hoist drive motor and the main power supply. The protective control system for load hang-up, a part of the overload protection system, should consist of load cell systems in the drive train or motor-current-sensing devices or mechanical load-limiting devices. The location of mechanical holding brakes and their controls should provide positive, reliable, and capable means to stop and hold the hoisting drum(s) for the condition described in the design specification and in this recommendation. This should include capability to withstand the maximum torque of the driving motor if a malfunction occurs and power to the driving motor cannot be shut off. The auxiliary hoist, if supplied, should be equipped with two independent travel-limit switches to prevent two-blocking.

The SFP Bridge Crane has both a weighted mechanical limit switch and a geared limit switch to stop upward motion of the hoist. The hoist has a load monitor/limiter to assure that the hoist is not subjected to a load hang-up. The limit switches and load monitoring features are verified complete prior to each refueling outage.

4.6 Lifting Devices

Requirement:

Lifting devices that are attached to the load block such as lifting beams, yokes, ladle or trunnion-type hooks, slings, toggles, or clevises should be conservatively designed with a dual or auxiliary device or combinations thereof. Each device should be designed or selected to support a load of three times the load (static and dynamic) being handled without permanent deformation.

The special lifting device used to lift the MCL will meet applicable requirements of ANSI N14.6-1978, "Standard for Special Lifting Devices for Shipping Containers Weighing 10,000 lb. (4500 Kg) or More for Nuclear Materials."

4.7 Wire Rope Protection

Requirement:

Side loads would be generated to the reeving system if hoisting were done at angles departing from a normal vertical lift and resulting damage could be incurred in the form of excessive wear on sheaves and wire rope. A potential would also exist for the wire rope to be cut by jumping its groove barrier on the drum. If side loads cannot be avoided, the reeving system should be equipped with a guard that would keep the wire rope properly located in the grooves on the drum.

This SFP crane is used to lift spent fuel bundles and will be used in the future to lift the TPBAR canisters. The bridge crane is designed to provide control to raise and lower spent fuel into the racks. The design of the handling tool and the required crane alignment necessary to engage the canister precludes side loading. Therefore, no special guard will be required on the hoist reeving.

4.8 Machinery Alignment

Requirement:

Power transmission gear trains are often supported by fabricated weldments of structural parts. The proper alignment of shafts and gears depends on the adequacy of bearings and their supports to maintain correct alignment of all components. The proper functioning of the hoist machinery during load handling can best be ensured by providing adequate support strength of the individual components parts and the welds or bolting that binds them

together. Where gear trains are interposed between the holding brakes and the hoisting drum, these gear trains should be single failure proof and should be of dual design.

This hoist was constructed as a production package by an experienced manufacturer. This hoist has been utilized for many years without internal hoist package alignment problems. Additionally, since the alignment issue is related to structural adequacy and the MCL is less than 1/2 of the hoist capacity, the potential for malfunctions due to misalignment are negligible.

4.9 Hoist Braking System

Requirement:

Mechanical holding brakes in the hoisting system (raising and lowering) that are automatically activated when electric power is off or mechanically tripped by overspeed devices or overload devices in the hoisting system will help ensure that a critical load will be safely held or controlled in case of failure in the individual load-bearing parts of the hoisting machinery.

Each holding brake should have more than full-load stopping capacity but should not have excessive capacity that could cause damage through sudden stopping of the hoisting machinery. A minimum brake capacity of 125% of the torque developed during the hoisting operation at the point of brake application has been determined to be acceptable.

The minimum hoisting braking system should included one power control braking system (not mechanical or drag brake type) and two holding brakes. The holding brakes should be applied when power is off and should be automatically applied on overspeed to the full holding position if a malfunction occurs. Each holding brake should have a torque rating not less than 125% of the full-load hoisting torque at point of application (location of the brake in the mechanical drive). The minimum number of braking systems that should be operable for emergency lowering after a single brake failure should be two holding brakes for stopping and controlling drum rotation.

The holding brake system should be single failure proof; i.e., any component or gear train should be dual if interposed between the holding brakes and the hoisting drums. The dynamic and static alignment of all hoisting machinery components, including gearing, shafting, couplings, and bearings, should be maintained throughout the range of loads

to be lifted, with all components positioned and anchored on the trolley machinery platform.

Manual operation of the holding brakes may be necessary during an emergency condition, and provision for this should be included in the design conditions. Adequate heat dissipation from the brake should be insured so that damage does not occur if the lowering velocity is permitted to increase excessively. It may be necessary to stop the lowering operation periodically to prevent overheating and permit the brake to dissipate the excess heat.

Portable instruments should be used to indicate the lowering speed during emergency operations. If a malfunction of a holding brake were to occur and emergency lowering of the load become necessary, the holding brake should be restored to working condition before any lowering is started.

The hoist has both a direct acting magnetic brake to stop rotation when the power is off, and a disc type brake to stop the load when desired. Also, since the MCL is less than ½ of the hook capacity, the braking system is significantly oversized for this lift.

5.0 BRIDGE AND TROLLEY

5.1 Braking Capacity

Requirement:

Failure of the bridge and trolley travel to stop when power is shut off could result in uncontrolled incidents. This would be prevented if both bridge and trolley drives are provided with control and holding braking systems that would be automatically applied when the power is shut off or if an overspeed or overload condition occurs because of malfunction or failure in the drive system.

To avoid the possibility of drive motor overtorque within the control system, the maximum torque capability of the drive motor and gear reducer for trolley motion and bridge motion of the overhead bridge crane should not exceed the capability of gear train and brakes to stop the trolley or bridge from the maximum speed with the DRL attached. Incremental or fractional inch movements, when required should be provided by such items as variable speed controls or inching motor drives. Control and holding brakes should each be rated at 100% of maximum drive torque that can be developed at the point of application. If two mechanical brakes, one for control and one for holding, are provided, they should be adjusted with one brake in each system leading the other and should be activated by release or shutoff of power. This applies to both trolley and bridge. The brakes should also be mechanically tripped to the "on" "holding" position in the event of a malfunction in the power supply or an overspeed condition. Provisions should be made for manual emergency operation of the brakes. The holding brake should be designed so that it cannot be used as a foot-operated slowdown brake. Drag brakes should not be used. Mechanical drag-type brakes are subject to excessive wear, and the need for frequent service and repair tends to make this type of brake less reliable; they should therefore not be used to control movements of the bridge and trolley.

Opposite-driven wheels on bridge or trolley that support bridge or trolley on their runways should be matched and should have identical diameters.

Trolley and bridge speed should be limited. The speed limits indicated for slow operating speeds for trolley and bridge in specification CMAA #70 are recommended for handling MCLs.

The trolley operation is a manual chain drive, therefore there are no loss of power, torque, braking, over-speed, overload or operating speed issues associated with the trolley.

The bridge drive is two speed (13.5 - 30 fpm). End stops are provided for both the bridge and trolley. Because the trolley is manual, no trolley brakes are required. Bridge and hoist movement is provided with an interlock. The MCL is less than one half of the crane capacity, thereby reducing braking requirements. Additionally, because the TPBARs are protected by the canister, in the highly unlikely event that the bridge drives it into the SFP wall or other structure, braking issues are not of major concern for TPBAR protection.

5.2 Safety Stops

Requirement:

Limiting devices, mechanical and/or electrical, should be provided to control or prevent overtravel and overspeed of the trolley and bridge. Buffers for bridge and trolley travel should be included at the ends of the rails.

Safety devices such as limit-type switches provided for malfunction, inadvertent operator action, or failure should be in addition to and separate from the limiting means or control devices provided for operation.

Both Bridge and Trolley have vendor supplied bridge and trolley stops.

6.0 DRIVERS AND CONTROLS

6.1 Driver Selection

Requirement:

The horsepower rating of the hoist driving motor should be matched with the calculated requirement that includes the design load and acceleration to the design hoisting speed. Overpowering of the hoisting equipment would impose additional strain on the machinery and load-carrying devices by increasing the hoisting acceleration rate.

To preclude excessive drive motor torque, the maximum torque capability of the electric motor drive for hoisting should not exceed the rating or capability of the individual components of the hoisting system required to hoist the MCL at the maximum hoisting speed. Overpower and overspeed conditions should be considered an operating hazard as they may increase the hazard of malfunction or inadvertent operation. It is essential that the controls be capable of stopping the hoisting movement within amounts of movement that damage would not occur. A maximum hoisting movement of 8 cm (3 inches) would be an acceptable stopping distance.

Normally a crane system is equipped with mechanical and electrical limiting devices to shut off power to driving motors when the crane hook approaches the end of travel or when other parts of the crane system would be damaged if power were not shut off. It is prudent to include safety devices in the control system for the crane, in addition to the limiting devices, for the purpose of ensuring that the controls will return to or maintain a safe holding position in case of malfunction. Electric circuitry design should be carefully considered so that the controls and safety devices ensure safe holding of the critical load when called upon to perform their safety function. For elaborate control systems, radio control, or ultimate control under unforeseen conditions of distress, an "emergency stop button" should be placed at ground level to remove power from the crane independently of the crane controls. For cranes with a DRL rating much higher than the MCL rating, it may be necessary to provide electrical or mechanical resetting of overload sensing devices when changing from one operation to the other. Such resetting should be made away from the operator cab location and should be included in an administrative control program.

The hoist motor was sized to lift spent fuel bundles, which weigh approximately 2000 lbs. The hoist is a standard package supplied by a vendor for the DRL. As a result, drivers are considered oversized for the MCL and are considered acceptable. Resetting of the load sensing device will be required and procedurally controlled when switching between fuel handling and TPBAR consolidation evolutions.

6.2 Driver Control Systems

Requirement:

The control systems should be designed as a combination of electrical and mechanical systems and may include such items as contactors, relays, resistors, and thyristors in combination with mechanical devices and mechanical braking systems. The control system(s) provided should include consideration of the hoisting (raising and lowering) of all loads, including the rated load, and the effects of the inertia of the rotating hoisting machinery such as motor armature, shafting and coupling, gear reducer, and drum. If the crane is to be used for lifting spent fuel elements, the control system should be adaptable to include interlocks, that will prevent trolley and bridge movements while the load is being hoisted free of a reactor vessel or a storage rack, as may be recommended in Regulatory Guide 1.13, "Spent Fuel Storage Facility Design Basis."

The control system provided with this SFP crane was designed for hoisting loads in the spent fuel pool. The bridge drive and the hoist are interlocked on this crane to prohibit simultaneous operation of the bridge and hoist. The crane system is designed to lift the weight of fuel bundles, and is of sufficient capacity to make these lifts. It is also of sufficient capacity to perform the TPBAR canister lift.

6.3 Malfunction Protection

Requirement:

Means should be provided in the motor control circuits to sense and respond to such items as excessive electric current, excessive motor temperature, overspeed, overload, and overtravel. Controls should be provided to absorb the kinetic energy of the rotating machinery and stop the hoisting movement reliably and safely through a combination of electrical power controls and mechanical braking systems and torque controls if one rope or one of the dual reeving systems should fail or if overloading or an overspeed condition should occur.

The SFP crane is a standard hoist package from an experienced vendor. Overload protection, etc. is commensurate with requirements of ANSI B30.16. Furthermore, since the MCL is less than one half of the hook capacity and the crane routinely handles much heavier loads, these protective features are less significant.

6.4 Slow speed drives

Requirement:

Increment drives for hoisting may be provided by stepless controls or inching motor drive. If jogging or plugging is to be used, the control circuit should include features to prevent abrupt change in motion. Drift point in the electric power system when provided for bridge or trolley movement should be provided only for the lowest operating speeds.

The SFP crane has been designed for fuel handling. As such, it is well suited to handling the lighter TPBAR consolidation canister between the SFP racks, the consolidation fixture, or the transportation cask. Travel speeds, jogging functions, etc., needed for consolidation are compatible with those needed for fuel handling activities.

6.5 Safety Devices

Requirement:

Safety devices such as limit-type switches provided for malfunction; inadvertent operator action, or failure should be in addition to and separate from the limiting means or control devices provided for operation.

The additional safety feature of the analyzed protective canister, lifting device with increased safety factors, additional administrative limitations, and the handling lanyard are in addition to the limiting means or control devices provided for normal crane operation.

6.6 Control Stations

Requirement:

The complete operating control system and provisions for emergency controls for the overhead crane handling system should preferably be located in a cab on the bridge. When additional operator stations are considered, they should have control systems similar to the main station. Manual controls for the bridge may be located on the bridge. Remote control or pendant control for any of these motions should be

identical to those provided ion the bridge cab control panel. Cranes that use more than one control station should be provided with electrical interlocks that permit only one control station to be operable at any one time. In the design of the control systems, provision for and locations of devices for control during emergency conditions should be provided.

This requirement is for a crane with a cab. Because the crane does not have a cab or a multiple control station, this requirement is not applicable.

7.0 INSTALLATION INSTRUCTIONS

7.1 General

Requirement:

Installation instructions should be provided by the manufacturer. These should include a full explanation of the crane handling system, its controls, and the limitations for the system and should cover the requirements for installation, testing, and preparations for operation.

The crane has been installed for several years. The vendor submitted technical drawings and Operation Manuals to explain the above.

7.2 Construction and Operating Periods

Requirement:

When the permanent plant crane is to be used for construction and the operating requirements for construction are more severe than those required for permanent plant service, the construction operating requirements should be defined separately. The crane should be designed structurally and mechanically for the construction loads, plant service loads, and their functional performance requirements. At the end of the construction period, the crane handling system should be modified as needed for the performance requirements of the nuclear power plant operating service. After construction use, the crane should be thoroughly inspected by nondestructive examination and load tested for the operating phase. The extent of nondestructive examination, the procedures used, and the acceptance criteria should be defined in the design specification. If allowable design stress limits for the plant operating service are to be exceeded during the construction phase, added inspection

supplementing that described in section 2.6 should be specified and developed.

During and after installation of the crane, the proper assembly of electrical and structural components should be verified as to satisfaction of installation and design requirements.

This SFP crane was used sparingly during construction because of its limited range and capacity (only can be used to make lifts in the spent fuel pool). Additionally, any use of this crane during construction was consistent with use during fuel handling operations. As a result, no additional requirements, examinations, or modifications are warranted.

8.0 TESTING AND PREVENTIVE MAINTENANCE

8.1 General

Requirement:

A complete check should be made of all the crane's mechanical and electrical systems to verify the proper installation and to prepare the crane for testing.

Information concerning proof testing on components and subsystems that was required and performed at the manufacturer's plant to verify the ability of components or subsystems to perform should be available for the checking and testing performed at the place of installation of the crane system.

The SFP crane/hoist have been in service for years and are operating normally. Proper operation and crane condition is verified prior to each refueling outage.

8.2 Static and Dynamic Load Tests

Requirement:

The crane system should be static load tested at 125% of the MCL. The tests should include all positions generating maximum strain in the bridge and trolley structures and other positions as recommended by the designer and manufacturer. After satisfactory completion of the 125% static test and adjustments required as a result of the test, the crane handling system should be given full performance tests with 100% of the MCL for all speeds and motions for which the system is designed. This should include verifying all limiting and safety control devices. The features provided for manual lowering of the load and manual movement of the

bridge and trolley during an emergency should be tested with the MCL attached to demonstrate the ability to function as intended.

The crane routinely lifts approximately 2000 lbs during refueling outages. It is procedurally checked out prior to outages and inspected. Since the crane is designed for more than double the MCL, and since it is routinely inspected at regular intervals, it is acceptable without further testing.

8.3 Two-Block Test

Requirement:

When equipped with an energy-controlling device between the load and head blocks, the complete hoisting machinery should be allowed to two-block during the hoisting test (load block limit and safety devices are bypassed). This test, conducted at slow speed without load, should provide assurance of the integrity of the design, the equipment, the controls, and the overload protection devices. The test should demonstrate that the maximum torque that can be developed by the driving system, including the inertia of the rotating parts at the overtorque condition, will be absorbed or controlled during a two-blocking or load hang-up. The complete hoisting machinery should be tested for ability to sustain a load hang-up condition by a test in which the load-block attaching points are secured in a fixed anchor or excessive load. The crane manufacturer may suggest additional or substitute test procedures that will ensure the proper functioning of protective overload devices.

The hoist is not equipped with energy controlling devices; therefore, a two-block test would be unacceptable. This hoist utilizes a load monitor/limiter to assure that any load hang-up will not damage the crane. Additionally, the hoist is equipped with dual limit switches to assure that it does not two-block.

8.4 Operational Tests

Requirement:

Operational tests of crane systems should be performed to verify the proper functioning of limit switches and other safety devices and the ability to perform as designed. However, special arrangements may have to be made to test overload and overspeed sensing devices.

The SFP crane has been installed and operating adequately for years. Proper functioning and condition of components associated with the crane are verified periodically by procedural testing.

8.5 Maintenance

Requirement:

After installation, equipment usually suffers degradation due to use and exposure. A certain degree of wear on such moving parts as wire ropes, gearing, bearings, and brakes will reduce the original design factors and the capacity of the equipment to handle the rated load. With good maintenance practice, degradation is not expected to exceed 15% of the design load rating, and periodic inspection coupled with a maintenance program should ensure that the crane is restored to the design condition if such degradation is found. Essentially, the MCL rating of the crane should be established as the rated load capacity, and the design rating for the degradable portion of the handling system should be identified to obtain the margin available for the maintenance program. The MCL should be plainly marked on each side of the crane for each hoisting unit. It is recommended that the critical-load-handling cranes should be continuously maintained above MCL capacity.

An inspection procedure is currently in place to assure that the SFP crane is well maintained. The crane is a special purpose crane and is not capable of miscellaneous lifts. Therefore markings other than required by ANSI B30.16 are not necessary.

9.0 OPERATING MANUAL

Requirement:

The crane designer and crane manufacturer should provide a manual of information and procedures for use in checking, testing and operating the crane. The manual should also describe a preventive maintenance program based on the approved test results and information obtained during the testing. It should include such items as servicing, repair, and replacement requirements, visual examinations, inspections, checking, measurements, problem diagnosis, nondestructive examination, crane performance testing, and special instructions.

The operating instructions for all travel movements (vertical and horizontal movements or rotation, singly or in combination) incorporated in the design for permanent plant cranes should be clearly defined in the operating manual for

hoisting and for trolley and bridge travel. The designer should establish the MCL rating and the margin for degradation of wear susceptible component parts.

Vendor Manuals were provided when the crane was purchased. The manuals contain information such as operation information, preventive maintenance, servicing, repair, and problem diagnosis. Procedures have been written to provide guidance on items such as testing and inspecting the crane, visual examinations, crane performance testing, and operating instructions.

10. QUALITY ASSURANCE

Requirement:

Although crane handling systems for critical loads are not required for the direct operation of a nuclear power plant, the nature of their function makes it necessary to ensure that the desired quality level is obtained. A quality assurance program should be established to the extent necessary to include the recommendations of this report for the design, fabrication, installation, testing and operation of crane handling systems for safe handling of critical loads.

In addition to the quality assurance program established for site assembly, installation, and testing of the crane, applicable procurement documents should require the crane manufacturer to provide a quality assurance program consistent with the pertinent provisions of Regulatory Guide 1.28, "Quality Assurance Program Requirements (Design and Construction)," to the extent necessary.

The program should address all the recommendations in this report. Also included should be qualification requirements for crane operators.

Quality Assurance (QA) for the crane is established by the site. Modifications, tests, repairs and inspections performed on the crane are performed in accordance with TVA QA requirements. Qualifications for crane operators are outlined in TVA procedures.