Attachment 6

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LIFTING DEVICES AND LIFTING POINTS

STRESS ANALYSIS FOR FUEL POOL GATE LIFTING POINTS, HYDRAULIC TENSIONER LIFTING DEVICE AND LIFTING POINTS, AND REACTOR PRESSURE VESSEL INSULATION REMOVAL LIFTING DEVICE AND REACTOR PRESSURE VESSEL INSULATION LIFTING POINTS TO COMPLY WITH NUREG 0612

FOR

PEACH BOTTOM UNITS 2 AND 3

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ABSTRACT

Stress analyses have been performed for heavy loads handling equipment to determine whether the General Electric (GE) supplied lifting devices and lifting points of the Reactor Pressure Vessel (RPV) insulation removal lifting device, RPV insulation, fuel pool gate and hydraulic tensioner for Peach Bottom Units 2 and 3 are in compliance with the recommendations of NUREG 0612. The analyses indicate that all the above mentioned equipment meets the guidelines set by NUREG 0612 with the exception of the Unit 2 hydraulic tensioner. The hydraulic tensioner component which does not comply with the NUREG 0612 criteria is identified in Section 6.5.5 of this report. A recommendation to satisfy NUREG 0612 criteria is provided in Section 4.0 of this report.

1.0 INTRODUCTION

In nuclear plant operation, maintenance and refueling activities, heavy loads may be handled in several plant areas. If these loads were to drop, they could impact on stored fuel, fuel in the core, or equipment that may be required to achieve safe shutdown or permit continued decay heat removal. If sufficient stored fuel or fuel in the core were damaged and if the fuel is highly radioactive due to its irradiation history, the potential releases of radioactive material could result in offsite doses that exceed 10 CFR Part 100 limits.

For the purpose of NUREG 0612 (reference 1) a heavy load is defined as a load whose weight is greater than the combined weight of a single fuel assembly and its handling tool.

The purpose of this heavy load stress analysis is to evaluate whether the GE supplied lifting devices and lifting points meet the criteria of NUREG 0612 sections 5.1.1(4), 5.1.6(1) and 5.1.6(3).

The workscope includes (1) search of existing QA records for material mechanical properties and any material deviation, (2) field survey to document the hardware as-built configuration, (3) stress calculation to check compliance with NUREG 0612 criteria, and (4) identification of alternatives for PECO to evaluate if non-compliance is indicated. The following lifting devices and lifting points are analyzed:

1. RPV insulation lifting points
   GE VPF #2641-14-6 for both units (reference 2).

2. RPV insulation removal lifting device [hereafter referred to as the RPV strongback as per telecon PECO (W. Alexander, R. Scott) and GE (D. Townsend) dated March 26, 1982]
   GE drawing #729E413, Rev. 9 for both units (reference 3)

3. Fuel Pool Gate Lifting Points
GE drawing #718E865, Rev. 4 for both units (reference 4)

4. Hydraulic Tensioner Lifting Device and Lifting Points
Diamond Power Specialist Corporation drawing #701334-1842, Rev. F (reference 5).

2.0 NUREG 0612 AND ANSI N146-1978 GUIDELINES

The sections which are related to special lifting devices and lifting points are as follows:

2.1 NUREG 0612

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." 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.

5.1.6(1) Lifting Devices:

(a) Special lifting devices that are used for heavy loads in the area where the crane is to be upgraded should meet ANSI N14.6 1978, "Standard for Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More for Nuclear Materials." As specified in Section 5.1.1(4) of this report except that the handling device should also comply with Section 6 of ANSI N14.6-1978. If only a single lifting device is provided instead of dual devices, the special lifting device should have twice the design safety factor as required to satisfy the guidelines of Section 5.1.1(4). However, loads that have been evaluated and shown to satisfy the evaluation criteria of Section 5.1 need not have lifting devices that also comply with Section 6 of ANSI N14.6.

5.1.6(3) Interfacing lift points such as lifting lugs or cask trunnions should also meet one of the following for heavy loads handled in the area where the crane is to be upgraded unless the effects of a drop of the particular load have been evaluated and shown to satisfy the evaluation criteria of Section 5.1:

(a) Provide redundancy or duality such that a single lift point failure will not result in uncontrolled lowering of the load; lift points should have a design safety factor with respect to ultimate strength of five (5) times the maximum combined concurrent static and dynamic load after taking the single lift point failure, or

(b) A non-redundant or non-dual lift point system should have a design safety factor of ten (10) times the maximum combined concurrent static and dynamic loads.

2.2 ANSI N14.6-1978 (reference 6)

3.2.1.1 The load-bearing members of a special lifting device shall be capable of lifting three times the combined weight of the shipping container with which it will be used, plus the weight of intervening components of the special lifting device, without generating a combined shear stress or maximum tensile stress at any point in the device in excess of the corresponding minimum yield strength of their material at construction. They shall also be capable of lifting five times the weight without exceeding the ultimate strength of the materials. Some materials have yield strengths very close to their ultimate strength. When materials that have yield strengths above 80% of their ultimate strength are used, each case requires special consideration, and the foregoing stress design factors do not apply. Design shall be on the basis of the material's fracture toughness, and the designer shall establish the criteria.

6. Special Lifting Devices for Critical Loads

6.1 General When special requirements call for the handling of a critical load, the crane performing the hoisting and transporting shall have special features, such as increased stress design factors or a dual-load-path hoisting system. The special lifting device used with a crane such as this shall have either of the following:

(1) Load-bearing members with increased stress design factors for handling the critical load

(2) A design such that while handling critical loads a single component failure or malfunction will not result in uncontrolled lowering of the load.

6.2 Design Criteria

6.2.1 A special lifting device designed with increased stress design factors instead of a dual-load path shall have its load-bearing members designed with at least twice the normal stress design factor for handling the critical load.

6.2.2 The attachment from a critical load handling crane with a dual-load-path hoisting system to the special lifting device shall be such that two separate and distinct load paths are provided. In the event that one path fails, the second path shall continue to hold the shipping container for transport to a setdown area.

The dual-load-path attachment points on the special lifting device shall be so designed that each load path will be able to support a static load of 3W ("W" being the weight of the critical load, including intervening components of the lifting device) plus the impact load

due to any weight transfer that occurs due to failure of one load path, without exceeding the yield point of the material.

6.2.4 In the event of a failure of one of the dual-load paths, the weight of the container is transferred from one load path to the other. Any expected increase in stress level shall be within design limits of all components, including those of the crane hoisting system. Provision should be made to minimize the time and distance for load transfer.

6.2.5 If it is intended that the load be shared between the two load paths by maintaining approximately zero slack in either path, then provision shall be included to allow for load-path slack takeup.

6.2.6 The special lifting device shall be designed to maintain a vertical load balance about the center of lift during its normal attachment.

3.0 CONCLUSION

The lifting points of the large and small fuel pool gates for each unit meet the NUREG 0612 criteria. The maximum combined load does not exceed the allowable stresses based on the ultimate strength of the material with a single load path (see Table 1).

The RPV insulation removal lifting points for each unit meet the NUREG 0612 criteria. The maximum combined load does not exceed the allowable stresses based on the ultimate strength of the materal with a dual load path (see Table 1).

The RPV head strongback for each unit, with the RPV head insulation as the working load, meets the NUREG 0612 criteria. The maximum combined load does not exceed the allowable stresses based on the ultimate strength of the material with a dual load path (see Table 1).

The hydraulic tensioner lifting device for each unit meets the NUREG 0612 criteria. The maximum combined load does not exceed the allowable stresses based on the ultimate strength of the material with a dual and a single load path. However, the hydraulic tensioner lifting attachments for unit 2 do not comply with NUREG 0612 criteria in that the resulting stresses exceed the allowable stresses (see Table 2).

Information pertaining to the hydraulic tensioner support cables (see Figure 3) and attaching devices (shackles, turnbuckles, etc.) was not available. Therefore, the cables and attaching devices in use must be capable of supporting the "Safe Working Load" designated in Section 6.5.7 of this report in order to satisfy NUREG 0612 criteria.

TABLE 2

Hydraulic Tensioner Lifting Device and Lifting Points

LOAD PATH	SATISFY NUREG 0612 YES	NO	REFERENCE SECTIONS
Hydraulic Tensioner Lifting Device & Lifting Points			
Support Beam	X		6.5.1
Support Pipe	X		6.5.2
Pipe-Beam Interface Point	X		6.5.3
Lifting Box	X		6.5.4
Lifting Attachments			6.5.5
Unit 2		X	
Unit 3	X		
Hydraulic Tensioner Support Points	X		6.5.6

4.0 RECOMMENDATIONS

Hydraulic Tensioner Lifting Attachments (Unit 2)

The hydraulic tensioner lifting attachments for Unit 2 which do not meet the criteria of NUREG 0612 are the "C-shaped" attachment points identified in Figure 4-2. GE recommends that the Unit 2 lifting attachments be replaced with the same type lifting attachments as used on Unit 3 (Figure 4-1).

5.0 RECORD SEARCH

A record search was performed for the heavy load handling equipment indicated in this report. The available records, including QA records and drawings, were used for dimensional information, material specifications and welding specifications. For the hydraulic tensioner lifting device and lifting points, field measurements were used to supplement available information.

Most materials used are as specified in the parts list of the drawings or specifications, although the hydraulic tensioner lifting device and lifting points were assumed to be ASTM A36 since no material specifications were available.

6.0 ANALYSIS

The RPV head strongback, RPV insulation lifting points, fuel pool gate lifting points and hydraulic tensioner lifting device and lifting points were not designed for carrying critical loads. Even though the travel path of the crane which carries the heavy load does not pass over the fuel storage pool or the safe shutdown equipment, a load drop could result in damage to equipment required for safe shutdown or decay heat removal according to Section 5.1.6(1) of NUREG 0612. Therefore, the above heavy load equipment is considered as carrying critical loads.

6.1 Assumptions

- The dynamic load is 15% of the static load for a maximum crane speed of 5 feet per minute (reference 7).

- The RPV head strongback and the hydraulic tensioner lifting device are considered to be carrying critical loads and provided with dual load paths. These lifting devices should be capable of lifting the combined static and dynamic loads with two arms (two lifting points) without exceeding the allowable stresses.

  For Lifting Devices (RPV head strongback and hydraulic tensioner lifting device)

  dual load path[2] (Section 2 (5.1.6(1)))

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(2) Dual Load Path - each load path will be able to support a combined static and dynamic load due to any weight transfer that occurs resulting from failure of one of the load paths.

$$\sigma \text{Allowable} = \frac{\sigma_y}{(3)} \text{ or } \frac{\sigma_u}{(5)} \text{ whichever is smaller}$$

where σ_y - yield strength

σ_u - ultimate strength

<u>For Lifting Points</u> (RPV head insulation lifting points and hydraulic tensioner lifting points)

dual load path (section 2 (5.1.6(3b)))

$$\sigma \text{Allowable} = \frac{\sigma_u}{(5)}$$

- o The fuel pool gate lifting points were analyzed based on critical load critiera for a single load path. Therefore, the allowable stresses are:

$$\sigma \text{Allowable} = \frac{\sigma_u}{(10)}$$

- o No material specification information can be found on the hydraulic tensioner lifting device. Therefore, GE assumed the material to be ASTM A36. This steel was chosen because it is inexpensive, commonly used in design and it provides conservative results.

- o The allowable shear stress is half of the allowable tensile stress based on maximum-shear stress theory (reference 8).

- o A single component failure in the lifting device will not result in uncontrolled lowering of the load.

- o For lifting devices and lifting points carrying a critical load with a redundant load path, the safety factor (with respect to the material ultimate strength) is five times the maximum combined static and dynamic loads.

- o Unless specifically noted in the analysis, ASTM specifications for material ultimate and yield strengths will be used.

- The turnbuckles are assumed to evenly distribute the load among lifting points by achieving zero slack so that the lifting devices are horizontal during transportation.

- Conservative values of field-measured dimensions of Peach Bottom Units 2 and 3 were utilized for several calculations. These calculations are applicable to both units.

6.2 RPV Head Strongback

The RPV head strongback is designed for lifting the RPV head and drywell head in conjunction with the crane hook. (The single failure-proof hook is not in the scope of this analysis.) In addition, this equipment is also used to lift the RPV head insulation.

The strongback is a cruciform shaped structure with four equally spaced lifting points and a hook box in the center for engaging it to the crane hook. Turnbuckles and shackles are suspended on each arm for engaging to the lifting points of the RPV head insulation structure (see Figure 1 for illustration). The maximum bending moment for this evaluation is considered to be half the combined load of the RPV insulation structure concentrated on a span equal to the span of the drywell head points or the RPV insulation lifting points (2L .).

The RPV head strongback was first analyzed where the working loads were the RPV head and the drywell head. The results of this analysis, seen in NSE report 50-0582, (reference 9), show that particular components of the strongback did not meet NUREG 0612 for these loads. However, since the RPV head insulation structure is a much lighter load than either the RPV head or the drywell head, only those components of the strongback that did not meet NUREG 0612 have to be reanalyzed for the new loading condition.

The following components of the RPV head strongback were reanalyzed using the RPV head insulation structure as the working load.

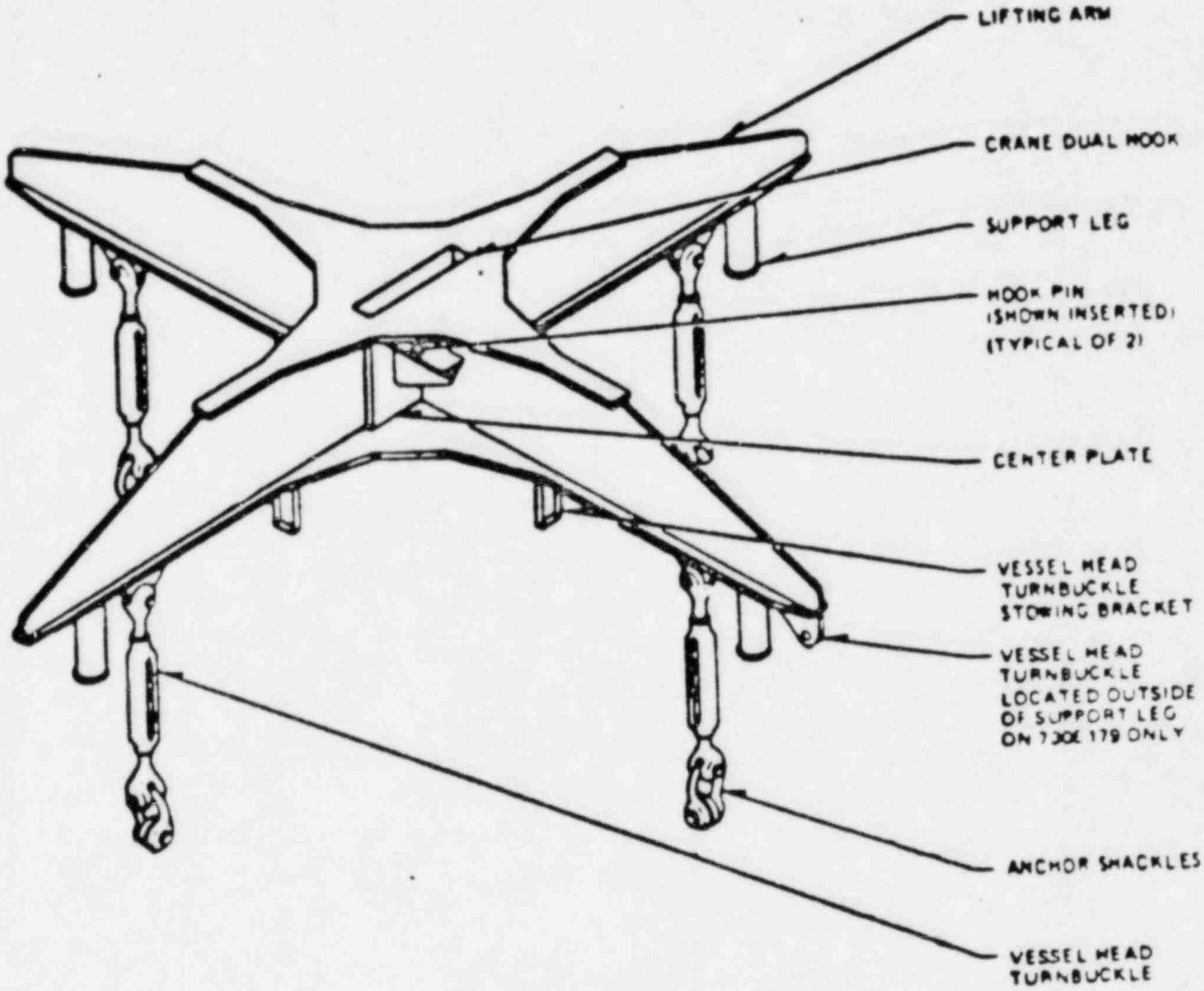

Figure 1. RPV HEAD STRONGBACK

A) hook pin (lower)

B) Section A-A

B-B

D-D

C) Lug Plate

D) Turnbuckles

RPV Head Strongback (GE drawing #729E413)

6.2.1 Hook Pin (Lower Pin) (Quantity = 1) (GE drawing #131C7969)

Material ASTM A519

Ultimate Stress = 120 ksi

Yield Stress = 100 ksi

Allowable Tensile Stress = 24.0 ksi

Allowable Shear Stress = 12.0 ksi

Estimated Static Weight of the Strongback = 34 kips

Estimated Static Weight of the RPV insulation = 11.4 kips

Applied Load = 1.15 (34 + 11.4) = 52.2 kips

Shear Stress = 2.93 ksi < 12.0 ksi

Bending Stress = 6.72 ksi < 24.0 ksi

The lower hook pin satisfies NUREG 0612 criteria.

6.2.2 Cruciform Arms

Sections A, B, C, D and E are shown on Figure 2.

Material: ASTM A36

Ultimate Strength = 67.8 ksi (from certified material properties)

Yield Strength = 43.8 ksi (from certified material properties)

Allowable Tensile Stress = 13.6 ksi

Allowable Shear Stress = 6.8 ksi

Section A Compressive Stress = 0.89 ksi < 13.6 ksi (allowable tensile stress)

Tensile Stress = 1.28 ksi < 13.6 ksi

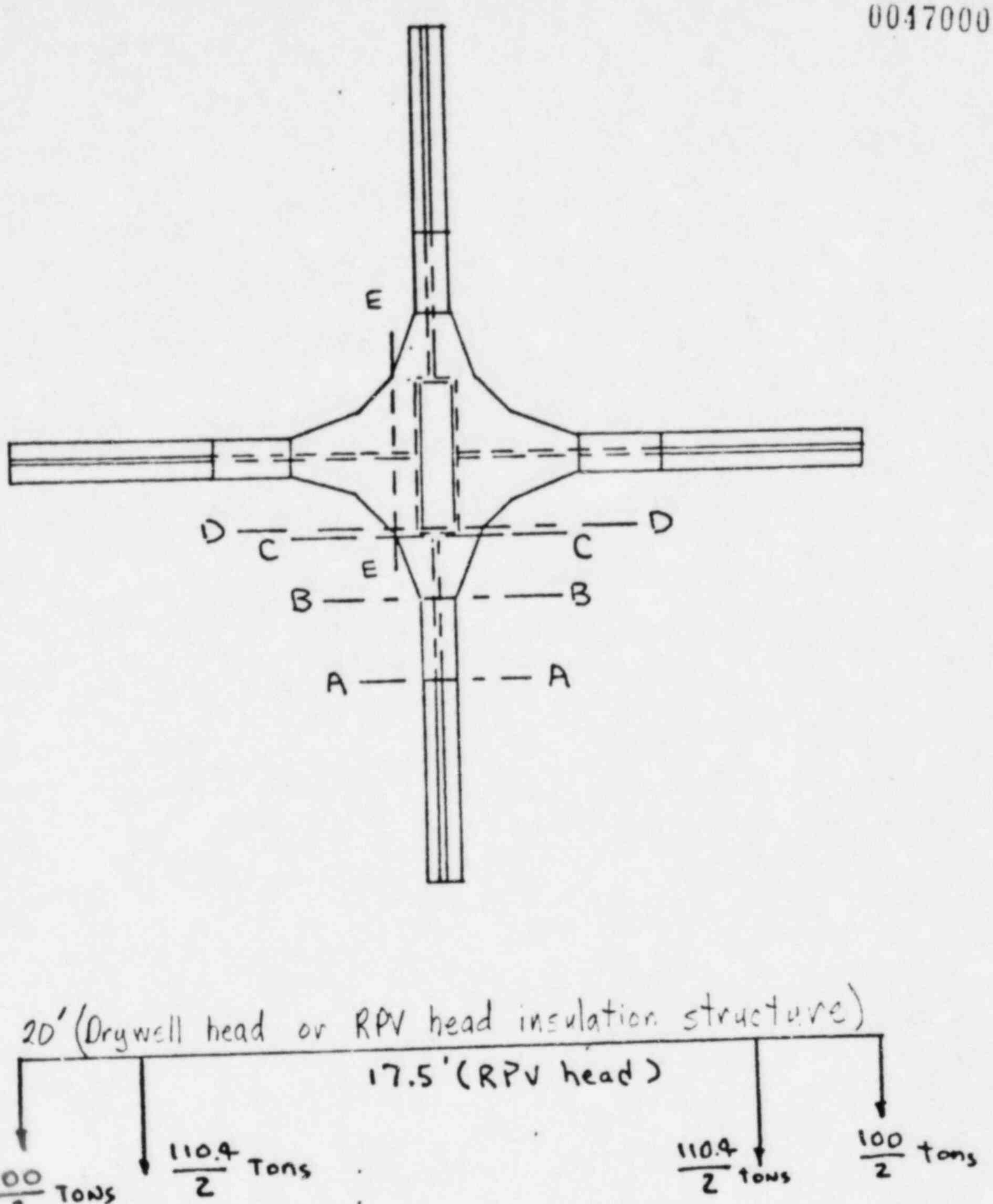

Figure 2. RPV HEAD STRONGBACK SECTION LAYOUT

Section B Tensile Stress = 1.30 ksi < 13.6 ksi
Compressive Stress = 1.30 ksi < 13.6 ksi

Section D Tensile Stress = 1.11 ksi < 13.6 ksi

The local/lateral buckling, flange stress, web crippling and web depth have been examined and satisfy the AISC specifications (reference 10) for all above sections (reference 9).

Sections A, B and D of the cruciform arms satisfy NUREG 0612 criteria.

6.2.3 Strongback Lifting Points (Lug Plate) (the allowable stresses are the same as the cruciform arms)

Material: ASTM A36
Applied Load = 6.6 kips
Tensile Stress in Plate = 4.95 ksi < 13.6 ksi
Shear Stress (tearout) 3.86 ksi < 6.8 ksi

The strongback lifting lugs satisfy NUREG 0612 criteria.

6.2.4 2-3/4" x 24" Turnbuckles Crosby Laughlin Cat. #G228

Safe Working Load = 75.0 kips
Applied Load = 6.6 kips < 75.0 kips

The turnbuckles satisfy NUREG 0612 criteria.

6.3 RPV Insulation Lifting Points (Quantity 4)

The RPV head insulation is a dome-like structure which fits over and thermally insulates the RPV head from its surroundings. It is a beam type structure with insulation panels attached around its periphery. The structure has four lifting points which engage with the RPV head strongback for installation and removal.

Static Weight by calculation = 13.2 kips

Material: AISI 1020 (VPF #2641-14-6) (RPV insulation lifting points)

ASTM A36 (VPF #2641-14-6) (base metal)

Minimum Ultimate Stress = 60 ksi (RPV insulation lifting points)

Minimum Ultimate Stress = 58 ksi (base metal)

Allowable Tensile Stress = 12.0 ksi (RPV insulation lifting points)

Allowable Tensile Stress = 11.6 ksi (base metal)

Allowable Shear Stress = 6.0 ksi (RPV insulation lifting points)

Allowable Shear Stress = 5.8 ksi (base metal)

Vertical Applied load per lug = 6.6 kips

Tensile Stress = 5.85 ksi < 12.0 ksi (allowable tensile stress)

Shear Stress = 4.39 ksi < 6.0 ksi (allowable shear stress)

Welds for lifting point to structure:

Actual tensile stress = 2.86 ksi < 11.6 ksi

Actual shear stress = 1.98 ksi < 5.8 ksi

RPV head insulation lifting lugs satisfy NUREG 0612 criteria.

6.4 Fuel Pool Gate Lifting Points (GE drawing #718E865)

The fuel pool gate is a rectangular, plate-like structure which is used to separate the spent fuel pool from the reactor well area. During normal plant operation, the fuel pool gate prevents water from leaving the spent fuel pool so that the reactor well area remains dry. However, during refuel operations, the reactor well area is flooded and the fuel pool gate is removed to allow spent fuel to be stored in the spent fuel pool.

There are two fuel pool gate lifting points per gate and they are attached to the top of the structure. During installation or removal of the gate, a two arm sling is used for lifting or lowering.

There is a large and a small fuel pool gate. Since the lifting points on each gate have the same design, only the heavier (large) of the two gates was analyzed.

Material: ALUM 6061-T6

Ultimate Stress = 42 ksi

Yield Stress = 35 ksi

Allowable Tensile Stress = 8.4 ksi

Allowable Shear Stress = 4.2 ksi

Tensile Stress = 1.19 ksi < 8.4 ksi

Shear Stress = 1.45 ksi < 4.2 ksi

Welds for lifting lug to gate:

Allowable Tensile Stress = 4.80 ksi(3)

Allowable Shear Stress = 2.40 ksi(3)

Tensile Stress = 1.30 ksi < 4.80 ksi

Shear Stress = 0.70 ksi < 2.40 ksi

The Fuel Pool Gate Lifting Points satisfy NUREG 0612 criteria.

6.5 Hydraulic Tensiler Lifting Device and Lifting Points (reference 5)

The hydraulic tensioner lifting device is used to support and position the hydraulic tensioners during installation of the RPV head. The lifting device is attached to the crane with slings and lowered to the RPV head level, where the hydraulic tensioners are used to elongate the RPV head bolts.

The lifting device is a cruciform shaped structure using S-shaped beams as the base and pipes for vertical support. The structure is attached to the crane by way of a lifting box. Four hydraulic tensioners are supported from the four structural arms using cables (see Figure 3 for illustration).

Material: ASTM A36 (Assumed)(4)

Hydraulic Tensioner Weight = 1.5 kips

Lifting Device Applied Load (including 4 hydraulic tensioners) = 1.15 (7.15 kips) = 8.22 kips

(3)Allowable Stresses for ALUM 6061-T6 due to welding process (reference 14).

(4)A conservative estimate of material type, since no information about the material has been provided.

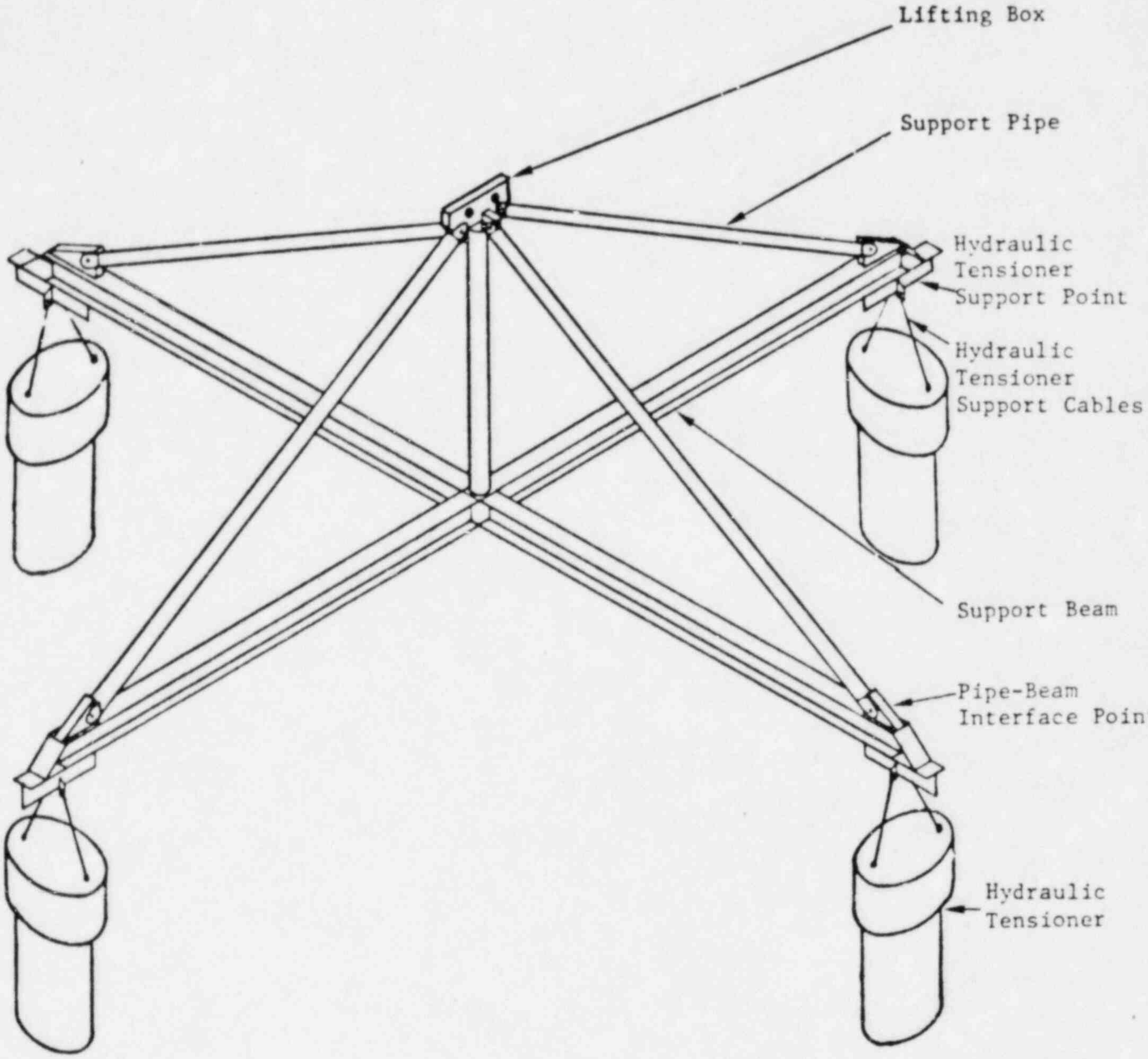

Figure 3. HYDRAULIC TENSIONER LIFTING DEVICE

Ultimate Stress = 58 ksi

Yield Stress = 36 ksi

Allowable Tensile Stress = 11.6 ksi (dual load path)
= 5.8 ksi (single load path)

Allowable Shear Stress = 5.8 ksi (dual load path)
= 2.9 ksi (single load path)

Allowable Compressive load = 10.66 kips

6.5.1 Support Beam

Bending Stress = 3.90 ksi < 5.8 ksi

Compressive Load = 3.16 kips < 10.66 kips

The S-shaped support beam satisfies the axial compressive and bending requirements of reference 11 as follows:

For $\frac{f_a}{F_a} = 0.297 > 0.15$,

$$\frac{f_a}{F_a} + \frac{C_{mx} f_{bx}}{(1-f_a/F_{ex})F_{bx}} = 0.996 < 1.0 \text{ and}$$

$$\frac{f_a}{0.6f_y} + \frac{f_{bx}}{F_{bx}} = 0.892 < 1.0$$

where
f_a = computed axial stress
f_{bx} = computed compressive bending stress
F_a = allowable axial stress
F_{bx} = allowable compressive bending stress
f_y = yield stress
F_{ex} = allowable combined axial and bending stress
C_{mx} = coefficient

The support beam satisfies NUREG 0612 criteria.

6.5.2 Support Pipe

Tensile Stress = 2.11 ksi < 5.8 ksi (single load path)

Welds between pipe and pipe attachments points:

Tensile Stress = 2.73 ksi < 5.8 ksi (single load path)

The support pipe satisfies NUREG 0612 criteria.

6.5.3 Pipe-Beam Interface Point

Shear Stress = 1.92 ksi < 2.9 ksi (single load path)
Tensile Stress = 2.4 ksi < 5.8 ksi (single load path)
Pin Shear Stress = 2.29 ksi < 2.9 ksi (single load path)

Weld between pipe attachment and S-shaped beam:

Shear Stress = 1.33 ksi < 2.9 ksi (single load path)
Tensile Stress = 0.73 ksi < 5.8 ksi (single load path)

The pipe-beam interface point satisfies NUREG 0612 criteria.

6.5.4 Lifting Box

Tensile Stress = 10.39 ksi < 11.6 ksi (dual load path)
Shear Stress = 2.06 ksi < 5.8 ksi (dual load path)
Pin Shear Stress = 4.53 ksi < 5.8 ksi (dual load path)

The lifting box satisfies NUREG 0612 criteria.

6.5.5 Lifting Attachments (See Figure 4 for illustration)

For Peach Bottom #2

Shear Stress = 5.48 ksi < 5.8 ksi (dual load path)
Tensile Stress = 6.27 < 11.6 ksi (dual load path)

Bending Stress = 95.0 ksi ≥ 11.6 ksi (dual load path)

The lifting attachment for Peach Bottom #2 does not satisfy NUREG 0612 criteria.

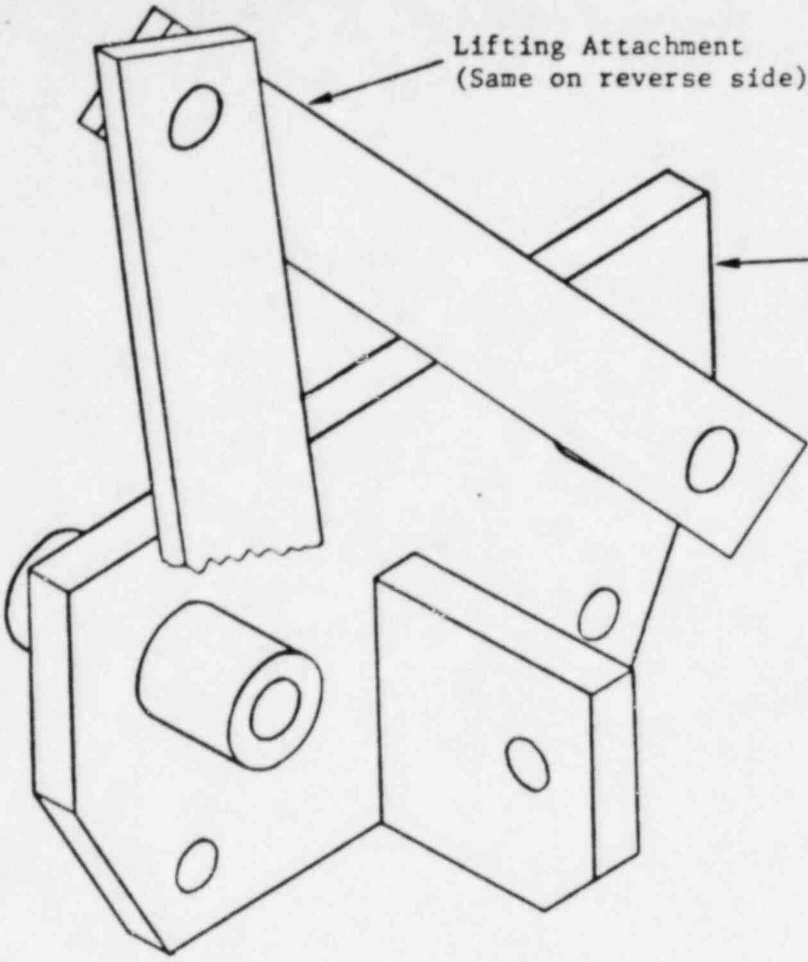

Figure 4-1
Lifting Attachment Layout
Peach Bottom 3

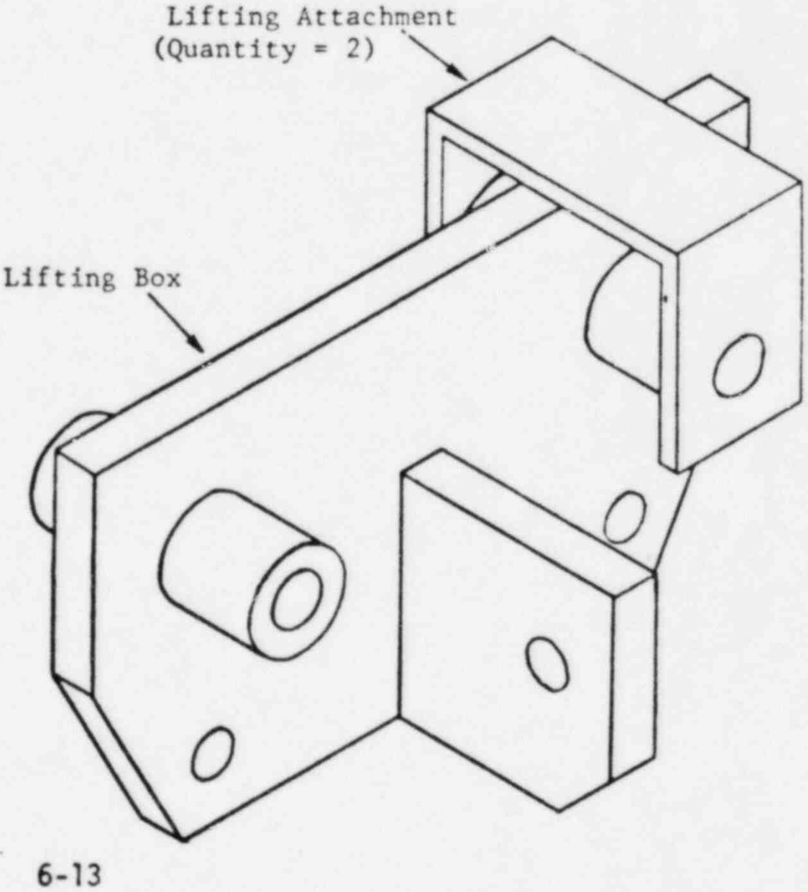

Figure 4-2

Lifting Attachment Layout
Peach Bottom 2

For Peach Bottom #3

Shear Stress = 4.50 ksi < 5.8 ksi (dual load path)

Tensile Stress = 5.14 ksi < 11.6 ksi (dual load path)

The lifting attachment for Peach Bottom #3 satisfies NUREG 0612 criteria.

6.5.6 Hydraulic Tensioner Support Points

Shear Stress = 3.45 ksi < 5.8 ksi (dual load path)

Tensile Stress = 3.94 ksi < 11.6 ksi (dual load path)

Bending Stress = 5.58 ksi < 11.6 ksi (dual load path)

Weld between support lug and tee:

Shear Stress = 1.05 ksi < 5.8 ksi (dual load path)

Bending Stress = 1.35 ksi < 11.6 ksi (dual load path)

The hydraulic tensioner support points satisfy NUREG 0612 criteria.

6.5.7 Hydraulic Tensioner Support Cables

Since no information about the hydraulic tensioner support cables was available, specific cables could not be analyzed. However, in order to satisfy NUREG 0612 criteria, cables in use must be able to support the following Safe Working Load:

$$\text{Safety Working Load} = \frac{A \times B \times C}{N}$$

where A = combined static and dynamic loading factor

B = single load path safety factor

C = static weight of one hydraulic tensioner

$$\text{Safe Working Load} = \frac{17{,}250 \text{ lbf}}{N}$$

where N = number of cables supporting the hydraulic tensioner

7.0 REFERENCES

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

2. RPV Head Insulation Structure (both units) VPF #2641-14-6

3. RPV Head Strongback (both units) 729E413, Rev. 9

4. Fuel Pool Gate (both units) 718E865, Rev. 4

5. Hydraulic Tension Lifting Device, Diamond Power Specialist Corporation drawing #701334-1842, Rev. F

6. ANSI N14.6-1978, "American National Standard for Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or more for Nuclear materials.

7. CMAA Specification #70

8. J.E. Shigley, "Mechanical Engineering Design," 3rd ed.

9. NSE report 50-0582, "Lifting Device and Lifting Points Stress Analysis for Reactor Pressure Vessel Head Strongback, Steam Dryer/Separator Sling and Service Platform to Comply with NUREG 0612 for Peach Bottom Units 2 and 3, dated May 1982.

10. The Manual of Steel Construction (ALSC) 7th ed.

11. Roark & Young "Formulas for Stress and Strain" 5th ed.

12. Popov, E.P., "Introduction to Mechanics of Solids", 1968.

13. Aluminum Association, "Section 3 - Engineering Data for Aluminum Structures," 1975.

14. Johnston, B. G. & F. J. Lin, "Basic Steel Design", 1974.