# 1.4 Excessive Tensioning of Vertical Tendons

Description:

The design calls for tensioning the Vertical tendons to 1,635 kips with an upper limit at 1,878 kips during tensioning (80% of Guaranteed Ultimate Tensile Strength (GUTS)) and 1,721 kips afterwards (FM 1.4 Exhibit 3 is the CR3 tendon surveillance program). When considering the number of vertical tendons and the diameter of the containment building, we can calculate the number of vertical tendons per unit circumference and the vertical tendon force per unit circumference (FM 1.4 Exhibit 1 is a PII calculation of the pre-stress generated when tensioning the vertical tendons).

Additionally, occasional excessive tensioning, as allowed by normal operation, can damage the concrete by generating localized micro-cracks and/or enhanced creep.

Data to be collected and Analyzed:

1. Calculate loads and stresses generated by vertical tendons (FM 1.4 Exhibit 1);
2. NCR incidents in the past that may have involved over-tensioning of vertical tendons;
3. Procedure review for when to write an NCR for overstressing tendons (FM 1.4 Exhibit 3 and FM 1.4 Exhibit 5 is the 1997 pre-surveillance package from Precision Surveillance Corporation (PSC) for the CR3 tendons);
4. Interview with experienced and knowledgeable tendon engineers (FM 1.4 Exhibit 2 is an interview with Richard Portmann, the CR3 Responsible Engineer for IWL/IWE surveillance);
5. PSC procedures which state that the maximum tension is 80% of the yield (FM 1.4 Exhibit 5).


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Verified Supporting Evidence:

None

Verified Refuting Evidence:

a. The pre-stress generated by vertical tendons is low compared to the compressive strength of the material (FM 1.4 Exhibit 1). It is also low compared to the hoop pre-stress generated by the hoop tendons (1,106 psi versus 2,000 psi). The concrete used at CR3 has a specified 28 days compressive strength of 5,000 psi and a tested 32 years (today) compressive strength of 7,500 psi with a standard deviation of 820 psi. The vertical pre-stress level is therefore only around 22% of the specified f'c and 15% of the measured f'c. This remains too low to damage the concrete material in compression;

b. Personnel interview documents that no evidence of over-tensioning was recorded. Search by Progress found no NCRs written on the subject (FM 1.4 Exhibit 2);

c. Additionally, the worst case scenario of having tendon force at 80% of GUTS increases the existing vertical pre-stress by less than 14%. This is not sufficient to initiate damage in the material.

Discussion:

We can note that the original Gilbert Associates calculations specified a vertical pre-stress level of 457 kips/ft (FM 1.4 Exhibit 4). This is in strong agreement with our calculated end-of-life value of 451 kips/ft (FM 1.4 Exhibit 1).

The requirements for writing NCRs for over-stressing tendons are contained in the PSC procedure on tendon surveillances (FM 1.4 Exhibit 3). The procedure calls for writing an NCR if the tendon lift-off force exceeds 80% GUTS. It does not call for writing an NCR if the measured lift-off force is higher than the "predicted" tendon force from tendon force loss predictions (see FM 6.5 and FM 6.6 for details).

The surveillance procedure is performed the same way for horizontal and vertical tendons, except that lift-off measurements are only performed at the lower end (tendon gallery) for the vertical tendons since the upper end (at the ring girder) is not accessible. Since the vertical tendons are straight, unlike the curved hoop tendons, the tendon force angular friction is not a factor and the force is much


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more homogeneous along a vertical tendon. The exceptions would be the vertical tendons going around the equipment and personnel hatches (see FM 1.14).

Conclusion:

It is concluded that excessive tensioning of the Vertical tendons did not contribute to the 2009 delamination of the containment concrete.



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# Forces and stresses from Vertical tendons

## A. Tendon force at 1,635 kips

The forces and stresses generated by the vertical tendon forces are calculated based on the following:

- Vertical tendon force $F_{tendon}$ = 1,635 kips
- Vertical tendon centerline radius $r$ = 807 in
- Number of Vertical tendons per panel $n_V$ = 24 tendons

### A.1 Vertical force per unit circumference

There are 24 vertical tendons on 1/6 of the containment perimeter

The vertical force per unit circumference is equal to

$$F_V = \frac{F_{tendon}}{2.pi.r/6} * \#_{tendon} = 557\ \frac{\text{kips}}{\text{ft}}$$

### A.2 Average vertical stress

The above vertical force per unit circumference acts on concrete that is 42 inches wide.

The average vertical stress is then

$$\sigma = \frac{F_V}{12 * 42} = 1{,}106\ \text{psi}$$

## B. End of life tendon force of 1,325 kips

When using the end-of-life tendon force of 1,325 kips, we get the following results

### B.1 Vertical force per unit circumference

$$F_V = \frac{F_{tendon}}{2.pi.r/6} * \#_{tendon} = 451\ \frac{\text{kips}}{\text{ft}}$$

Note that the original Gilbert Associates calculations specified a vertical pre-stress level of 457 kips/ft (FM 1.4 Exhibit 4).

### B.2 Average vertical stress

The average vertical stress is equal to

$$\sigma = \frac{F_V}{12 * 42} = 896\ \text{psi}$$

FM 1.4 Exhibit 1

1/27/2010 Interview with Richard Portmann (Tendon Engineer) for FM 1.3 and 1.4

- Precision Surveillance Corporation (PSC) does tension surveillance for Progress.
- PSC has a separate Quality Program and NCR reporting program. If they over stress a tendon PSC has to write a NCR and Progress does also.
- Richard Portmann has seen no NCRs on overstressing tendon.
- 80% of tensile will only increase the existing radial stress by 15% and is not sufficient to initiate separation. 80% is the initial tension used for new wires.
- WO 681043-01 contains all work documents, PSC procedures and results. It is about 150 MB and it is in the Progress FM 1.3 file.
- Richard Portmann does pre-job brief for crews and a job safety analysis before they go to work on the surveillance.
- PSC procedure SQ 9.0S covers monitoring of liftoff values and Q 10.0 covers detensioning.
- PSC procedure SP-182 covers the Reactor Building Structural Integrity Tendon Surveillance. SP-182 section 3.3.16 covers the maximum overstress of 80%.
- The surveillance is performed the same way for horizontal and vertical tendons.

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NOTE

These Enclosures are included for reference by the Surveillance Contractors Inspection Manual discussed in Section 4.0, Instructions.

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## 1.0 PURPOSE

The purpose of the Tendon Surveillance Program is to demonstrate the integrity of the containment prestressing system, including containment tendons, tendon end anchorage hardware, general and adjacent concrete integrity, and evaluation of the corrosion protective (grease) system. Individual inspections of selected tendons, as well as tendon wire and grease sample testing, are to be performed to the requirements of this procedure, to evaluate the overall integrity of the prestressing system.

## 2.0 REFERENCES

### 2.1 Developmental References

2.1.1 Technical Specification References

| Applicable References | Surveillance Performance During Modes | LCO/Other Requirements During Modes |
|---|---|---|
| 3.6.1 | 1 through 6 | 1, 2, 3, 4 |
| SR 3.6.1.2 | 1 through 6 | N/A |
| 5.6.2.8 | 1 through 6 | N/A |
| 5.7.2 | N/A | N/A |

Frequency Notes:

Tendon surveillance was required at 1, 3, and 5 years after the Initial Containment Structural Integrity Test (SIT), and shall be performed every 5 years thereafter for the life of the plant. The 10 year and subsequent examinations shall commence not more than 1 year prior to the specified dates and shall be completed not more than 1 year after such dates.

2.1.2 Drawing References

2.1.2.1 Prescon Corporation - Tendons Drawings (series)

2.1.2.2 Swan Manufacturing Company - Conduit Drawings (series)

2.1.2.3 Reactor Building - Concrete Drawings (series)

2.1.3 Procedure References

2.1.3.1 CAP-NGGC-0200, Corrective Action Program

2.1.3.2 MNT-NGGC-0050, Measuring & Test Equipment Calibration Program

2.1.3.3 OPS-NGGC-1305, Operability Determinations

2.1.3.4 Compliance Procedure, CP-151, External Reporting Requirements

2.1.3.5 Administration Instruction, AI-400E, Performance and Transmittal of Procedures

2.1.3.6 Administration Instruction, AI-500, Conduct of Operations - Operations Department Organization and Administration

2.1.3.7 SAF-ESGX-00002, Energy Supply Fall Protection Procedure

2.1.3.8 Administration Instruction, AI-1803, Safety Standard for Ladders, Scaffolds, and Ancillary Equipment

2.1.3.9 Administration Instruction, AI-607, Pre-Job and Post-Job Briefings

2.1.4 Code and Standard References

2.1.4.1 ASTM A421-65, Standard Specification for Uncoated Stress Relieved Wire for Prestressed Concrete

2.1.4.2 ACI 201.1R-68, Revised 1984, Guide for Making a Condition Survey of Concrete Inservice

2.1.4.3 ASTM D512, Standard Test Methods for Chloride Ion in Water

2.1.4.4 ASTM D992, Standard Test Methods for Nitrite-Nitrate in Water

2.1.4.5 APHA 427, Standard Methods for Examination of Water and Waste Water

2.1.4.6 ASTM D95, Standard Test Method for Water in Petroleum Products and Bituminous Materials by Distillation

2.1.4.7 ASTM D974 (Modified), Standard Test Method for Acid and Base Number by Color-Indicator Titration

2.1.5 Other References

2.1.5.1 SAF-PGNF-00065, Accident Prevention Manual

2.1.5.2 Surveillance Contractor operating manuals and calibration charts for hydraulic stressing jack, pumps, and controls.

2.1.5.3 Dome, Vertical and Hoop Tendon History Sheets

2.1.5.4 Precision Surveillance Corporation, Inservice Inspection Manual N1002 for Florida Power Corporation - Crystal River Unit 3 Nuclear Station.

2.1.5.5 SP-182, Reactor Building Structural Integrity Tendon Surveillance Program, Revision 13, and past surveillance results.

2.1.5.6 Information Notice 99-10, Degradation of Prestressing Tendon Systems in Prestressed Concrete Containments.

2.1.6 Regulatory and Code Document References

2.1.6.1 U.S. Regulatory Guide 1.35, Revision 3, July 1990, Inservice Inspection of Ungrouted Tendons in Prestressed Concrete Containments

2.1.6.2 Section XI of the ASME Boiler and Pressure Vessel Code, Subsection IWL, Requirements for Class CC Concrete Components of Light-Water Cooled Plants, 1992 Addenda of the 1992 Edition as amended by 10CFR50.55a, Codes and Standards

2.1.7 Design Analysis/Calculation References

2.1.7.1 Calculation S-95-0082, Preparation of Tendon Force Curves for 6th Tendon Surveillance

2.1.7.2 Calculation S-80-0002, Required Minimum Average Tendon Forces

2.1.7.3 Calculation S-01-0019, Preparation of Tendon Force Curves for the 7th Tendon Surveillance at Crystal River.

2.1.7.4 Calculation S-07-0033, Preparation of Tendon Force Curves for the 8th Tendon Surveillance at Crystal River

## 3.0 PERSONNEL INDOCTRINATION

### 3.1 Setpoints

None

### 3.2 Description

The Containment Tendon Surveillance Program defined in this SP-182, including inspection frequencies, and acceptance criteria, complies with the requirements from the 1992 addenda of the 1992 Edition of ASME Section XI, Subsection IWL and the applicable amendments as specified in 10CFR50.55a, Codes and Standards.

The Tendon Surveillance Program is usually conducted during an outage. However, it may be conducted periodically during plant operation. For the surveillance during plant operation, special precautions must be taken to avoid work in hazardous areas resulting from plant operating conditions. This includes the steam vent zone outside and between buttresses 1 and 3, and areas inside the plant where radiological or other safety hazards must be considered. Also, any potential impact or effects on safety related systems and equipment in the immediate vicinity of the surveillance activity must be considered.

For surveillance periods during plant outages, the effects of heavy load drops must be considered for all surveillance work performed over the fuel pool area during the period when fuel pool missile shields have been removed for fuel transfer.

3.2.1 Tendon Selection

Eleven tendons shall be selected for each surveillance period consisting of 5 hoop tendons, 3 vertical tendons, and 3 dome tendons.

Inspections performed at 1, 3, 5, 10, 15, 20 and 25 years after the initial SIT have indicated no abnormal degradation of the post-tensioning system. Therefore, the number of tendons selected for subsequent surveillances complies with ASME Section XI, Subsection IWL, in that at least 2% of the population of each group of tendons (hoop, vertical and dome), or 5 tendons, whichever is less, with a minimum of 3 tendons in each group, will be included.

It will not be necessary to enter the Reactor Building at any time during Tendon Surveillance Program activities. Access to the vertical tendon upper anchorage is from the top of the ring girder and access to the lower anchorage is from the tendon gallery. In instances where a tendon is not accessible or acceptable for lift-off tests, Engineering Technical Services will be notified. If the tendon was identified to be inspected it will be exempted from this surveillance and Engineering will select an alternate tendon as close as possible to the original tendon. The exempted tendon will be inspected per IWL-2524 and IWL-2525 to the extent that the anchorage areas are accessible either during operation or at an outage. If the tendon was an adjacent tendon, Engineering will select the closest neighboring tendon and adjacent (excluding the reduced force tendons, see Enclosure 6: Reduced Force Dome Tendons).

3.2.2 Hold Points

The "Hold Points" identify steps beyond which work will not proceed until an inspection is performed by a qualified Nuclear Quality Control Inspector. The Site Project Manager for the surveillance, or his designee, must notify the Nuclear Quality Control Supervisor, or his designee, at each "Hold Point".

3.2.3 End Cap Removal and Inspection

The end cap will be removed and inspected for any moisture or free water. If free water is present, samples will be taken for later testing. Two grease samples will be collected from each tendon end for the testing laboratory, see Section 3.2.9: Laboratory Testing. If the end cap shows signs of corrosion it will be cleaned of all grease and sent to the Site Paint Shop for cleaning and re-painting by CR3. The tendon anchorage areas, including the bearing plates and shims, will be inspected for corrosion or other signs of deterioration. The anchorage assembly will be inspected for missing buttonheads, missing, broken, and/or damaged wires or other obvious defects. The degree of corrosion will be compared with that noted at the time of installation or previous tendon surveillance inspections. The thickness of the shim pack will also be measured.

The concrete in the area surrounding the tendon anchorage assembly will be inspected for any large spall, severe scaling, D-cracking (as defined in ACI-201.1R-68), other surface deterioration or disintegration, or grease leakage. Engineering will be notified if any cracks are measured to be wider than 0.010 inch.

In addition to the end caps for the selected tendons, all accessible end caps of the remaining tendons shall be visually inspected for significant grease leakage or end cap deformation.

3.2.4 Lift-Off Measurements

Lift-off will be determined by the following method:

The jacking pressure will be applied to the anchor head until lift-off is achieved. (Note: The jacking force will not exceed 1721 kips based on 163 available wires.) After achieving lift-off 2 feeler gauges (0.030 inch) shall be inserted about 180 degrees apart, between the anchor head washer and the shim. The pressure will then be reduced to transfer the load back to the shim stack. Pressure will be applied to the tendon until the feeler gauges can be pulled out with some effort.

3.2.5 Detensioning

Tendons to be detensioned are listed in Enclosure 2: Identification of Surveillance Tendons - Inspection Period 8. The control tendon shall not be detensioned unless required due to failure to meet acceptance criteria. If it must be detensioned a new control tendon, of the same type, will be selected. The jacking pressure will be increased until the shims can be removed, not exceeding a force of 1721 kips (based on 163 available wires). All buttonheads will be visually inspected for off-size, cracked, and missing heads. Also the anchorage assembly will be inspected for missing, broken, and/or damaged wires. The degree of corrosion will be compared with that noted at the time of installation or previous tendon surveillance inspections.

3.2.6 Wire Removal

Tendons selected for a physical condition test are noted in Enclosure 2: Identification of Surveillance Tendons - Inspection Period 8. One random wire will be removed while the tendon is completely detensioned. Any wires identified as broken will be removed and handled the same as the random wire sample. The wire will be measured and inspected for pitting, corrosion, or other signs of deterioration. If there are areas of significant pitting or loss of area on any wire, Engineering will be notified and will determine the course of action. A minimum of 3 samples will be taken for the testing laboratory (see Section 3.2.9: Laboratory Testing). A sample from each end, and one from the middle will be obtained. A fourth sample will be cut from the area of most significant corrosion or pitting, if it exists. The length of each sample shall be the maximum length acceptable for the test apparatus to be used by the testing laboratory.

3.2.7 Retensioning

Tendons to be retensioned shall be stressed to 80% of the minimum ultimate tensile strength of the available wires in the tendon (1868 kips for a 163 available wire tendon). This is performed to minimize the frictional effects on the forces in the overall tendon. During retensioning of the tendon, the elongation of the tendon wires shall be measured and recorded along with the corresponding force at 3 equally spaced intervals. The stressing force will then be reduced to the accepted lift-off or BASE Value (100% value) for final lock-off with a tolerance of -0% to +6%.

At the conclusion of retensioning, all buttonheads will be visually inspected for cracked and/or missing heads. Also, the anchorage assembly will be inspected for broken and/or damaged wires.

3.2.8 Tendon Regreasing

Once all inspections are completed on a tendon the end cap will be replaced with a new 0-ring. If any scratches, nicks, and other sharp depressions are present in the gasket bearing surface, a nonmetallic epoxy will be used to repair them prior to end cap installation. The tendon will then be filled with grease.

The grease will be pumped at a minimum temperature of 130°F, but not greater than 210°F. The pressure will not exceed 55 psi at the filler end of the hoop, dome and upper vertical tendon grease cap. The pressure at the lower vertical grease cap will not exceed 125 psi. Engineering will be notified when the absolute difference between the amount of grease removed and the amount of grease pumped is equal to 5% of the net duct volume for a given tendon. Pumping can continue up to 20 gallons beyond this point under Engineering approval.

3.2.9 Laboratory Testing

Testing laboratories qualified by the Surveillance Contractor's Quality Program will be required to perform the following services for this procedure:

- inspect wires for corrosion and other defects
- perform required tensile tests for yield strength, ultimate tensile strength, and elongation
- test bulk filler grease samples for chlorides, sulfides, nitrates, reserve alkalinity, and water content
- test free water samples for pH level

In the event that the testing laboratory finds a wire with significant pitting or loss of area, Engineering will determine the required course of action. An acceptable course of action would be to remove additional wires from the applicable surveillance tendons to be inspected to determine the extent and cause of change. However, each tendon shall have at least 155 wires which meet the acceptance criteria of Enclosure 8, Criteria and Categories for Rating Degrees of Corrosion on Tendon Anchorage Assemblies and Selected Wires, and Enclosure 9, Criteria for Missing, Broken, and/or Damaged Wires.

One grease sample will be sent to the testing laboratory while the remaining sample is held by the surveillance contractor or CR3 for possible confirmation testing.

**3.3 Definitions**

3.3.1 Adjacent Tendons - Adjacent or adjoining tendons are usually on each side of a selected tendon. Reduced Force Dome Tendons, Enclosure 6, are not considered adjacent tendons for a normal selected dome tendon. The next immediate normal tendon shall be considered the adjacent tendon. For hoop tendons located at the very bottom or top of a grouping, the next 2 tendons directly above or below, respectively, are considered the adjacent tendons.

3.3.2 Anchor Head (stressing washer) - round flat piece of steel that the tendon buttonheads bear.

3.3.3 Anchorage - components that distribute the forces in the tendon to the concrete containment structure.

3.3.4 BASE or BASE Curve (Predicted) - A plot of the predicted tendon force versus time accounting for prestress losses based on the criteria provided in Regulatory Guide 1.35.1, Revision 0.

3.3.5 Bearing Plate (baseplate) - steel plate embedded in the concrete containment that the anchor head transfer the tendon load to.

3.3.6 Buttonhead - the end of the tendon wire that transfers the tendon load to the anchor head.

3.3.7 Corrosion Protection Medium (grease, filler material) - wax and oil compound that fills the tendon cavity to protect against corrosion.

3.3.8 Elongation - the distance that a tendon wire stretches under load.

3.3.9 End Cap - steel container that protects the tendon anchorage and is bolted to the bearing plate.

3.3.10 Free Water - moisture of a quantity that is observed collected or draining out from the end cap during inspection.

3.3.11 Hold Point - point beyond which work will not proceed until an inspection is performed and sign-off by a qualified Nuclear Quality Control Inspector.

3.3.12 Lift-Off - the force (or pressure) required to separate the anchor head form the shim stack.

3.3.13 Lock-Off - the force (or pressure) when the tendon load is transferred to the shim stack.

3.3.14 Minimum Required Prestress Levels - Average prestress force levels which satisfy the design load conditions for maintaining the structural integrity of the containment. Force levels for this average prestress condition are 1215 kips for the dome tendon group, 1149 kips for the vertical tendon group, and 1252 kips for the hoop tendon group.

3.3.15 Normalization Factor - Factors for each individual tendon which are based upon the original tendon stressing sequence of installation. The normalization factor accounts for the effects of elastic shortening.

3.3.16 Overstress - the force (or pressure) that is approximately the yield strength of the tendon (80% of the minimum ultimate tensile strength).

3.3.17 Pit - An indentation visible to the unaided eye. A pit is caused by corrosion and is not the result of mechanical damage to the wire.

3.3.18 Ram - hydraulic jacking device used to apply force to a tendon.

3.3.19 Sheathing (cavity, conduit, duct, void) - thin-walled pipe in the concrete containment that the tendon wires pass through.

3.3.20 Shims - steel plates inserted between the anchor head and the bearing plate.

3.3.21 Stressing Adaptor (coupler) - threaded device that connects the ram to the anchor head.

3.3.22 Tendon - name for combination of wires and anchor heads.

3.3.23 Tendon Identification Number - the numbering convention for locating the tendons:

Dome: D xxx where:
Vert: y V xx xxx or xx = sequence numbers
Hoop: yz H xx y or z = buttress numbers

3.3.24 Trumpet - the portion of the sheathing connected to the bearing plate (larger diameter then the sheathing).

3.3.25 Wire - 7 mm diameter wire.

**3.4 Responsibilities**

3.4.1 Surveillance Contractor - This procedure is designed and written for work to be performed by an experienced Surveillance Contractor. The Surveillance Contractor, Precision Surveillance Corporation for the 8th Tendon Surveillance shall be responsible for assuring that all individuals under its supervision are properly trained in the use of this procedure, their inspection manual and associated equipment. The work supervisor is responsible for performance of the step by step instructions of this procedure, and their inspection manual - and for assuring that work is completed satisfactorily and QC is notified for data collection/inspection steps.

3.4.2 Site Project Manager - Responsible for coordinating site support activities for the Surveillance Contractor.

3.4.3 Engineering Technical Services, or its designee - Is responsible for providing technical support and for the evaluation and disposition of problems as identified during the surveillance. This includes responsibility for the general walkdown and inspection of the containment, and for the documentation of the results of this inspection.

3.4.4 Nuclear Quality Control (NQC) Supervisor, or designee - Is to be notified at each "Hold Point" within this procedure and is responsible for providing the required QC inspection personnel.

3.4.5 Nuclear Quality Control Inspector - Is responsible for performing QC inspections as indicated within this procedure, and for the recording and documentation of all inspections. The QC Inspector is responsible for providing the documented approval to proceed at each "Hold Point".

3.4.6 Responsible Engineer (RE) - A Registered Professional Engineer experienced in evaluating the in-service condition of structural concrete. The RE is responsible for development of inspection procedures, approval of examination personnel, evaluation of results, and the preparation of repair procedures.

**3.5 Limits & Precautions**

3.5.1 General

3.5.1.1 Work must be in compliance with the safety requirements of OSHA, and CR3 procedures and policies.

3.5.1.2 Missile shields shall be in place over Spent Fuel Pool "A" during surveillance activities for applicable tendons, if any, as designated in Enclosure 2: Identification of Surveillance Tendons Inspection Period 8, unless all equipment has been secured/rigged in accordance with NUREG-0612.

3.5.1.3 Missile shields shall be in place when moving any platforms and/or stressing rams over Spent Fuel Pool "A", unless all equipment has been secured/rigged in accordance with NUREG-0612.

3.5.1.4 Dome tendons listed in Enclosure 6, Reduced Force Dome Tendons, are not acceptable for normal lift-off testing; therefore, they shall not be substituted as adjacent tendons.

3.5.1.5 No more than 3 adjacent tendons shall be detensioned at any given time without Engineering concurrence.

3.5.1.6 During plant operation, work cannot be performed in the area between buttress numbers 1 and 3 (see Enclosure 3: Dome Tendon Locations Plan - Inspection Period 8). This is to avoid potential exposure to high pressure steam from the steam vents.

3.5.1.7 For work located in Radiation Controlled areas, due consideration must be given to the ALARA program. This may result in a determination that special preparation and/or precautions are necessary.

3.5.2 Filler Material

3.5.2.1 A certified test report bearing 2 signatures for the grease specified in Step 3.7.1.25 is required. The water soluble chloride and sulfide content must not exceed 2 ppm. The water soluble nitrate content must not exceed 4 ppm.

3.5.2.2 The reuse of filler material in the end cap is acceptable provided a Surveillance Contractor supplied procedure for reuse is accepted by CR3. All grease drained or removed from the anchorage area and tendon cavity shall be disposed of as waste grease.

3.5.2.3 Care must be taken when removing the end cap since the filler material may drop off or drip as a medium viscous liquid.

3.5.2.4 At the lower anchorage, the entire column of filler material may drain from the tendon during end cap removal.

3.5.2.5 Samples of the grease shall be taken prior to cleaning of the anchorage area.

3.5.2.6 Do not use metal implements to remove filler material from around the anchorage. Wooden or plastic instruments may be used.

3.5.2.7 Grease temperatures within the 55-gallon drum must not exceed 210°F.

3.5.3 Equipment

3.5.3.1 Calibration of all equipment used to measure tendon force shall be done in accordance with a calibration procedure prior to the first tendon force measurement and after the final tendon force measurement. Accuracy of the calibration shall be within 1.5% of the specified minimum ultimate strength of the tendon. Calibration of all measuring devices must be signed, dated, and traceable to the National Institute of Standards and Technology (NIST) documentation.

3.5.3.2 Verification of calibration of the stressing jack-pressure gauge systems must be checked daily against a master pressure gauge which is used only for this purpose.

3.5.4 Inspection and Testing

3.5.4.1 "Hold Points" must be verified by a qualified NQC Inspector(s) to comply with the requirements of Appendix B, Criterion X of 10CFR50.

3.5.4.2 Provide sufficient manpower to remove the end caps. The weight of each end cap with grease is about 225 lbs.

3.5.4.3 Once the inspection of a given tendon end has begun, it should be completed as soon as possible to avoid unnecessary exposure of the anchor head.

3.5.4.4 Do not leave the anchorage area and the end cap unprotected when work is not being performed. Tendon anchorages which have been cleaned of grease for an inspection shall be protected by applying a coat of grease to all exposed surfaces prior to the temporary or permanent installation of the end cap.

3.5.4.5 During inclement weather, provide protection to prevent moisture from entering the end anchorage.

3.5.4.6 The Surveillance Contractor shall confirm that the proper stressing adaptor is attached to the anchor head prior to stressing the tendon.

3.5.4.7 Do not stand behind hydraulic jack while stressing a tendon.

3.5.4.8 Exercise extreme caution if fingers or hands are required near the tendon anchor head during testing.

3.5.4.9 Do not exceed a jack force of 1721 kips (based on 163 available wires) during the tendon stressing without NPTS concurrence, except as stated in Step 3.2.7: Retensioning.

3.5.4.10 Do not detension either tendon end until lift-off has been determined for both ends of a hoop or dome tendon (vertical tendons are detensioned at top end only). Lift-off for each end may be determined on separate days.

3.5.4.11 Detensioning of each tendon end may proceed independently of the other end. However, jacks must not be uncoupled until the tendon is completely detensioned. To alleviate holding jacks under pressure for periods of time, it is recommended that both ends of a tendon be detensioned in unison. This should assist in correct positioning of the anchor head washer.

3.5.4.12 Vertical tendons are detensioned from the top end only, which is the shop end of the tendons. All inspection requirements apply to both top and bottom anchorages.

3.5.5 Wire Removal

3.5.5.1 Verify that all lift-off force measurements and detensioning is complete prior to wire removal.

3.5.5.2 Perform necessary measures when removing and handling tendon wires to preclude wire damage such as scratches, kinks, etc., and to preclude the accumulation of dirt or other contaminants on the surface of the wire.

3.5.5.3 The Surveillance Contractor shall carefully clean removed tendon wires just prior to visual inspection and packaging for delivery to the testing laboratory.

3.5.5.4 Do not stand directly in front of either end of the tendon when a wire is to be cut since some tendons may not be completely detensioned.

3.5.6 Retensioning

3.5.6.1 The Surveillance Contractor shall confirm that the proper stressing adaptor is attached to the anchor head prior to stressing the tendon.

3.5.6.2 Both ends of a hoop or dome tendon shall be retensioned simultaneously in a controlled manner. Maintain approximately the same elongation on both ends of the tendon.

3.5.6.3 It is important that when stressing from both ends that the crew's operation in stressing be coordinated so that a rapid stressing unit does not outpace a slower stressing unit. Ideally, the target gauge pressures must meet at the same time.

3.5.6.4 Vertical tendons only require retensioning from the top of the tendon.

3.5.7 End Cap Installation

3.5.7.1 Detrimental foreign matter (if present) such as loose mill scale, loose rust, loose or flaking paint on the gasket bearing surface can be removed with power tools.

3.5.7.2 A thread chaser may be required to clean the grease cap mounting holes.

3.5.7.3 All temporary tubes used for filling the end cap with grease, shall be removed.

3.6 **Acceptance Criteria**

**NOTE**

**Contingency actions for non-compliance with the following acceptance criteria are provided in Section 5.2: Contingencies.**

3.6.1 All documentation has been satisfactorily completed, including all required signatures and dates.

3.6.2 Abnormal conditions determined as the result of a visual inspection of the exterior concrete surface of the containment shall be recorded and documented, and investigated by Engineering for possible degradation of the structure.

Cracks found in concrete adjacent to the tendons (within 2 feet of the bearing plate) having widths greater than 0.010 inch shall be recorded and reported to Engineering for evaluation and resolution. Any crack widths greater than 0.050 inch shall be cause for investigation by Engineering to determine the cause and if there is any abnormal degradation of the structural integrity of the containment.

3.6.3 The wire tensile test shall have no failure below the minimum guaranteed ultimate stress of 240,000 psi. The breaking strength of the sample shall be greater than the minimum breaking strength for the wire diameter shown on Enclosure 11: Minimum Wire Break Strengths. Elongation shall meet or exceed the minimum required value for the tendon material. Wire corrosion indicative of metal reduction shall not be present.

3.6.4 Acceptance criteria for tendon force shall be as defined in Steps 3.6.4.1 through 3.6.4.6.

3.6.4.1 IF the measured prestressing force of the selected tendon in a group lies above the BASE value, or is equal to or greater than 95% of the BASE value (as defined in reference 2.1.7.3),
THEN the lift-off test is acceptable for that selected tendon.

3.6.4.2 IF the measured prestressing force of a selected tendon in a group is less than 95% but greater than or equal to 90% of the BASE value,
THEN two adjacent tendons shall be checked for their prestressing forces.
IF the measured prestressing forces of each of the second and third tested tendons are equal to or greater than 95% of their BASE value,
AND the measured prestressing force in all remaining tendons in a group are equal to or greater than 95% of their BASE value,
THEN all three tendons shall be restored to their required BASE value of prestress and the three tendons shall be considered acceptable.

3.6.4.3 IF the measured prestressing force of any two adjoining tendons falls below 95% of their BASE values,
THEN Engineering shall initiate an investigation into the causes of the occurrence. This condition is unacceptable.

3.6.4.4 IF the measured prestressing force of the selected tendon lies below 90% of the BASE value,
THEN the tendon shall be considered defective. Engineering shall initiate an investigation, and determine the extent and cause of such occurrence and the required course of action to be taken. This condition is unacceptable.

3.6.4.5 The normalized average of all measured tendon forces for each tendon group (i.e., dome, vertical, hoop) shall be greater than the minimum required prestress level for that group (as defined in Step 3.3.14). Engineering shall review and disposition any conditions where this is not met.

3.6.4.6 Engineering shall review the results and trends of the measured prestress forces from consecutive surveillances.
IF it is determined that the trend of prestress loss for individual tendons, or for any of the three groups of tendons is larger than expected,
THEN Engineering shall determine the cause and extent of such occurrence.
IF this trend indicates that the resulting prestress forces will be less than the minimum

required prestress forces prior to the next scheduled surveillance, THEN additional testing and evaluation shall be performed prior to the completion of the current surveillance to determine the cause and extent of such occurrence. This condition is unacceptable.

3.6.5 Acceptance criteria for sheathing filler samples shall be as defined in Steps 3.6.5.1 through 3.6.5.6.

3.6.5.1 Water content shall not exceed 10% by weight.

3.6.5.2 Water soluble chlorides, nitrates, and sulfides shall not exceed 10 ppm.

3.6.5.3 Reserve alkalinity (base numbers) shall not be less than 50% of the installed value or less than zero when the installed value was less than 5. If the tendon duct is filled with a mixture of materials having various as-installed base numbers, the lowest number shall govern acceptance.

3.6.5.4 The absolute difference between the amount of grease removed and the amount of grease replaced on a given tendon shall not exceed 10% of the net duct volume.

3.6.5.5 Any grease leakage determined as a result of surveillance inspection activities shall be investigated and repaired using an Engineering approved procedure.

3.6.5.6 Presence of free water shall be measured, sampled and documented and evaluated by Engineering.

3.6.6 During detensioning and retensioning of tendons, if the elongation corresponding to a specific load differs by more than +/- 10% from that recorded during installation an investigation shall be made by Engineering to ensure that the difference is not related to wire failures or wire slips in anchorages. This condition is unacceptable.

3.7 **Prerequisites**

3.7.1 Equipment

The equipment items listed in this section are recommended for implementation of this inspection.

3.7.1.1 Mobile crane with sufficient capacity and boom length to perform all necessary lifts of equipment and materials into position for surveillance activities.

3.7.1.2 All platforms and rigging, scaffolding, hoisting equipment, and accessories for access to the tendons and for performance of all surveillance work.

3.7.1.3 Two hydraulic stressing jacks (ram) having a loading capacity of 1000 tons with stressing pumps, pressure gauges, controls, and adjustable ram support device. The range and divisions of the pressure gages must be such as to permit reading of a 1000 ton force within an accuracy of +/- 2%.

3.7.1.4 Portable metal scaffolds as required.

3.7.1.5 Portable platform or plywood to be used for supporting the tendon end cap when removed (2 feet x 2 feet minimum).

3.7.1.6 Grease pump, transmission lines, various fittings, etc., connected to 55-gallon drum, equipped with heating system to heat grease to a temperature between 130°F and 210°F.

3.7.1.7 Containers, such as 55-gallon drums, to hold bulk filler grease removed from end anchorages during inspection.

**NOTE**

**Permanent 480 volt electrical outlets exist on the top surface of the ring girder. There are five 480V, 3 phase receptacles on top of RB roof. Power provided by vent MCC 3a (MTMC-10) unit 5br located in IB119. See drawings 209-064, 209-131 sh 3 and 215 series for the one labeled RB160 South.**

3.7.1.8 Electrical cables or heavy duty extension cords as necessary for lights, hydraulic stressing jack pumps, and other miscellaneous power tools.

3.7.1.9 Portable lights for illuminating tendon anchorage assemblies during check for corrosion and defects.

3.7.1.10 A set of portable communications equipment for communicating between crews at each end of the tendon being inspected.

3.7.1.11 Feeler gages (required range of blade sizes: 0.025 inch to 0.035 inch by 0.001 inch increments).

3.7.1.12 Optical comparators with 0.005 inch accuracy for measuring crack widths in concrete.

3.7.1.13 Grid paper for showing crack patterns.

3.7.1.14 Magnifying glass, 5X.

3.7.1.15 Temperature gauge(s) with a range of 0°F to 300°F and an accuracy of +/- 2% of full scale.

3.7.1.16 Wrenches to remove grease can hold down studs (3/4") and nuts.

3.7.1.17 Extraction tool for removing wires subject to tensile tests.

3.7.1.18 Come-along hoist for applying force to wire extraction tool in Step 3.7.1.17 (or similar device).

3.7.1.19 Torque wrench for end cap replacement, 40 ft-lb through 75 ft-lb minimum capacity.

3.7.1.20 Six-foot diameter wire coiler to coil the removed wire.

3.7.1.21 Small portable power tools (e.g., electric drill, saw, etc.) as required.

3.7.1.22 Wire cutters to cut wires 3/8" diameter (maximum).

3.7.1.23 Wire brush.

3.7.1.24 Steel hand hammer (approximately 24 oz.).

**NOTE 1**

**The quantity is an estimate only; more or less may be required.**

**NOTE 2**

**The grease supplier must be acceptable to CR3 and qualified by the Surveillance Contractor's Quality Program for approving subcontractors and material suppliers.**

**NOTE 3**

**A certified test report bearing two signatures for the grease is required, indicating the water soluble chloride, sulfide, and nitrate content. The tests must be in accordance with the references specified in Section 2.1.1: Codes and Standard References. The water soluble chloride and sulfide content must not exceed 2 ppm and the water soluble nitrate content must not exceed 4 ppm.**

**NOTE 4**

**The reuse of grease from the end cap is acceptable provided a vendor-supplied procedure for reuse is accepted by CR3 in writing.**

3.7.1.25 An appropriate quantity of certified filler grease (Visconorust 2090-P4 or latest approved compatible formulation, by Viscosity Oil Company).

**NOTE**

**Chemical composition of solvent must be certified to meet requirements for Viscosity #16.**

3.7.1.26 Solvent that can be used for removing grease from around tendon anchorage and cleaning any stained concrete (Viscosity #16 solvent by Viscosity Oil Company, or equal solvent certified to meet the requirements for Viscosity #16, as approved by CR3).

**NOTE**

**Specifications of replacement materials delineated in Steps 3.7.1.27 through 3.7.1.31 shall be the same as those of the original items.**

3.7.1.27 New O-rings for hoop, dome, and upper vertical tendon end caps (1/2" dia., 60 durometer, neoprene or nitrile base rubber, 14-1/2" ID x 15-1/2" OD).

3.7.1.28 New O-rings for lower vertical tendon end caps (5/8" dia. 60 durometer, neoprene or nitrile base rubber, 15-3/8" ID x 16-5/8" OD).

3.7.1.29 3/4" dia x 4-1/2", 10 TPI, material ASTM A193 Grade B7 studs, hex nuts (ASTM A194 Grade 2H), and washer assemblies.

3.7.1.30 3/4"-10 thread per inch thread chaser.

**NOTE**

**Quantity is estimate only; more or less may be required.**

3.7.1.31 Wire split increment shims of various thicknesses, recommended quantity and sizes: 30 sets 3/16", 25 sets 1/4", 20 sets 3/8", 20 sets 1/2". Material to be ARMCO VNT single normalized ASTM A633, Grade E or equal.

3.7.1.32 Supply of clean rags for cleanup with solvent around anchorages.

3.7.1.33 Wooden or plastic paddles or spatulas to scoop out bulk filler grease from around the anchorage assembly.

3.7.1.34 Carbo Zinc 11, zinc-filled inorganic coating (made by Carboline Co., or equal, as determined by the NPTS and the manufacturer).

3.7.1.35 Non-metallic Epoxy.

3.7.1.36 Any other miscellaneous material and tools as required.

3.7.2 Initial Conditions

3.7.2.1 Perform a Pre-Job Briefing for each new crew/shift in accordance with AI-607, Pre-Job and Post-Job Briefings. This briefing is required once at the start of the work by that crew. Also, notify the Control Room Supervisor (or designee), at the beginning of each work day, that work is to begin on this procedure.

3.7.2.2 Missile shields shall be in place over Spent Fuel Pool "A" during surveillance activities for those tendons indicated in Enclosure 2, Identification of Surveillance Tendons - Inspection Period 8, and as defined in Steps 3.5.1.2 and 3.5.1.3, unless all equipment has been secured/rigged in accordance with NUREG-0612. The Maintenance Manager or designee shall review all equipment setup and rigging to ensure NUREG-0612 requirements have been met prior to performing work activities which could impact the spent fuel pool without the missile shields installed.

3.7.2.3 Read and understand the Limits & Precautions, Section 3.5.

3.7.2.4 Read and understand the Description, Section 3.2.

3.7.2.5 Ensure that all applicable equipment listed in Section 3.7.1, Equipment, is available and ready to be used.

3.7.2.6 Ensure that there is adequate access to all tendon end caps of tendons that are to be tested (see Enclosure 2: Identification of Surveillance Tendons - Inspection Period 8).

3.7.2.7 Ensure that the testing laboratory indicated in Step 3.2.9 is prepared to receive the wires.

3.7.2.8 Ensure that the testing laboratory indicated in Step 3.2.9 is prepared to receive the grease and free water samples.

3.7.2.9 Ensure references listed in Section 2.0, References, are available for use.

3.7.2.10 Ensure that all personnel are familiar with the operating manuals of the equipment to be used during the inspection.

**NOTE**

**Calibrated equipment must be re-calibrated at the end of the tendon surveillance program by the Post-Test Due Date in accordance with the requirements of that item.**

3.7.2.11 Verify that stressing jacks, pressure gauges, comparators, and all other measuring devices have been calibrated per Step 3.5.3.1 and are in good working condition AND that calibrations are not expected to expire during the time period it will take to perform this surveillance.
IF the calibration is expected to expire prior to completing the surveillance,
THEN have equipment re-calibrated prior to commencing the surveillance.

3.7.2.12 Notify the Radwaste Organization that waste grease will need proper disposal.

3.7.2.13 Notify the NQC Supervisor or his designee that work is to begin on this procedure.

## 4.0 INSTRUCTIONS

Refer to Precision Surveillance Corporation's Inservice Inspection Manual N1002 for the step-by-step instructions to be followed for the 8th Tendon Surveillance at Crystal River Unit #3.

Only "controlled" copies of PSC's In-Service Inspection Manual N1002 shall be used for the performance of this surveillance.

## 5.0 FOLLOW-UP ACTIONS

### 5.1 Restoration Instructions

5.1.1 System restoration is accomplished during performance of Section 4.0: Instructions.

5.1.2 Repair procedures shall be developed and performed in accordance with IWL-4000.

5.1.3 Post repair system pressure testing requirements shall be developed and performed in accordance with IWL-5000.

5.1.4 Reinstallation and replacement requirements of the post-tensioning system shall be developed and performed in accordance with IWL-7000.

### 5.2 Contingencies

5.2.1 IF the acceptance criteria of Step 3.6.4.5 is not met,
AND engineering evaluation cannot ascertain acceptability of the containment tendons,
THEN refer immediately to the "Action Statement" of Technical Specification 3.6.1, Containment, and Technical Specification 5.7.2, Special Reports.

5.2.2 IF any of the acceptance criteria of Steps 3.6.2, 3.6.3, 3.6.4.3, 3.6.4.4, 3.6.4.6, 3.6.5, and 3.6.6 are not met,
THEN it shall be evaluated by Engineering per IWL-3300.

5.2.3 IF there is rejectable corrosion or pitting on the wire as defined in Enclosure 8, Criteria and Categories For Rating Degrees of Corrosion on Tendon Anchorage Assemblies and Selected Wires,
OR, if existing broken or unseated wires and/or detached buttonheads were not documented and accepted during a pre-service examination or during previous inspections,
OR, if the number of missing, broken, and/or damaged wires does not meet the criteria of Enclosure 9, Criteria For Missing, Broken, and/or Damaged Wires,
THEN each case shall be evaluated by Engineering per IWL-3300.

5.2.4 IF there is rejectable corrosion, pitting, or cracking, as defined in Enclosure 8, Criteria and Categories For Rating Degrees of Corrosion on Tendon Anchorage Assemblies and Selected Wires, on the tendon anchorage assembly,
THEN it shall be evaluated by Engineering per IWL-3300.

5.2.5 IF the post-test calibration of the equipment used to measure tendon force (Step 3.5.3.1) differs from the pretest calibration by more than the specified accuracy tolerance,
THEN the results of the examination shall be evaluated by Engineering.

**5.3 Reports**

5.3.1 Surveillance Contractors Report

A written report documenting the inspection results, laboratory test results and surveillance conclusions for each inspection period must be prepared and submitted to CR3 within 30 days of completion of the inspections and tests. The surveillance contractor's approved report and all data must be forwarded to Engineering.

5.3.2 Reportable Conditions

In the event that the acceptance criteria in Section 3.6 is not met, the Surveillance Contractor shall notify Engineering within 1 working day. Engineering shall follow the reporting process defined in CP-151: External Reporting Requirements (Step 2.1.3.5). If Engineering determines that there is abnormal degradation of the containment structure (based on the contingency actions in Section 5.2: Contingencies), CR3 shall submit a report to the NRC within 30 days of the current surveillance completion. This report shall include a description of the degradation, operability determination, root cause determination and the corrective action.

5.3.3 Procedure Closure

Upon completion of each Tendon Surveillance, Engineering is to ensure that SP-182 and Precision Surveillance Corporation Manual N1002 are transmitted to Records Management.

5.3.4 Evaluation Summary Report

A written summary report of the results and conclusions for each inspection period must be prepared within 90 days of the completion of the tests and inspections. The report shall also include items that did not meet the acceptance criteria and were evaluated by Engineering and address the following:

- the cause of the condition which did not meet the acceptance criteria
- the acceptability of the concrete containment without repair of the item
- whether or not repair or replacement is required and, if required, the extent, method, and completion date for the repair or replacement
- extent, nature, and frequency of additional examinations

This report shall be submitted to the NRC as part of the 90 ISI Summary Report.

## IDENTIFICATION OF SURVEILLANCE TENDONS FROM PRIOR SURVEILLANCE PERIODS

| | 1ST SURVEILLANCE 11/77-2/78 | 2ND SURVEILLANCE 3/80-5/80 | 3RD SURVEILLANCE 9/81-12/81 | 4TH SURVEILLANCE 9/87-11/87 | 5TH SURVEILLANCE 11/93-1/94 | 6TH SURVEILLANCE 10/97-1/98 | 7TH SURVEILLANCE 08/01-12/01 |
|---|---|---|---|---|---|---|---|
| DOME TENDONS 123 TOTAL 3 GROUPS OF 41 D100s, D200s, D300s | D139 | D122 | D123 | D105 D | D215 | D212 | D212 |
| | D215 | D140 | D125 | D212 | D231 D | D304 D | D339 D |
| | D221 D | D208 D | D212 | D328 | D224 | D113 | D126 |
| | D228 | D323 | D322 D | | | D115 | |
| | D234 | D331 | D329 | | | D311 | |
| | D340 | | | | | | |
| VERTICAL TENDONS 144 TOTAL 6 GROUPS OF 24 12, 34, 56, 23, 45, 61 | 12V19 | 12V12 | 12V1 | 12V1 | 34V6 | 12V1 | 12V1 |
| | 12V20 | 12V20 | 34V6 | 34V4 | 56V15 D | 61V21 D | 61V08 |
| | 12V21 | 23V5 | 34V19 D | 56V2 D | 61V14 | 23V2 | 45V14 D |
| | 23V15 | 34V1 | 45V16 | | | | |
| | 34V6 | 45V6 | 56V11 | | | | |
| | 45V3 D | 56V20 | 61V5 | | | | |
| | 56V1 | 56V1 D | | | | | |
| HORIZONTAL TENDONS 282 TOTAL 6 GROUPS @ 47 HIGH, 13, 24, 35, 46, 51, 62 | 13H10 | 13H22 | 13H19 | 13H20 | 34H1 | 51H26 | 46H21 |
| | 13H19 | 13H32 D | 13H46 | 13H40 D | 42H1 | 42H18 | 46H36 |
| | 13H37 | 13H43 | 42H20 | 51H26 | 46H21 | 42H32 | 53H16 D |
| | 13H47 | 51H10 | 42H40 | 51H41 | 46H28 | 42H44 | 62H02 |
| | 51H11 | 51H23 | 51H26 | 64H19 | 46H29 D | 53H2 | 62H13 |
| | 62H9 | 51H37 | 51H45 | | 46H30 | 62H41 D | |
| | 64H21 | 53H24 | 53H35 | | 46H47 D | 62H46 | |
| | 64H29 | 53H28 | 53H40 | | 62H8 | 53H46 | |
| | 64H37 D | 53H44 | 62H34 | | | 42H49 | |
| | 64H46 | 64H42 | 64H10 D | | | 42H30 | |
| | | | | | | 42H31 | |
| | | | | | | 42H33 | |
| | | | | | | 42H34 | |
| | | | | | | 42H35 | |
| TENDONS INSP. | 23 | 22 | 21 | 11 | 14 | 22 | 11 |
| TOTAL TENDONS = 549 | | | | | | | |
| TOTAL TENDONS INSPECTED UP TO 7TH SURVEILLANCE = 124 | | | | | | | |

NOTE: For information only. These tendons were completed in past surveillance.
D – Designates a detensioned tendon.

## IDENTIFICATION OF SURVEILLANCE TENDONS
## INSPECTION PERIOD 8

| SELECTED DOME TENDONS | ADJACENT TENDONS |
|---|---|
| D129 * ** | D128, D130 |
| D212 C | D211, D213 |
| D238 D,* | D237, D239 |

| SELECTED VERTICAL TENDONS | ADJACENT TENDONS |
|---|---|
| 12V1 C ** | 61V24, 12V2 |
| 45V20 D | 45V19, 45V21 |
| 61V17 | 61V16, 61V18 |

| SELECTED HOOP TENDONS | ADJACENT TENDONS |
|---|---|
| 46H21 C,* | 46H20, 46H22 |
| 42H46 ** | 42H45, 42H47 |
| 13H36 | 13H35, 13H37 |
| 62H30 * ** | 62H29, 62H31 |
| 51H34D ** | 51H33, 51H35 |

C Denotes selected control tendon.

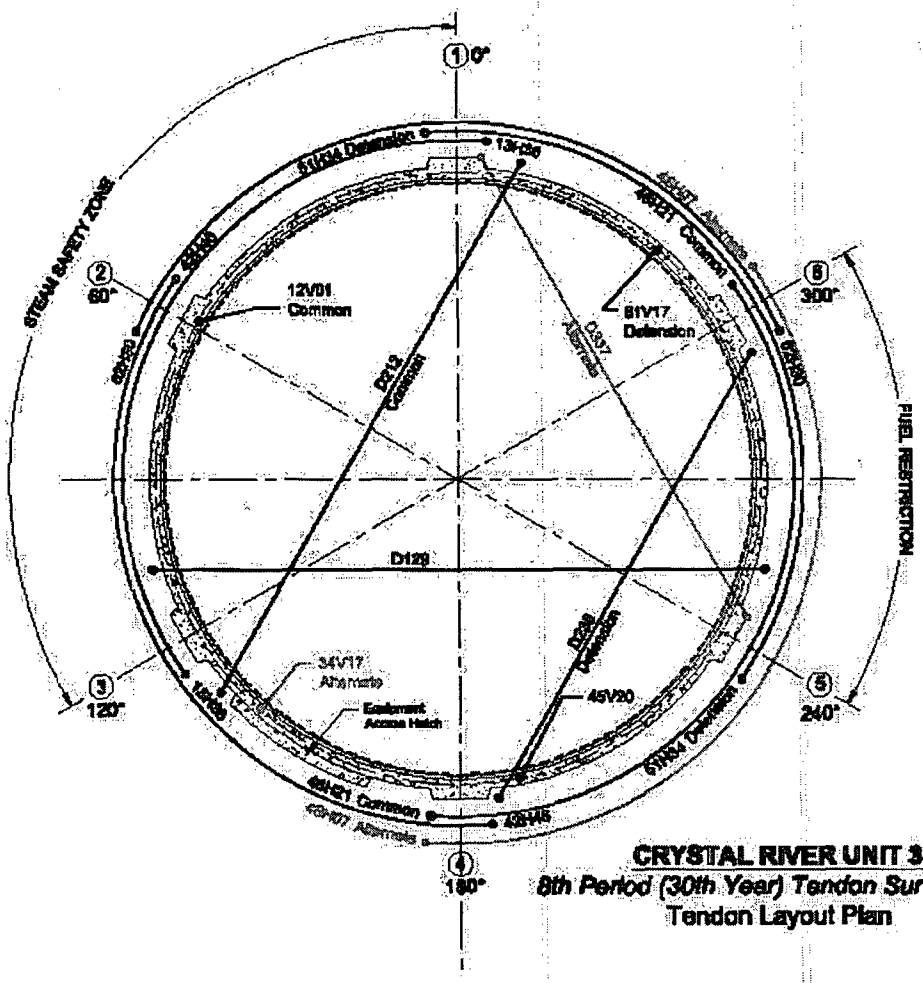
D Denotes selected tendon for detensioning and wire removal. If removal of one wire from tendon would subject it to rejection per Enclosure 9, Criteria For Missing, Broken, and/or Damaged Wires, contact Engineering for a substitute tendon.

*Denotes tendons, if any, which must have missile shields in-place over Fuel Pool "A", per Step 3.7.2.2, unless all equipment has been secured/rigged in accordance with NUREG-0612.

**Denotes tendons, if any, located in the Steam Zone Region.

ENCLOSURE 3

DOME, VERTICAL, and HOOP TENDON LOCATION PLAN – INSPECTION PERIOD 8

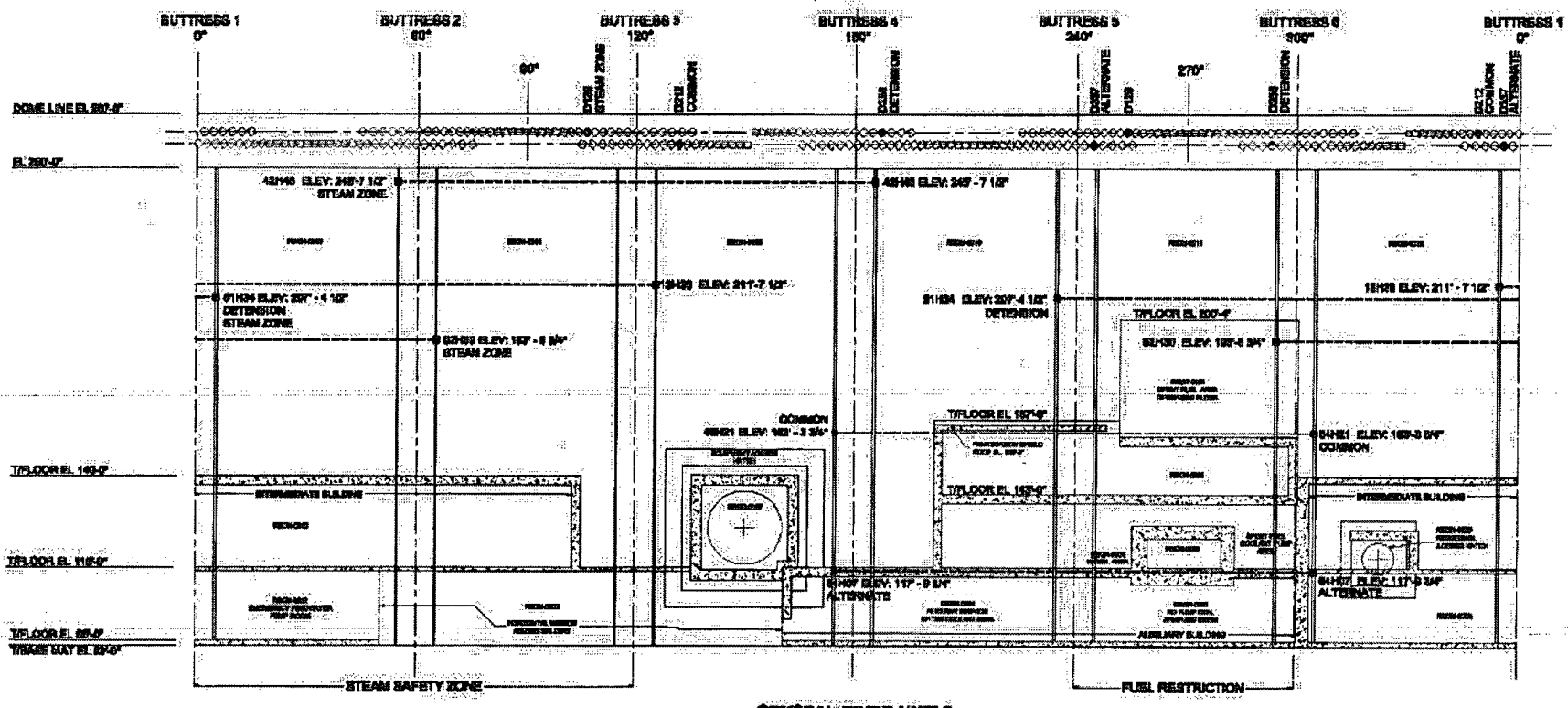



**CRYSTAL RIVER UNIT 3**

***8th Period (30th Year) Tendon Surveillance***

**Tendon Layout Plan**

## DOME and HOOP TENDON LOCATION PLAN – INSPECTION PERIOD 8




**CRYSTAL RIVER UNIT 3**
*8th Period (30th Year) Tendon Surveillance*
Tendon Layout Elevation

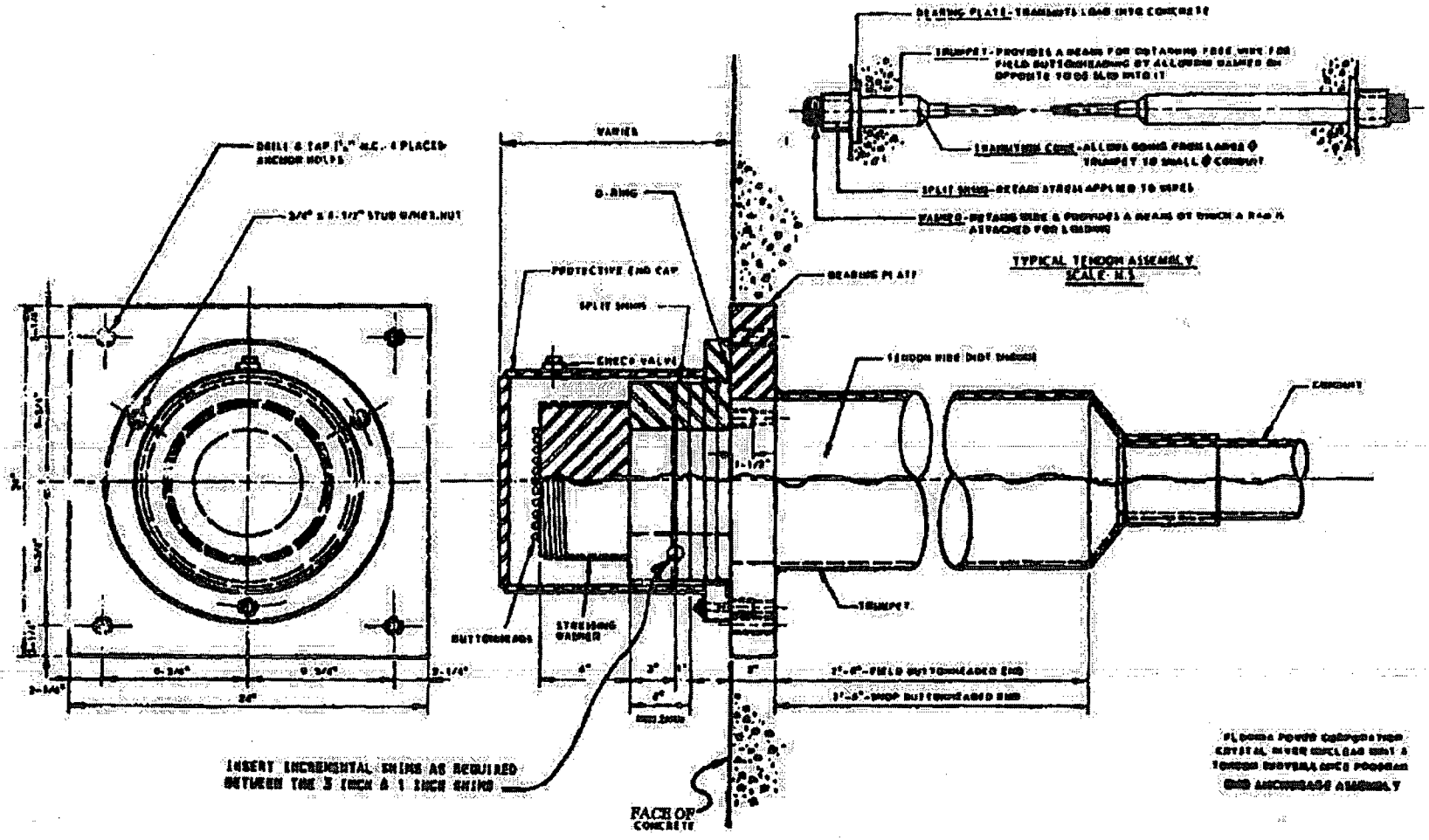
ENCLOSURE 5

## REDUCED FORCE DOME TENDONS

The following tendons are not acceptable for normal lift-off testing:

| | | |
|---|---|---|
| D 101 | D 201 | D 301 |
| D 109 | D 209 | D 309 |
| D 117 | D 217 | D 317 |
| D 125 | D 225 | D 325 |
| D 133 | D 233 | D 333 |
| D 141 | D 241 | D 341 |

## ANCHORAGE ASSEMBLY DETAIL



ENCLOSURE 7

## CRITERIA AND CATEGORIES FOR RATING DEGREES OF CORROSION ON TENDON ANCHORAGE ASSEMBLIES AND SELECTED WIRES

### CATEGORIES OF CORROSION

1. Bright metal; no visible oxidation.
2. Metal reddish brown color, no pitting.
3. Metal having patches of red oxide, removable but ready to start pitting.
4. Metal having patches of red oxide, not removable and/or leaving noticeable pits.
5. Metal having heavy rusting, dark red, and about to form an extremely hard crust which when removed leaves very noticeable pitting.
6. Conditions more severe than Category 5.

### ACCEPTANCE CRITERIA

Anchorage assembly components in Category 1, 2, or 3 are acceptable.

Wire in Category 1 or 2 is acceptable.

Anchorage assembly components in Category 4, 5, or 6 and/or wires in Category 3, 4, 5, or 6 should be further evaluated by NPTS.

### CRITERIA FOR VISUAL INSPECTION OF GREASE

Note that the original Visconorust 2090-P2 grease is no longer available. The new 2090-P4 grease will not be the exact color as the original 2090-P2 grease when it was new. Therefore, color comparisons of old grease against new grease must be made considering this basic difference.

Note if any of the following items are observed during visual inspection of the grease:

1. Extreme discoloration even when considering the above change in grease type.
2. Presence of corrosive particles and/or dirt mixed within the grease, indicating adjacent metal pitting and metal breakdown.
3. Signs of moisture within the bulk filler.
4. Other signs of grease deterioration.

ENCLOSURE 8

## CRITERIA FOR MISSING, BROKEN, AND/OR DAMAGED WIRES

1. Broken wires and unacceptable buttonheads shall not exceed 8 wires per individual tendon, nor more than 2 percent of the total number of wires in that group, nor more than 3 percent in any 10 consecutive tendons in a group. A group shall be defined as follows: Vertical tendons - one stressing sequence quadrant (36 tendons); Dome tendons - one series of layer (41 tendons); Hoop tendons - one side of a buttress (47 tendons).

2. An unseated wire, after stressing, that will move at one end of the tendon but is observed not to move at the other end is to be considered a broken wire.

   **CAUTION - Do not strike the buttonhead with any heavy object.**

3. If an unseated wire, after stressing, will not move - document and notify Engineering.

NOTE: Missing, broken, and/or damaged wire criteria is based on original quantity of 163 wires per tendon.

## ORIGINAL ACCEPTANCE CRITERIA FOR BUTTONHEADS

## PRECISION BUTTONHEADS – 0.275" ϕ/ (7mm) WIRE

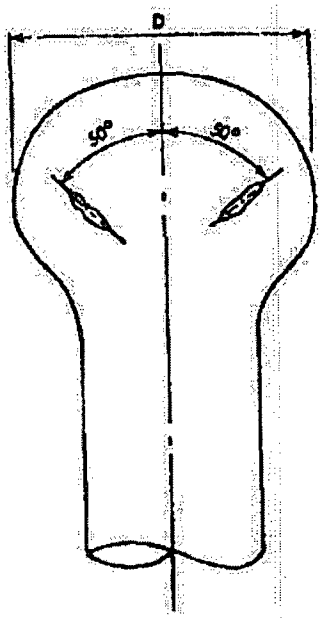
1. DIMENSIONS

| | |
|---|---|
| Diameter – D | |
| Minimum | 0.410" |
| Maximum | 0.450" |

2. SPLITS

| | |
|---|---|
| Maximum admissible number | 4 |
| Maximum admissible width | 0.060" Per Split |
| Maximum admissible length | 0.350" Per Split |
| Maximum admissible angle to axis of wire | 50° |

NOTE: This is the criteria for new buttonheads and is given in this detail for reference only. The checks called for in Section 4.0, Instructions, of the procedure are not meant to verify these numbers, but they are meant to detect obvious gross deficiencies in any buttonhead.



## MINIMUM WIRE BREAK STRENGTHS

(Tinius-Olson Direct Reading - High Scale or Equal)

| WIRE DIAMETER (inch) | CROSS SECTIONAL AREA (sq in) | ULTIMATE TENSILE STRENGTH | MINIMUM BREAK (kips) (1,000 lbs) |
|---|---|---|---|
| 0.27359 (-) | 0.05879 | 240 ksi | 14.110 |
| 0.27459 (-) | 0.05922 | 240 ksi | 14.213 |
| 0.27559 (7 mm) | 0.05965 | 240 ksi | 14.316 |
| 0.27659 (+) | 0.06008 | 240 ksi | 14.316+ |
| 0.27759 (+) | 0.06052 | 240 ksi | 14.316+ |

ENCLOSURE 11
(Page 1 of 4)

## ORIGINAL STRESSING AVERAGE TENDON LIFT-OFF VALUES
## VERTICAL TENDONS

| TENDON I.D. | LIFT-OFF | TENDON I.D. | LIFT-OFF | TENDON I.D. | LIFT-OFF |
|---|---|---|---|---|---|
| 12 V 1 | 1675 | 34 V 1 | 1651 | 56 V 1* | 1784 |
| 12 V 2 | 1699 | 34 V 2 | 1588 | 56 V 2* | 1603 |
| 12 V 3 | 1687 | 34 V 3 | 1597 | 56 V 3 | 1694 |
| 12 V 4 | 1651 | 34 V 4 | 1585 | 56 V 4 | 1658 |
| 12 V 5 | 1711 | 34 V 5 | 1633 | 56 V 5 | 1696 |
| 12 V 6 | 1586 | 34 V 6 | 1609 | 56 V 6 | 1622 |
| 12 V 7 | 1574 | 34 V 7 | 1646 | 56 V 7 | 1633 |
| 12 V 8 | 1615 | 34 V 8 | 1621 | 56 V 8 | 1602 |
| 12 V 9 | 1634 | 34 V 9 | 1605 | 56 V 9 | 1654 |
| 12 V 10 | 1615 | 34 V 10 | 1709 | 56 V 10 | 1598 |
| 12 V 11 | 1669 | 34 V 11 | 1605 | 56 V 11 | 1658 |
| 12 V 12 | 1670 | 34 V 12 | 1696 | 56 V 12 | 1646 |
| 12 V 13 | 1675 | 34 V 13 | 1644 | 56 V 13 | 1685 |
| 12 V 14 | 1687 | 34 V 14 | 1648 | 56 V 14 | 1687 |
| 12 V 15 | 1625 | 34 V 15 | 1655 | 56 V 15* | 1638 |
| 12 V 16 | 1598 | 34 V 16 | 1639 | 56 V 16 | 1651 |
| 12 V 17 | 1650 | 34 V 17 | 1663 | 56 V 17 | 1617 |
| 12 V 18 | 1639 | 34 V 18 | 1633 | 56 V 18 | 1699 |
| 12 V 19 | 1654 | 34 V 19* | 1573 | 56 V 19 | 1664 |
| 12 V 20 | 1598 | 34 V 20 | 1637 | 56 V 20 | 1687 |
| 12 V 21 | 1638 | 34 V 21 | 1660 | 56 V 21 | 1661 |
| 12 V 22 | 1655 | 34 V 22 | 1624 | 56 V 22 | 1665 |
| 12 V 23 | 1638 | 34 V 23 | 1646 | 56 V 23 | 1651 |
| 12 V 24 | 1624 | 34 V 24 | 1648 | 56 V 24 | 1675 |
| 23 V 1 | 1711 | 45 V 1 | 1686 | 61 V 1 | 1629 |
| 23 V 2 | 1598 | 45 V 2 | 1627 | 61 V 2 | 1629 |
| 23 V 3 | 1661 | 45 V 3* | 1639 | 61 V 3 | 1627 |
| 23 V 4 | 1670 | 45 V 4 | 1610 | 61 V 4 | 1663 |
| 23 V 5 | 1711 | 45 V 5 | 1649 | 61 V 5 | 1643 |
| 23 V 6 | 1670 | 45 V 6 | 1614 | 61 V 6 | 1658 |
| 23 V 7 | 1636 | 45 V 7 | 1607 | 61 V 7 | 1675 |
| 23 V 8 | 1676 | 45 V 8 | 1675 | 61 V 8 | 1598 |
| 23 V 9 | 1627 | 45 V 9 | 1661 | 61 V 9 | 1625 |
| 23 V 10 | 1616 | 45 V 10 | 1677 | 61 V 10 | 1598 |
| 23 V 11 | 1673 | 45 V 11 | 1696 | 61 V 11 | 1643 |
| 23 V 12 | 1646 | 45 V 12 | 1603 | 61 V 12 | 1610 |
| 23 V 13 | 1687 | 45 V 13 | 1673 | 61 V 13 | 1711 |
| 23 V 14 | 1646 | 45 V 14* | 1697 | 61 V 14 | 1646 |
| 23 V 15 | 1615 | 45 V 15 | 1625 | 61 V 15 | 1590 |
| 23 V 16 | 1598 | 45 V 16 | 1661 | 61 V 16 | 1628 |
| 23 V 17 | 1660 | 45 V 17 | 1683 | 61 V 17 | 1646 |
| 23 V 18 | 1598 | 45 V 18 | 1661 | 61 V 18 | 1598 |
| 23 V 19 | 1598 | 45 V 19 | 1624 | 61 V 19 | 1591 |
| 23 V 20 | 1633 | 45 V 20 | 1624 | 61 V 20 | 1634 |
| 23 V 21 | 1663 | 45 V 21 | 1629 | 61 V 21* | 1622 |
| 23 V 22 | 1622 | 45 V 22 | 1672 | 61 V 22 | 1622 |
| 23 V 23 | 1639 | 45 V 23 | 1634 | 61 V 23 | 1663 |
| 23 V 24 | 1634 | 45 V 24 | 1684 | 61 V 24 | 1616 |

*Tendons detensioned and/or retensioned during previous inspections.

[All Lift-off Values in kips (1000#)]

## ORIGINAL STRESSING AVERAGE TENDON LIFT-OFF VALUES (Cont'd)
## DOME TENDONS

| TENDON I.D. | LIFT-OFF | TENDON I.D. | LIFT-OFF | TENDON I.D. | LIFT-OFF |
|---|---|---|---|---|---|
| D101 | 643* | D201 | 652* | D301 | 660* |
| D102 | 1660 | D202 | 1649 | D302 | 1581 |
| D103 | 1606 | D203 | 1662 | D303 | 1653 |
| D104 | 1606 | D204 | 1649 | D304** | 1610 |
| D105** | 1646 | D205 | 1642 | D305 | 1629 |
| D106 | 1626 | D206 | 1643 | D306 | 1643 |
| D107 | 1667 | D207 | 1657 | D307 | 1656 |
| D108 | 1646 | D208** | 1648 | D308 | 1646 |
| D109 | 643* | D209 | 640* | D309 | 649* |
| D110 | 1622 | D210 | 1616 | D310 | 1636 |
| D111 | 1673 | D211 | 1689 | D311 | 1682 |
| D112 | 1676 | D212 | 1600 | D312 | 1640 |
| D113 | 1676 | D213 | 1646 | D313 | 1636 |
| D114 | 1670 | D214 | 1642 | D314 | 1621 |
| D115 | 1700 | D215 | 1666 | D315 | 1607 |
| D116 | 1646 | D216 | 1614 | D316 | 1604 |
| D117 | 658* | D217 | 660* | D317 | 660* |
| D118 | 1563 | D218 | 1626 | D318 | 1635 |
| D119 | 1642 | D219 | 1639 | D319 | 1697 |
| D120 | 1652 | D220 | 1619 | D320 | 1653 |
| D121 | 1633 | D221** | 1670 | D321 | 1668 |
| D122 | 1664 | D222 | 1649 | D322** | 1628 |
| D123 | 1610 | D223 | 1655 | D323 | 1670 |
| D124 | 1634 | D224 | 1598 | D324 | 1664 |
| D125 | 634* | D225 | 649* | D325 | 660* |
| D126 | 1634 | D226 | 1625 | D326 | 1640 |
| D127 | 1634 | D227 | 1649 | D327 | 1661 |
| D128 | 1660 | D228 | 1669 | D328 | 1670 |
| D129 | 1619 | D229 | 1650 | D329 | 1645 |
| D130 | 1635 | D230 | 1665 | D330 | 1634 |
| D131 | 1600 | D231** | 1651 | D331 | 1636 |
| D132 | 1620 | D232 | 1603 | D332 | 1667 |
| D133 | 652* | D233 | 652* | D333 | 660* |
| D134 | 1640 | D234 | 1643 | D334 | 1598 |
| D135 | 1673 | D235 | 1632 | D335 | 1669 |
| D136 | 1679 | D236 | 1591 | D336 | 1616 |
| D137 | 1562 | D237 | 1661 | D337 | 1622 |
| D138 | 1645 | D238 | 1664 | D338 | 1638 |
| D139 | 1686 | D239 | 1615 | D339* | 1639 |
| D140 | 1669 | D240 | 1615 | D340 | 1634 |
| D141 | 649* | D241 | 660* | D341 | 652* |

*Reduced Force Tendons
**Tendons detensioned and/or retensioned during previous inspections.

[All Lift-off Values in kips (1000#)]

## ORIGINAL STRESSING AVERAGE TENDON LIFT-OFF VALUES (Cont'd)
## HOOP TENDONS

| TENDON I.D. | LIFT-OFF | TENDON I.D. | LIFT-OFF | TENDON I.D. | LIFT-OFF |
|---|---|---|---|---|---|
| 13 H 1 | 1629 | 53 H 1 | 1640 | 64 H 1 | 1642 |
| 13 H 2 | 1640 | 53 H 2 | 1555 | 64 H 2 | 1701 |
| 13 H 3 | 1630 | 53 H 3 | 1598 | 64 H 3 | 1649 |
| 13 H 4 | 1640 | 53 H 4 | 1645 | 64 H 4 | 1628 |
| 13 H 5 | 1643 | 53 H 5 | 1606 | 64 H 5 | 1579 |
| 13 H 6 | 1658 | 53 H 6 | 1627 | 64 H 6 | 1628 |
| 13 H 7 | 1630 | 53 H 7 | 1622 | 64 H 7 | 1643 |
| 13 H 8 | 1634 | 53 H 8 | 1673 | 64 H 8 | 1646 |
| 13 H 9 | 1593 | 53 H 9 | 1591 | 64 H 9 | 1623 |
| 13 H 10 | 1604 | 53 H 10 | 1650 | 64 H 10* | 1646 |
| 13 H 11 | 1606 | 53 H 11 | 1584 | 64 H 11 | 1635 |
| 13 H 12 | 1598 | 53 H 12 | 1663 | 64 H 12 | 1616 |
| 13 H 13 | 1691 | 53 H 13 | 1615 | 64 H 13 | 1649 |
| 13 H 14 | 1604 | 53 H 14 | 1609 | 64 H 14 | 1680 |
| 13 H 15 | 1624 | 53 H 15 | 1651 | 64 H 15 | 1589 |
| 13 H 16 | 1595 | 53 H 16* | 1639 | 64 H 16 | 1616 |
| 13 H 17 | 1630 | 53 H 17 | 1603 | 64 H 17 | 1617 |
| 13 H 18 | 1618 | 53 H 18 | 1657 | 64 H 18 | 1670 |
| 13 H 19 | 1625 | 53 H 19 | 1604 | 64 H 19 | 1617 |
| 13 H 20 | 1604 | 53 H 20 | 1633 | 64 H 20 | 1665 |
| 13 H 21 | 1642 | 53 H 21 | 1634 | 64 H 21 | 1653 |
| 13 H 22 | 1652 | 53 H 22 | 1651 | 64 H 22 | 1665 |
| 13 H 23 | 1649 | 53 H 23 | 1609 | 64 H 23 | 1637 |
| 13 H 24 | 1646 | 53 H 24 | 1621 | 64 H 24 | 1653 |
| 13 H 25 | 1643 | 53 H 25 | 1663 | 64 H 25 | 1657 |
| 13 H 26 | 1628 | 53 H 26 | 1650 | 64 H 26 | 1635 |
| 13 H 27 | 1618 | 53 H 27 | 1627 | 64 H 27 | 1655 |
| 13 H 28 | 1658 | 53 H 28 | 1626 | 64 H 28* | 1690 |
| 13 H 29 | 1607 | 53 H 29 | 1669 | 64 H 29* | 1667 |
| 13 H 30 | 1658 | 53 H 30 | 1704 | 64 H 30 | 1642 |
| 13 H 31 | 1635 | 53 H 31 | 1532 | 64 H 31 | 1655 |
| 13 H 32* | 1653 | 53 H 32 | 1668 | 64 H 32 | 1635 |
| 13 H 33 | 1623 | 53 H 33 | 1646 | 64 H 33 | 1648 |
| 13 H 34 | 1641 | 53 H 34 | 1632 | 64 H 34 | 1702 |
| 13 H 35 | 1631 | 53 H 35 | 1604 | 64 H 35 | 1655 |
| 13 H 36 | 1650 | 53 H 36 | 1655 | 64 H 36 | 1678 |
| 13 H 37 | 1629 | 53 H 37 | 1664 | 64 H 37* | 1617 |
| 13 H 38 | 1612 | 53 H 38 | 1643 | 64 H 38 | 1645 |
| 13 H 39 | 1671 | 53 H 39 | 1616 | 64 H 39 | 1665 |
| 13 H 40* | 1623 | 53 H 40 | 1660 | 64 H 40 | 1586 |
| 13 H 41 | 1660 | 53 H 41 | 1634 | 64 H 41 | 1611 |
| 13 H 42 | 1660 | 53 H 42 | 1622 | 64 H 42 | 1599 |
| 13 H 43 | 1641 | 53 H 43 | 1646 | 64 H 43 | 1641 |
| 13 H 44 | 1654 | 53 H 44 | 1653 | 64 H 44 | 1641 |
| 13 H 45 | 1635 | 53 H 45 | 1634 | 64 H 45 | 1647 |
| 13 H 46 | 1623 | 53 H 46 | 1628 | 64 H 46 | 1644 |
| 13 H 47 | 1623 | 53 H 47 | 1688 | 64 H 47* | 1623 |

*Tendons detensioned and/or retensioned during previous inspections.

[All Lift-off Values in kips (1000#)]

## ORIGINAL STRESSING AVERAGE TENDON LIFT-OFF VALUES (Cont'd)
## HOOP TENDONS

| TENDON I.D. | LIFT-OFF | TENDON I.D. | LIFT-OFF | TENDON I.D. | LIFT-OFF |
|---|---|---|---|---|---|
| 51 H 1 | 1639 | 42 H 1 | 1645 | 62 H 1 | 1603 |
| 51 H 2 | 1620 | 42 H 2 | 1650 | 62 H 2 | ** |
| 51 H 3 | 1645 | 42 H 3 | 1653 | 62 H 3 | 1615 |
| 51 H 4 | 1625 | 42 H 4 | 1672 | 62 H 4 | 1631 |
| 51 H 5 | 1675 | 42 H 5 | 1605 | 62 H 5 | 1672 |
| 51 H 6 | 1608 | 42 H 6 | 1679 | 62 H 6 | 1603 |
| 51 H 7 | 1608 | 42 H 7 | 1647 | 62 H 7 | 1603 |
| 51 H 8 | 1644 | 42 H 8 | 1665 | 62 H 8 | 1624 |
| 51 H 9 | 1627 | 42 H 9 | 1641 | 62 H 9 | 1639 |
| 51 H 10 | 1674 | 42 H 10 | 1645 | 62 H 10 | 1604 |
| 51 H 11 | 1615 | 42 H 11 | 1599 | 62 H 11 | 1603 |
| 51 H 12 | 1668 | 42 H 12 | 1614 | 62 H 12 | 1675 |
| 51 H 13 | 1644 | 42 H 13 | 1597 | 62 H 13 | 1663 |
| 51 H 14 | 1644 | 42 H 14 | 1622 | 62 H 14 | 1603 |
| 51 H 15 | 1651 | 42 H 15 | ** | 62 H 15 | 1681 |
| 51 H 16 | 1649 | 42 H 16 | 1635 | 62 H 16 | 1627 |
| 51 H 17 | 1663 | 42 H 17 | 1661 | 62 H 17 | 1675 |
| 51 H 18 | 1608 | 42 H 18 | 1664 | 62 H 18 | 1609 |
| 51 H 19 | 1669 | 42 H 19 | 1647 | 62 H 19 | 1640 |
| 51 H 20 | 1668 | 42 H 20 | 1662 | 62 H 20 | 1610 |
| 51 H 21 | 1669 | 42 H 21 | 1641 | 62 H 21 | 1640 |
| 51 H 22 | 1638 | 42 H 22 | 1668 | 62 H 22 | 1663 |
| 51 H 23 | 1609 | 42 H 23 | 1617 | 62 H 23 | 1639 |
| 51 H 24 | 1644 | 42 H 24 | 1617 | 62 H 24 | 1639 |
| 51 H 25 | 1639 | 42 H 25 | 1647 | 62 H 25 | 1627 |
| 51 H 26 | 1661 | 42 H 26 | 1614 | 62 H 26 | 1663 |
| 51 H 27 | 1612 | 42 H 27 | 1635 | 62 H 27 | 1669 |
| 51 H 28 | 1668 | 42 H 28 | 1632 | 62 H 28 | 1633 |
| 51 H 29 | 1629 | 42 H 29 | 1629 | 62 H 29 | ** |
| 51 H 30 | 1657 | 42 H 30 | 1644 | 62 H 30 | 1597 |
| 51 H 31 | 1646 | 42 H 31 | 1653 | 62 H 31 | 1681 |
| 51 H 32 | 1658 | 42 H 32 | 1626 | 62 H 32 | 1639 |
| 51 H 33 | 1650 | 42 H 33 | 1665 | 62 H 33 | 1674 |
| 51 H 34 | 1651 | 42 H 34 | 1626 | 62 H 34 | 1626 |
| 51 H 35 | 1608 | 42 H 35 | 1657 | 62 H 35 | 1664 |
| 51 H 36 | 1616 | 42 H 36 | 1680 | 62 H 36 | 1639 |
| 51 H 37 | 1606 | 42 H 37 | 1641 | 62 H 37 | 1622 |
| 51 H 38 | 1628 | 42 H 38 | 1650 | 62 H 38 | 1639 |
| 51 H 39 | 1607 | 42 H 39 | 1623 | 62 H 39 | ** |
| 51 H 40 | 1664 | 42 H 40 | 1651 | 62 H 40 | 1639 |
| 51 H 41 | 1631 | 42 H 41 | 1623 | 62 H 41* | 1609 |
| 51 H 42 | 1610 | 42 H 42 | 1599 | 62 H 42 | 1609 |
| 51 H 43 | 1642 | 42 H 43 | 1611 | 62 H 43 | 1591 |
| 51 H 44 | 1646 | 42 H 44 | 1605 | 62 H 44 | 1651 |
| 51 H 45 | 1581 | 42 H 45 | 1665 | 62 H 45 | 1622 |
| 51 H 46 | 1657 | 42 H 46 | 1644 | 62 H 46 | 1645 |
| 51 H 47 | 1663 | 42 H 47 | 1615 | 62 H 47 | 1582 |

*Tendons detensioned and/or retensioned during previous inspections.
**Not Available.

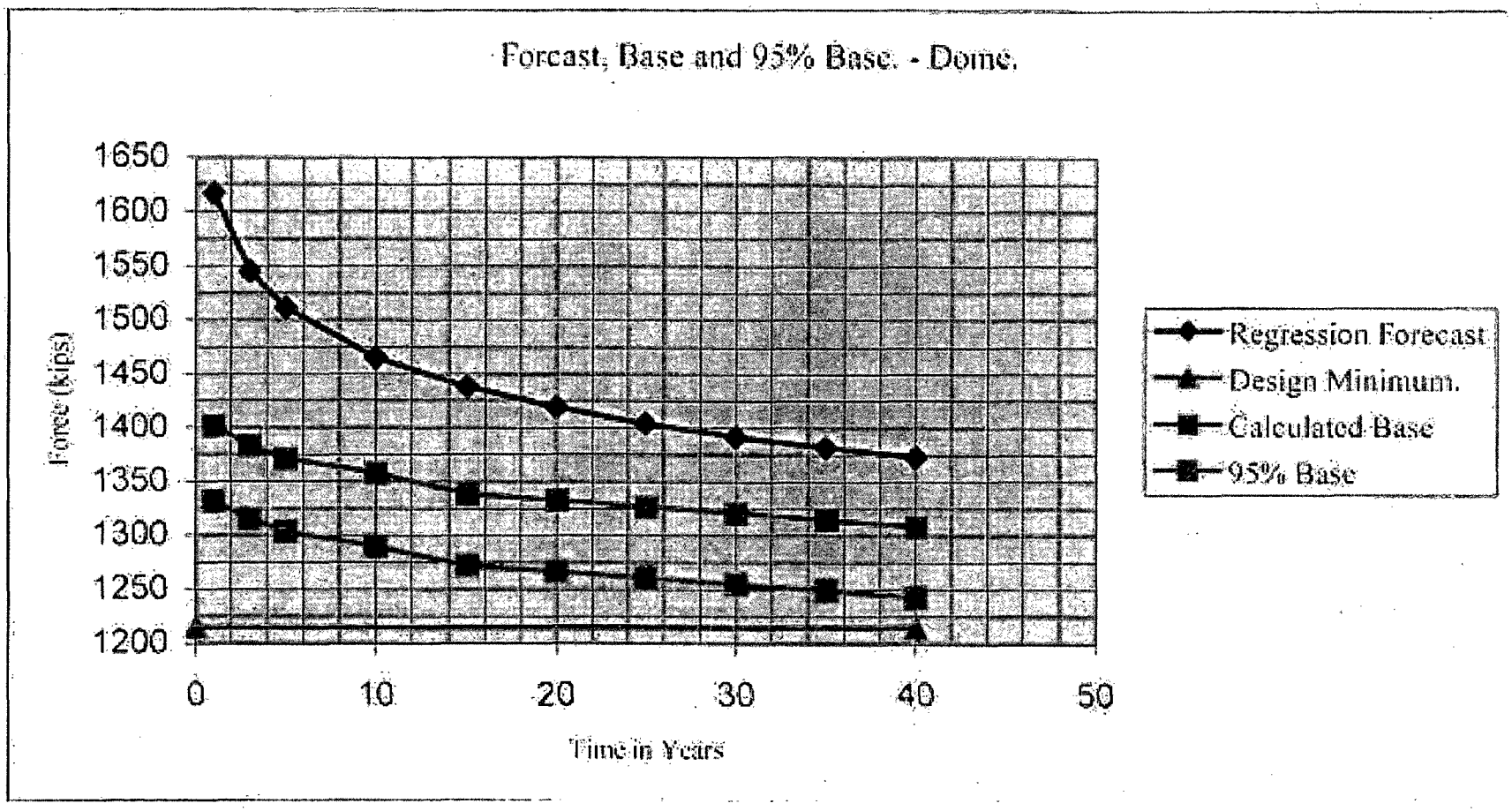
[All Lift-off Values in kips (1000#)]

ENCLOSURE 12

## TENDON NORMALIZING FACTORS – INSPECTION PERIOD 8

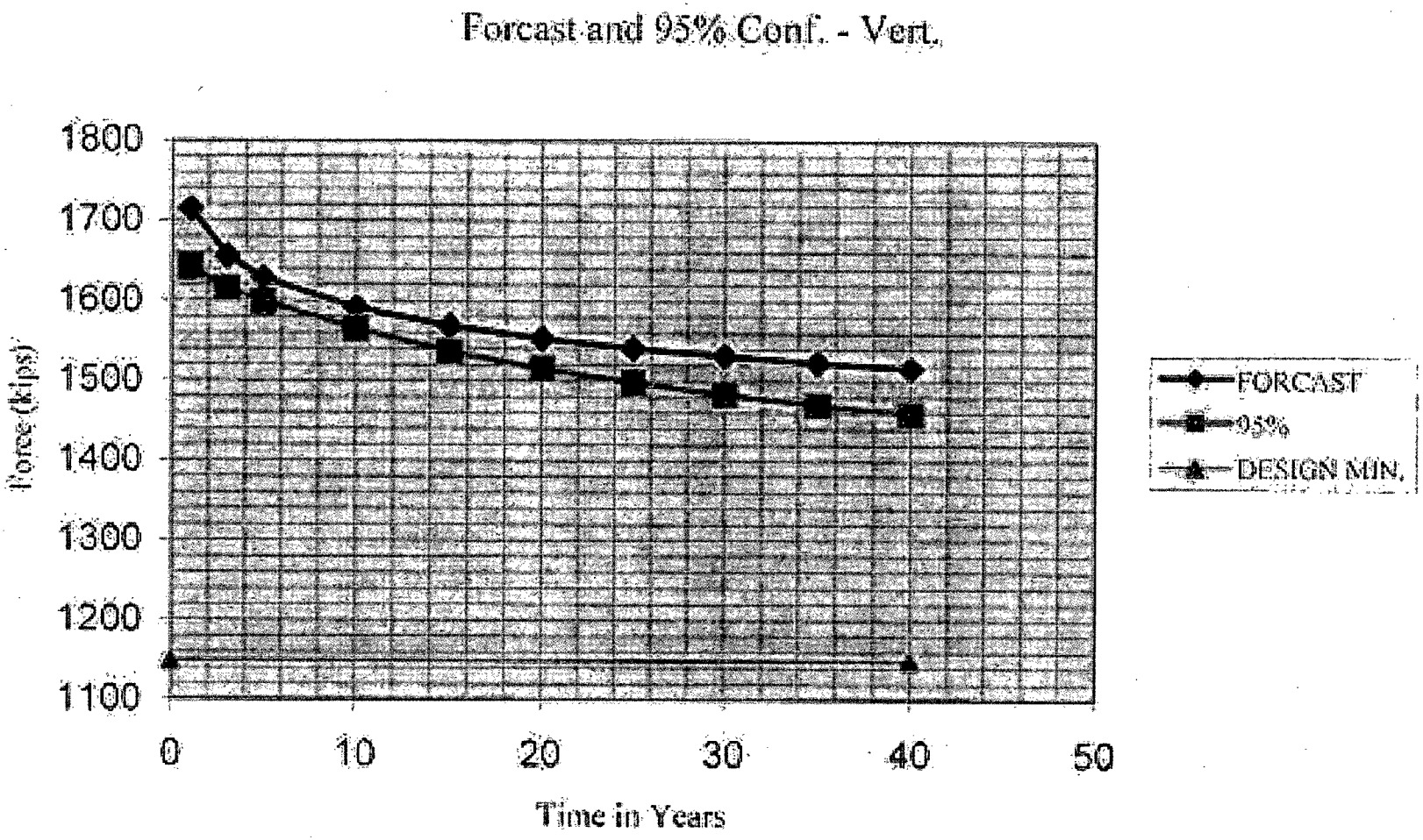
| DOME TENDONS | | VERTICAL TENDONS | | HOOP TENDONS | |
|---|---|---|---|---|---|
| TENDON I.D. | NORMALIZING FACTOR | TENDON I.D. | NORMALIZING FACTOR | TENDON I.D. | NORMALIZING FACTOR |
| D128 | 53 | 61V24 | -14 | 46H20 | -39 |
| D129 | 34 | 12V1 | -9 | 46H21 | -12 |
| D130 | 60 | 12V2 | -80 | 46H22 | -57 |
| D211 | 18 | 45V19 | 31 | 51H33 | 36 |
| D212 | 15 | 45V20 | -61 | 51H34 | -59 |
| D213 | 10 | 45V21 | -19 | 51H35 | 79 |
| D237 | -104 | 61V16 | -8 | 42H45 | -44 |
| D238 | -26 | 61V17 | 17 | 42H46 | -28 |
| D239 | -88 | 61V18 | 21 | 42H47 | 3 |
| | | | | 13H35 | 56 |
| | | | | 13H36 | -56 |
| | | | | 13H37 | 61 |
| | | | | 62H29 | 7 |
| | | | | 62H30 | 14 |
| | | | | 62H31 | -46 |

TENDON HISTORICAL TRENDS
DOME TENDONS

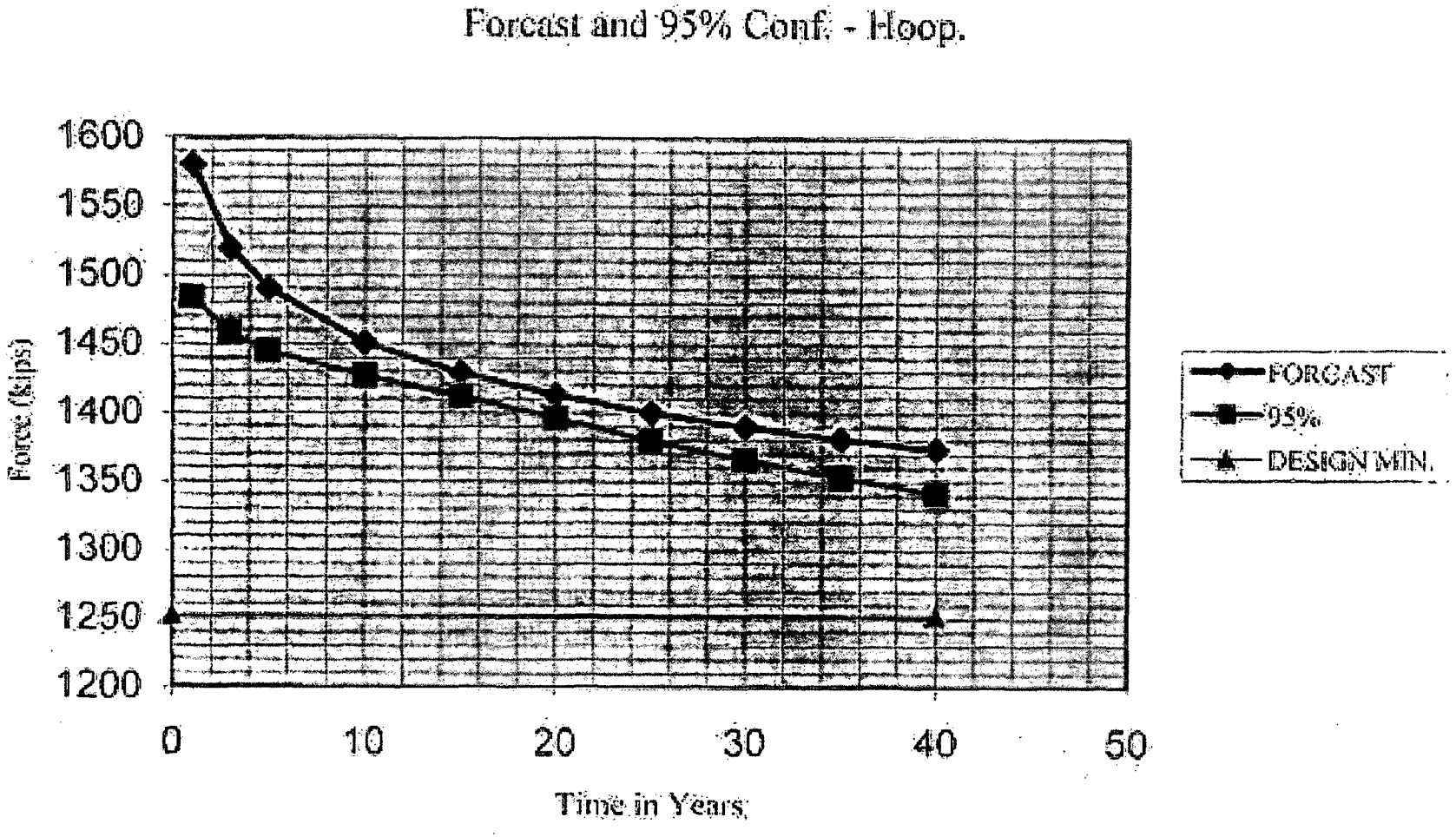


ENCLOSURE 13
(Page 2 of 3)

TENDON HISTORICAL TRENDS
VERTICAL TENDONS



TENDON HISTORICAL TRENDS
HOOP TENDONS



**REVISION SUMMARY**

| Section | Description |
|---|---|
| ALL | Entire procedure revised for the 8th surveillance. Procedure reformatted, no revision bars used. |
| 3.5.1.2, 3.5.1.3, 3.7.2.2, Enclosure 2 | Added the requirement that the equipment needs to be secured/rigged in accordance with NUREG-0612 for work over the spent fuel pool without the missile shields installed. Per EC 64487, Rev. 0 |
| PRR's incorporated | 0168617, 222722, 161499, 62724 |
| EC's Incorporated | EC 64487 |
| | |

| | | |
|---|---|---|
| MADE | GILBERT ASSOCIATES, INC. ENGINEERS AND CONSULTANTS READING, PENNA. | |
| CHK'D. F KLAT | | |
| SQ. CF. | | |
| CF. DFN. | | |
| ENG. | WORK ORDER / SIZE / DRAWING / REV. | |
| REV. CH. APP. DATE | | |

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## FLORIDA POWER CORPORATION

## CRYSTAL RIVER UNIT #3

### 1.01.7 REACTOR BUILDING DESIGN - PRESTRESSING


1:01.7/1 - 1:01.7/56 PRESTRESSING REQUIREMENTS ~ Nº TENDONS ETC.

1:01.7/56 - 1:01.7/59 CHECK PRESCON COMPONENTS + ANCHOR BLOCK REINFT + DENSITY (ρ) OF PRESTRESS REINFT.

1:01.7A - SH. 1 to 11 Tendon Surveillance/Prestress losses

1:01.7A - SH 12 to 17 Review & Design Verification

| | | |
|---|---|---|
| CRYSTAL RIVER | MADE R.S. | GILBERT ASSOCIATES, INC. ENGINEERS AND CONSULTANTS READING, PENNA. |
| | CHK'D. | |
| REACTOR BUILDING | BD. CF. | |
| | CP. DPN. | 4203-00 / 10D-115 |
| REVISED PRESTRESS REQUIREMENTS | ENG. | WORK ORDER / SIZE / DRAWING / REV. |
| | REV. CH. APP. DATE | 4-2-69 |

PRESTRESS DESIGN REQUIREMENTS AS GIVEN IN THE SPECIFICATIONS

(1) VERTICAL FORCE OF 457 KIPS PER FOOT OF CIRCUMFERENCE AT A RADIUS OF 67'-3"

(2) HOOP FORCE OF 829 KIPS PER FOOT OF VERTICAL HEIGHT AT A RADIUS OF 67'-7". THE HOOP FORCE FOR THE LOWER TEN FEET OF WALL SHALL BE 415 KIPS PER FOOT

(3) DOME FORCE OF 820 KIPS PER FOOT OF CIRCUMFERENCE AT A RADIUS OF 60'-0"

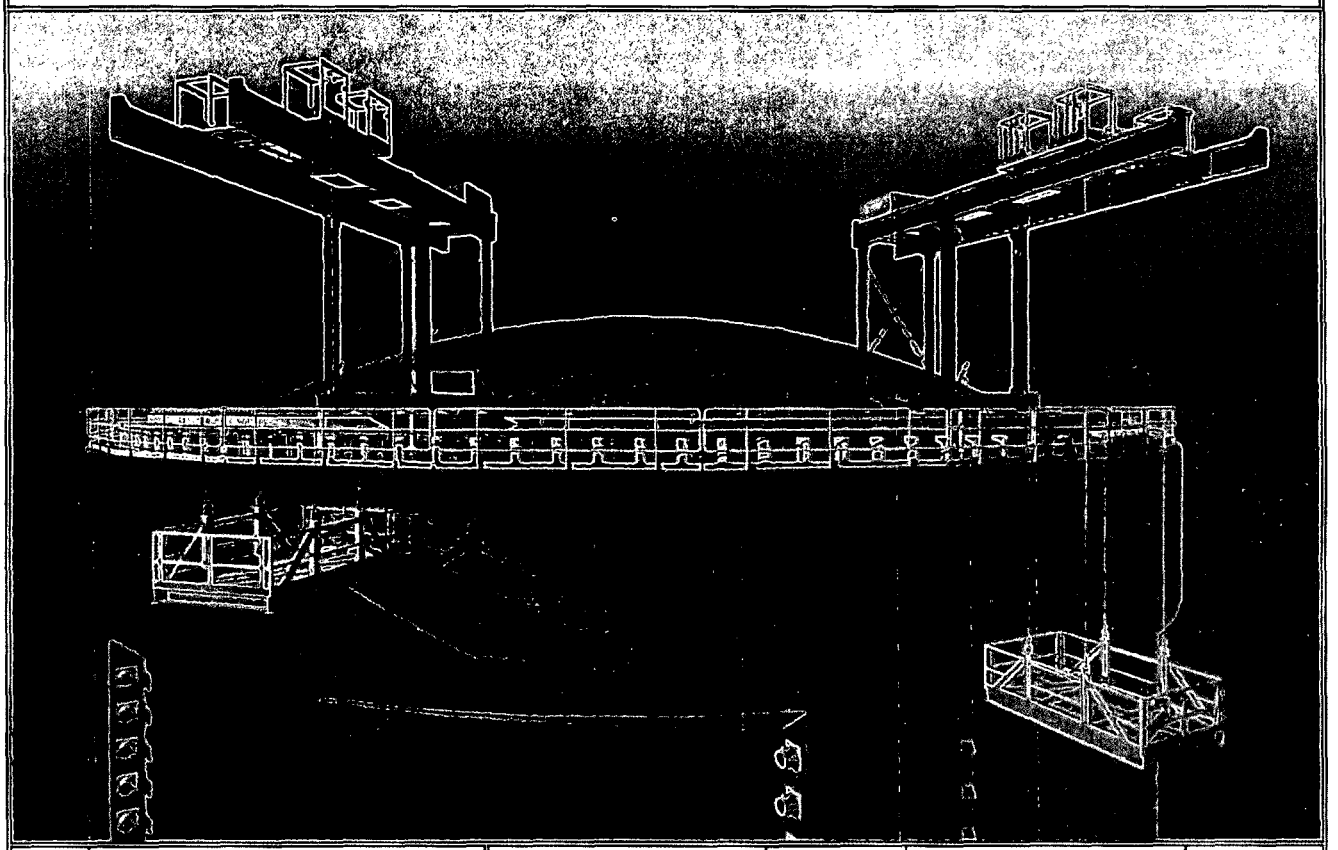
| | | | |
|---|---|---|---|
| DOCUMENT NUMBER: | CR-N1002-500 | REVISION: 0 | PAGE: i |
| DOCUMENT TITLE: | PRE-SURVEILLANCE ENGINEERING PACKAGE | | |
| PROJECT TITLE: | 30TH YEAR TENDON SURVEILLANCE AT CRYSTAL RIVER | DATE: | 08/15/07 |

Progress Energy

# DOCUMENT COVER SHEET

**Document No:** CR-1002-500

**Title:** PRE–SURVEILLANCE ENGINEERING PACKAGE



| No. | Description | Prepared By | Date | Reviewed By | Date |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| 0 | Original Issue | *B.A. GIOMETTI* | *08/15/07* | *C.E. COX* | *8/15/07* |
| | | PSC SIGN OFF | | | |

**REVISIONS**

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TABLE 13 : USF LATERAL REACTIONS – SET POSITION 22
FIGURE 10: SET POSITION OVERTURNING STABILITY 23
TABLE 14 : USF LATERAL REACTIONS – SET POSITION 23
TABLE 15 : USF LATERAL REACTIONS – SET POSITION 23
FIGURE 11: MOVING POSITION OVERTURNING STABILITY 24
TABLE 16 : USF LATERAL REACTIONS – SET POSITION 24

ATTACHMENTS

ATTACHMENT A – ASME SECTION XI, 1992 EDITION WITH 1992 ADDENDA I-14
ATTACHMENT B – NRC REGULATORY GUIDE 1.35, REVISION 3 I-7
ATTACHMENT C – CR-N991-100, "PREDICTED BASE FORCES" I - 142
ATTACHMENT D – CR-N1002-010, "SQ 11.1 RESTRESSING" I
ATTACHMENT E – CR-N1002-010, SQ 12.1 "GREASE VOID VOLUMES" I - 43
ATTACHMENT F – CR-N1002-100, USF "SET POSITION DESIGN" I - 35
ATTACHMENT G – CR-N1002-101, "USF MOVING POSITION DESIGN" I - 27
ATTACHMENT H – CR-N1002-102, "WORK PLATFORM DESIGN" I - 21

# 1.0 PURPOSE

## 1.1 SURVEILLANCE PURPOSE

1.1.1 The purpose of the Tendon Surveillance Program is to demonstrate the integrity of the containment post-tensioning system, including containment tendons, tendon end anchorage hardware; general and adjacent concrete integrity, and evaluation of the corrosion protective (grease) system. Individual inspections of selected tendons, as well as tendon wire and grease sample testing evaluate the overall integrity of the post-tensioning system.

## 1.2 DOCUMENT PURPOSE

1.2.1 The purpose of this document is to provide the engineering data and evaluations necessary to perform surveillance related activities. The scope of this document addresses:

1.2.1.1 The scope of work for the 8th period (30th Year) Tendon Surveillance

1.2.1.2 Predicted forces and normalization factors for selected scope tendons as well as the tendons adjacent to the ones selected. The predicted forces are used to accept as-found force levels if they are within the outlined acceptance criteria.

1.2.1.3 Tendon retensioning elongation tendon for all tendons scheduled to be detensioned for wire removal. The retension data is used to compare the elongation data obtained while restoring the tendon's force to the elongation that was observed while originally stressing the tendon in order to assure the force has been properly restored.

1.2.1.4 Grease void volumes for selected surveillance tendons and their respective adjacent tendons. The volumes allow IWL Level II Inspectors to document the percentage of the total void volume that is removed during inspection and replaced upon completion. This documentation is required per IWL-2526. If the absolute difference between the subject amounts exceeds 10% of the net duct volume, the Licensee shall report the conditions as required by 10CFR50.55a.

1.2.1.5 The design of the support frames and work platforms, which will be used to access hoop and dome tendons in order to assure their ability to withstand working and natural loadings.

1.2.1.5.1 The platform and the Upper Support Frame have been designed for both lateral and vertical loads by analyzing various loading conditions with RISA-3D Version 5.5. RISA-3D calculates both the force and stress in each individual member with respect to the member size designation. The entire system has been designed in accordance with AISC 9th Ed. ASD.

# 2.0 REFERENCES

## 2.1 REFERENCE DOCUMENTS

2.1.1 Crystal River Unit 3 Final Safety Analysis Report (FSAR), latest revision

2.1.2 American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components", 1992 Edition, with 1992 Addenda.

2.1.3 NRC Regulatory Guide 1.35, Revision 3. Dated July 1990, "Inservice Inspection of Ungrouted Tendons in Prestressed Concrete Containment"

2.1.4 Code of Federal Regulation 10 CFR 50.55a

2.1.5 AISC Manual of Steel Construction – Allowable Stress Design, 9th Edition.

2.1.6 ASCE Standard SEI/ASCE 7-02 – Minimum Design Loads for Buildings and Other Structures, 2nd Edition.

2.1.7 ASME Standard A120.1-2001 – Safety Requirements for Powered Platforms for Building Maintenance

2.1.8 PSC Engineering Document E-GEN-500 – Rail Clamp Capacity Test

2.1.9 PSC Engineering Document CR-N991-100, "Predicted Base Forces For The 30th Year Containment IWL Inspection"

2.1.10 PSC Engineering Document CR-N1002-010, "SQ 11.1 Restressing"

2.1.11 PSC Engineering Document CR-N1002-010, "SQ 12.1 Grease Void Volumes"

2.1.12 PSC Engineering Document CR-N1002-100, "Upper Support Frame Set Position Design"

2.1.13 PSC Engineering Document CR-N1002-101, "Upper Support Frame Moving Position Design"

2.1.14 PSC Engineering Document CR-N1002-102, "Work Platform Design"

## 2.2 REFERENCE DRAWINGS

2.2.1 S – 425 – 001 IWE/IWL Inspection Concrete Layout 0° to 180°

2.2.2 S – 425 – 002 IWE/IWL Inspection Concrete Layout 180° to 360°

2.2.3 S – 425 – 003 IWE/IWL Inspection Exterior Dome Layout

2.2.4 S – 425 – 004 IWE/IWL Inspection Vertical Tendon Layout

2.2.5 S – 425 – 005 IWE/IWL Inspection Hoop Tendon "13" Layout

2.2.6 S – 425 – 006 IWE/IWL Inspection Hoop Tendon "42" Layout

2.2.7 S – 425 – 007 IWE/IWL Inspection Hoop Tendon "53" Layout

2.2.8 S – 425 – 008 IWE/IWL Inspection Hoop Tendon "64" Layout

2.2.9 S – 425 – 009 IWE/IWL Inspection Hoop Tendon "51" Layout

2.2.10 S – 425 – 0010 IWE/IWL Inspection Hoop Tendon "62" Layout

2.2.11 S – 425 – 0011 IWE/IWL Inspection Dome Tendons Layout – Plan

2.2.12 S – 425 – 0012 IWE/IWL Inspection Dome Tendons Layout – Elevation

2.2.13 S – 425 – 0020 IWE/IWL Inspection Tendon Detail

2.2.14 SC – 421 – 041 Reactor Building Ring Girder Concrete Outline – Plan and Sections

## 3.0 BACKGROUND

### 3.1 CONTAINMENT ARRANGEMENT

3.1.1 The Crystal River Unit 3 containment building is a post-tensioned and reinforced concrete structure comprised of a vertical cylinder with a hemispherical dome roof, and is supported on a conventional reinforced concrete foundation slab.

3.1.2 The containment structure post-tensioning system provides sufficient external pressure load on the containment structure to balance the internal pressure of the structure as well as the design basis accident internal containment pressure.

3.1.3 The containment post-tensioning system consists of:

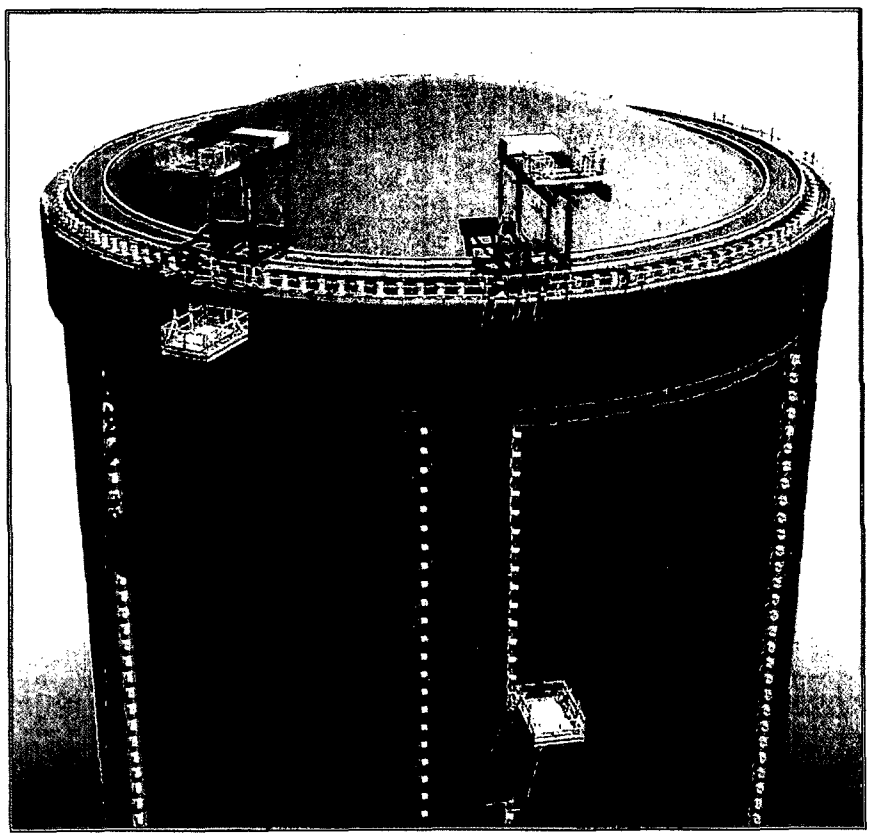
3.1.3.1 Approximately 144 vertical tendons in the cylinder wall anchored at the top surface of the ring girder and at the bottom of the base slab;

3.1.3.2 Approximately 282 hoop tendons in the cylinder wall anchored alternately at 120 degrees to each other. Each tendon encloses 120 degrees of arc and is anchored at two of the six vertical buttresses.

3.1.3.3 Three groups of 41 dome tendons (total 123 tendons) alternately oriented at 120 degrees to each other and anchored at the vertical face of the ring girder;

3.1.4 Each tendon consists of nominally 163 7mm diameter high strength low relaxation wires with buttonhead anchorages. The tendons are housed in individual spirally wrapped, corrugated, thin wall sheet metal sheathing connected to a steel bearing plate and trumplet at each end. The sheathing is cast into the containment structure concrete walls and dome. The tendons are capped at each anchorage with a sheathing filler cap and the tendon sheathing and caps are filled with corrosion preventing grease.

FIGURE 1: TYPICAL SURVEILLANCE SETUP



3.1.5 Inspection Equipment

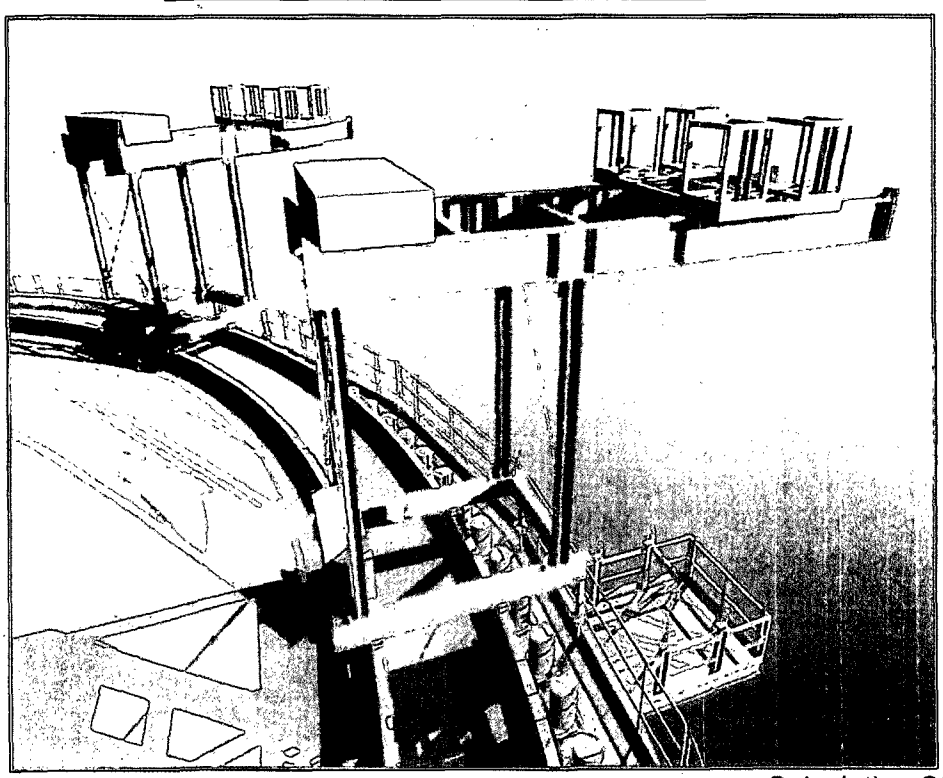
3.1.5.1 In order to perform the work required, PSC will supply the following equipment in order to perform the inspection activities. This list is for information only and equipment may be added or subtracted as needed.

| | | |
|---|---|---|
| 1400 Ton Hydraulic Rams | Heise Digital Hydraulic Gauge | 55 gallon empty drums |
| Jack Chairs | Misc. Electrical Transformers | 110 volt electric cable |
| High Pressure Hydraulic Pumps | Tractel Motor Assemblies | 480 volts electric cable |
| Jack chair extensions | 2 Ga. OTC pump | Buttonhead puller |
| 163 wire stressing adapters | Jib supports | Smooth wire puller |
| Pull rods with nuts | Hydraulic wire puller | Surveillance tool trailer |
| Inspection platforms (2) | 1" diameter guide pins | Grease can plugs |
| Upper Support Frames (2) | 1" diameter eye bolts | Graco grease pump |
| 5 ton electric chain hoists (2) | Trolleys | Grease hose 1½" x 50' |
| Spider baskets/platforms | 1½" diameter brass shut-off valves | 55 gallon drum heater |
| Hydraulic hoses - 20' long | Shop and field pulling caps | Office Trailer |
| 0-10000 psi Hydraulic Gauges | Anchorhead lifting ring | Mobile crane |

3.1.6 Access Equipment

3.1.6.1 In order to access the hoop and dome tendons, two Upper Support Frames (hereafter referred to as USF) will be installed on the containment dome rails. Each USF will have a 5-Ton hoist running on a monorail to facilitate the positioning of the hydraulic stressing ram. A work platform will also be hung from each USF attached to four drive motors, which will raise and lower the platform into working position. The entire USF assembly will utilize rollers, which will allow it to travel circumferentially around the dome in order to access all selected tendons.

FIGURE 2: UPPER SUPPORT FRAMES INSTALLED ON CONTAINMENT DOME



3.1.6.2 The setup and design information for the Upper Support Frames and work platforms is included in section 8.0 of this document.

3.1.7 Stressing Equipment

3.1.7.1 In order to perform stressing activities on the selected tendons (i.e. monitoring tendon forces, detensioning, and retensioning) PSC will provide the required 1400-ton hydraulic ram setups. Each setup includes:

3.1.7.1.1 A calibrated hydraulic cylinder used for stressing, whose calibration is traceable to the National Institute of Standards and Technology (NIST).

3.1.7.1.2 A jack chair used to support the cylinder against the bearing plate as well as facilitate the removal and installation of stressing shims.

3.1.7.1.3 A pullrod/nut combination to convert the compressive force of the cylinder to a tensile force being applied to the tendon

3.1.7.1.4 A 163-wire stressing adapter to couple the pulling rod to each selected tendon's anchorhead.

3.1.7.1.5 A two stage high pressure hydraulic pump to power the cylinder

3.1.7.1.6 A calibrated field gauge for reading the pressure applied

3.1.7.2 Extreme caution shall be taken to ensure that the stressing adapter is fully engaged with the anchorhead in order to eliminate the potential for overstressing of the anchorhead threads.

## 4.0 SCOPE OF WORK

### 4.1 TENDON SELECTION REQUIREMENTS

4.1.1 The specific requirements for selection of the scope of work as well as specific requirements and acceptance criteria for the performance of the inspection for the 8th period (30th Year) Tendon Surveillance are defined by The Crystal River Technical Specifications, the Code of Federal Regulations 10 CFR 50.55a and ASME Section XI, Sub-Section IWL, define the specific requirements for selection of the inspection tendons.

### 4.2 TENDON SELECTION

4.2.1 Tendons were selected for the eighth surveillance period by Progress Energy Florida and distributed to Precision Surveillance Corporation. Tendons to be examined are selected on a random basis among the tendons that have not been examined during previous inspections, except for one tendon from each group, which is designated as the common tendon and is examined during each surveillance.

4.2.1.1 Eleven tendons were selected for this surveillance consisting of 5 hoop tendons, 3 vertical tendons, and 3 dome tendons. In addition to the eleven surveillance tendons, one tendon from each group (vertical, hoop, dome) was selected as an alternate. The alternate tendons will only be inspected in the event that one of the surveillance tendons is found to be inaccessible. Table 1 below lists the tendons selected for the current surveillance as well as the inspections that will be performed on each tendon.

4.2.2 In the event that the acceptance criteria are not met for a certain tendon, it may be necessary to inspect either one or both tendons adjacent to the selected tendon. The criteria and need for this inspection are outlined in the applicable governing codes (see references 2.1.2, 2.1.3, and 2.1.4) as well as the surveillance procedure. The adjacent tendons are listed in Table 2.

**TABLE 1 : SCOPE OF WORK**

| CRYSTAL RIVER UNIT 3 – 30TH YEAR SURVEILLANCE SCOPE OF WORK | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | VISUAL | | | | | PHYSICAL | | | | | |
| TENDON | END | SQ6.0 | SQ6.1 | SQ7.0 | SQ8.0 | SQ8.3 | SQ9.0 | SQ10.2 | SQ10.3 | SQ11.0 | SQ12.1 | COMMENTS |
| 12V01 | D & G | ● | ● | ● | ● | ● | ● | | | | ● | COMMON, STEAM ZONE @ DOME |
| 45V20 | D & G | ● | ● | ● | ● | ● | ● | | | | ● | ORIGINAL SCOPE |
| 61V17 | D & G | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | DETENSION |
| 34V17 | D & G | | | | | | | | | | | ALTERNATE |
| | | | | | | | | | | | | |
| 13H36 | BT. 1 & 3 | ● | ● | ● | ● | ● | ● | | | | ● | |
| 42H46 | BT. 2 & 4 | ● | ● | ● | ● | ● | ● | | | | ● | STEAM ZONE @ BT2 |
| 46H21 | BT. 4 & 6 | ● | ● | ● | ● | ● | ● | | | | ● | COMMON |
| 51H34 | BT. 5 & 1 | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | DETENSION, STEAM ZONE @BT1 |
| 62H30 | BT. 6 & 2 | ● | ● | ● | ● | ● | ● | | | | ● | STEAM ZONE @BT 2 |
| 46H07 | BT. 4 & 6 | | | | | | | | | | | ALTERNATE |
| | | | | | | | | | | | | |
| D129 | BT. 3 & 5 | ● | ● | ● | ● | ● | ● | | | | ● | STEAM ZONE @BT3 |
| D212 | BT. 1 & 3 | ● | ● | ● | ● | ● | ● | | | | ● | COMMON |
| D238 | BT. 4 & 6 | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | DETENSION |
| D337 | BT. 1 & 5 | | | | | | | | | | | ALTERNATE |

LEGEND

SQ 6.0 – GREASE CAP REMOVAL
SQ 6.1 – INSPECTION FOR WATER
SQ 7.0 – AQUIRE GREASE SAMPLES
SQ 8.0 – ANCHORAGE INSPECTION
SQ 8.3 – CONCRETE INSPECTION
SQ 9.0 – MONITOR TENDON FORCE
SQ 10.2 – TENDON WIRE INSPECTION
SQ 10.3 – TESTING TENDON WIRES
SQ 11.0 – RETENSION TENDONS
SQ 12.1 – GREASE REPLACEMENT

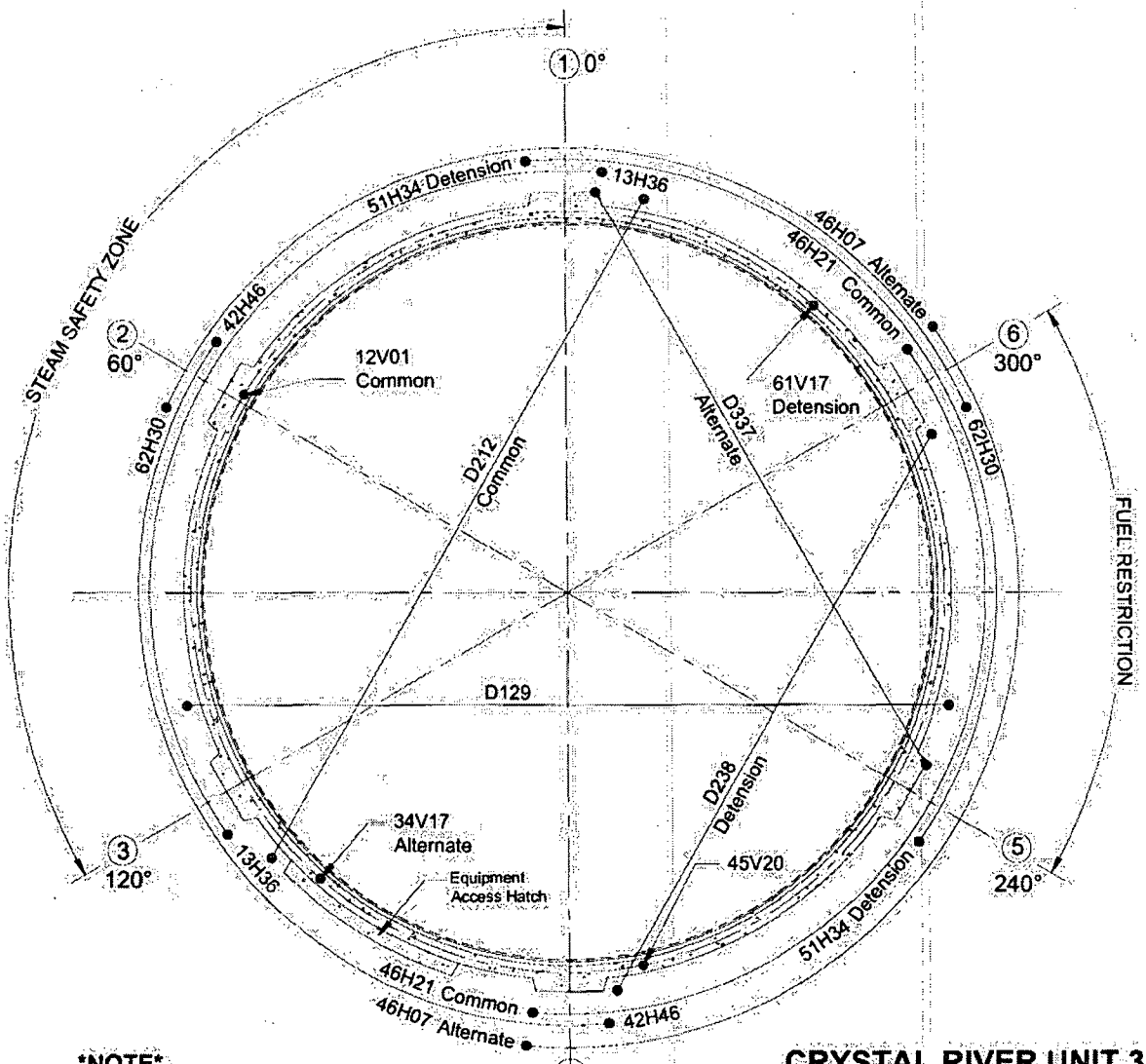
**TABLE 2 : ADJACENT TENDONS**

| CRYSTAL RIVER UNIT 3 – 30TH YEAR SURVEILLANCE ADJACENT TENDONS | | | | | | |
|---|---|---|---|---|---|---|
| TENDON | END | COMMENTS | | TENDON | END | COMMENTS |
| 61V24 | D & G | ADJACENT | | 51H33 | BT. 5 & 1 | ADJACENT |
| 12V02 | D & G | ADJACENT | | 51H35 | BT. 5 & 1 | ADJACENT |
| 45V19 | D & G | ADJACENT | | 62H29 | BT. 6 & 2 | ADJACENT |
| 45V21 | D & G | ADJACENT | | 62H31 | BT. 6 & 2 | ADJACENT |
| 61V16 | D & G | ADJACENT | | 46H06 | BT. 4 & 6 | ADJACENT OF ALTERNATE |
| 61V18 | D & G | ADJACENT | | 46H08 | BT. 4 & 6 | ADJACENT OF ALTERNATE |
| 34V16 | D & G | ADJACENT | | D128 | BT. 3 & 5 | ADJACENT |
| 34V18 | D & G | ADJACENT | | D130 | BT. 3 & 5 | ADJACENT |
| 13H35 | BT. 1 & 3 | ADJACENT | | D211 | BT. 1 & 3 | ADJACENT |
| 13H37 | BT. 1 & 3 | ADJACENT | | D213 | BT. 1 & 3 | ADJACENT |
| 42H45 | BT. 2 & 4 | ADJACENT | | D237 | BT. 4 & 6 | ADJACENT |
| 42H47 | BT. 2 & 4 | ADJACENT | | D239 | BT. 4 & 6 | ADJACENT |
| 46H20 | BT. 4 & 6 | ADJACENT | | D336 | BT. 1 & 5 | ADJACENT |
| 46H22 | BT. 4 & 6 | ADJACENT | | D338 | BT. 1 & 5 | ADJACENT |

### 4.3 Tendon Layout

4.3.1 In order to properly locate the correct tendon in the field, layouts of the selected surveillance tendons as well as alternates have been performed. There is a plan and elevation view showing the tendons as well as surrounding buildings. The tendon layouts are shown below in Figures 3, 4 and 5.

**Figure 3: CR03 8th Period Surveillance – Tendon Layout – Plan**

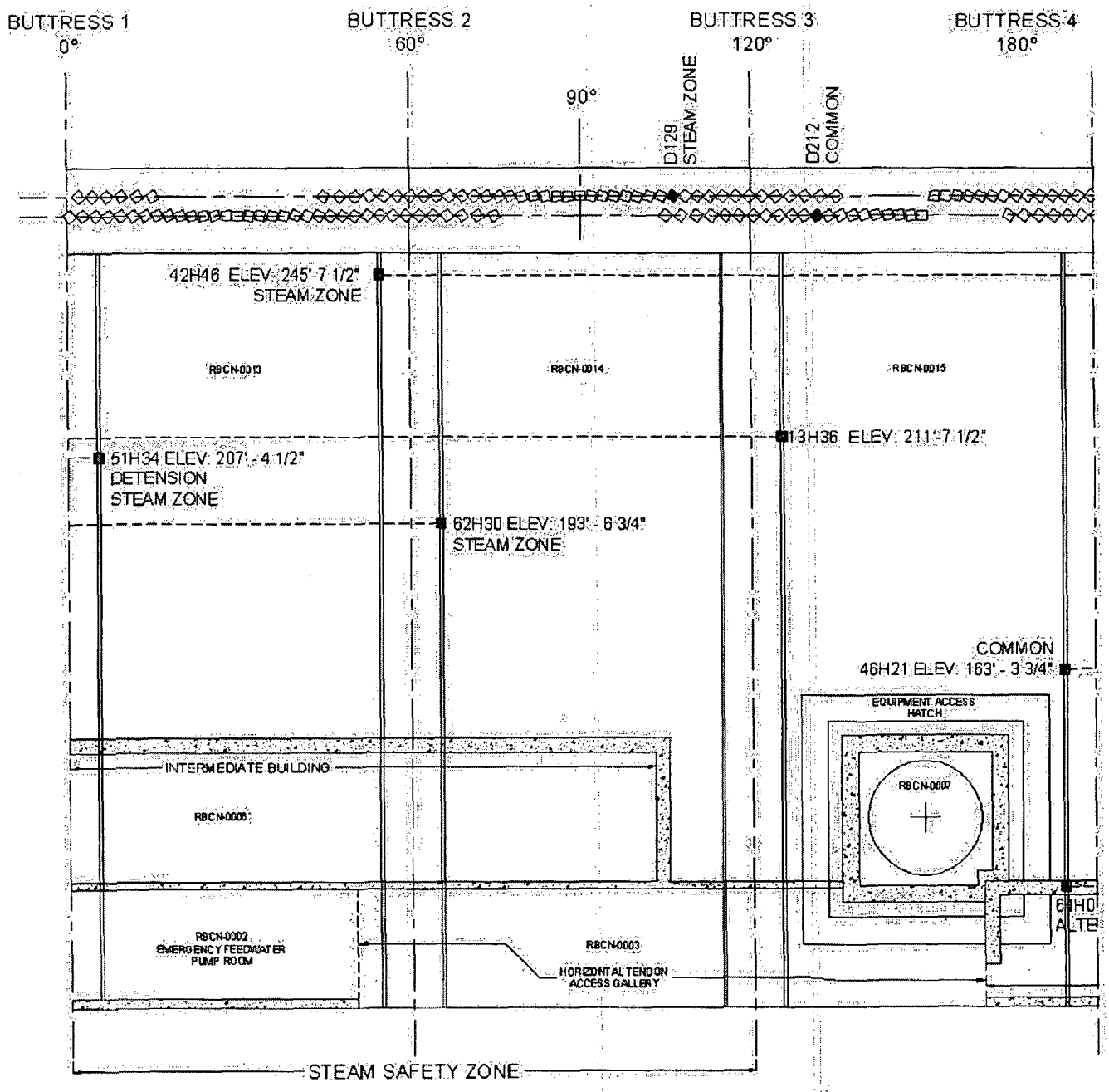



***NOTE***
All tendon Locations shall be verified in the field.

**CRYSTAL RIVER UNIT 3**
*8th Period (30th Year) Tendon Surveillance*
Tendon Layout Plan

| | | | |
|---|---|---|---|
| DOCUMENT NUMBER: | CR-N1002-500 | REVISION: 0 | PAGE: 8 |
| DOCUMENT TITLE: | PRE-SURVEILLANCE ENGINEERING PACKAGE | | |
| PROJECT TITLE: | 30TH YEAR TENDON SURVEILLANCE AT CRYSTAL RIVER | DATE: 08/15/07 | |

**FIGURE 4: CR03 8TH PERIOD SURVEILLANCE – TENDON LAYOUT – ELEVATION 0° TO 180°**




## CRYSTAL RIVER UNIT 3

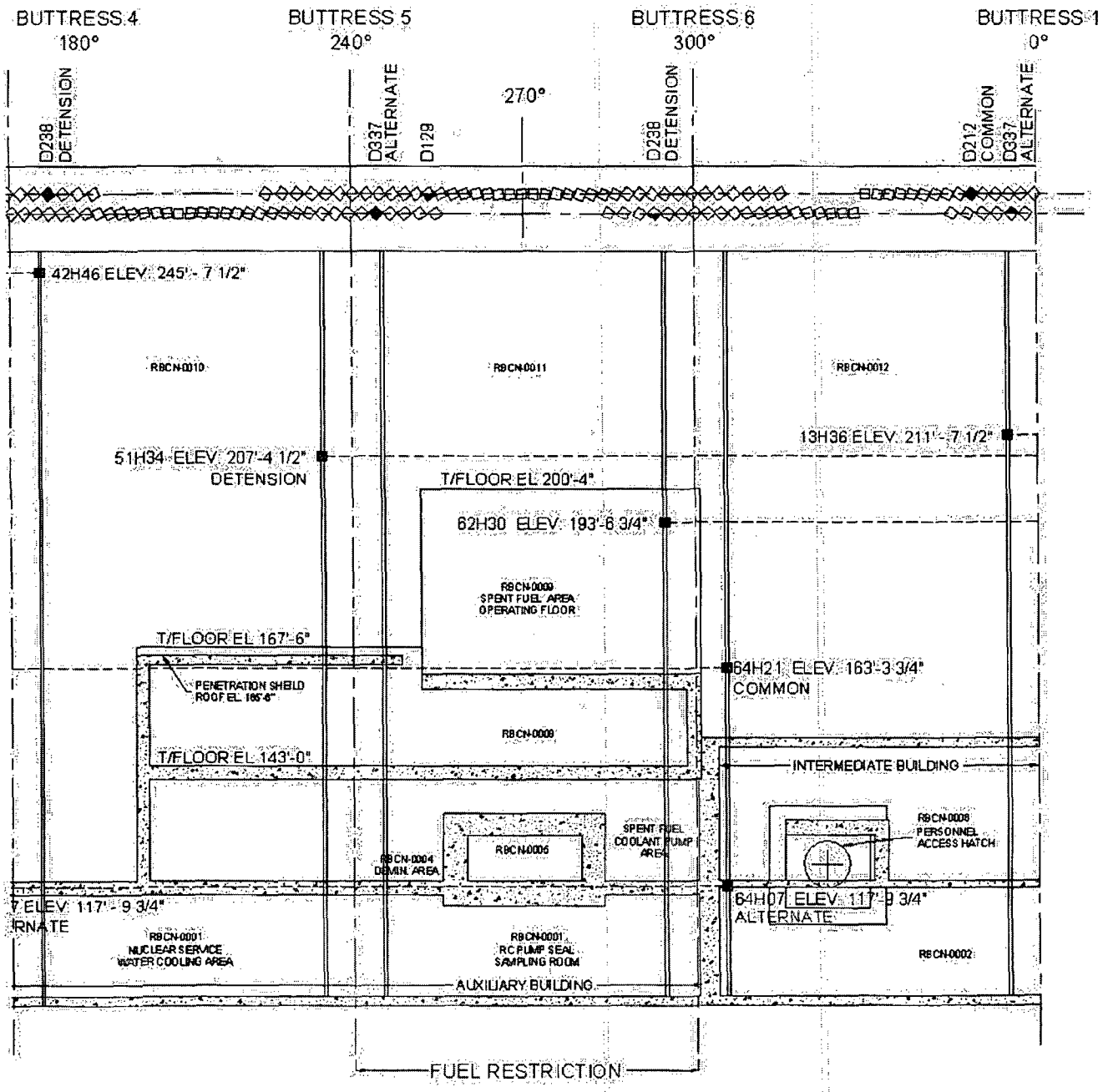
*8th Period (30th Year) Tendon Surveillance*

Tendon Layout Elevation - 0° to 180°

***NOTE***
All tendon Locations shall be verified in the field.

| | | | |
|---|---|---|---|
| DOCUMENT NUMBER: | CR-N1002-500 | REVISION: 0 | PAGE: 9 |
| DOCUMENT TITLE: | PRE-SURVEILLANCE ENGINEERING PACKAGE | | |
| PROJECT TITLE: | 30TH YEAR TENDON SURVEILLANCE AT CRYSTAL RIVER | DATE: 08/15/07 | |

**FIGURE 5: CR03 8TH PERIOD SURVEILLANCE – TENDON LAYOUT – ELEVATION 180° TO 360°**




**CRYSTAL RIVER UNIT 3**

*8th Period (30th Year) Tendon Surveillance*

Tendon Layout Elevation - 180° to 360°

***NOTE***
All tendon Locations shall be verified in the field.

## 5.0 MONITOR TENDON FORCES

### 5.1 PERFORMING LIFT-OFF TESTING

5.1.1 In order to check the force being held by each of the selected surveillance tendons a Lift-off test will be performed. This process will be performed in accordance with the PSC supplied In-Service Inspection Procedure. A lift-off is achieved by transferring the tension on the tendon from its shim stack to the hydraulic ram. Once the tension has been transferred, the force is calculated from the internal pressure of the hydraulic ram. The steps involved in performing a liftoff are as follows:

5.1.1.1 The hydraulic pressure will be applied to the ram until lift-off is achieved.

5.1.1.2 After achieving lift-off 2 feeler gauges (0.030 inch) shall be inserted about 180 degrees apart, between the anchor head and the top shim.

5.1.1.3 The pressure will then be reduced to transfer the load back to the shim stack.

5.1.1.4 Pressure will be applied to the tendon until the feeler gauge can be pulled out with some effort.

5.1.1.5 These steps will then be repeated until three consecutive readings within the specified tolerance are achieved.

5.1.1.6 The pressure used to achieve liftoff is then converted to the force for that tendon using the hydraulic ram calibration data, which is traceable to NIST, and the normalization factor and compared to the predicted force for that tendon to verify acceptability.

5.1.2 The predicted forces and normalization factors for each surveillance tendon, as well as the tendons adjacent to it, have been calculated and included in Attachment C and are summarized below in Table 3.

TABLE 3 : SQ 9.1 – PREDICTED FORECS SUMMARY

CRYSTAL RIVER UNIT 3 – SQ 9.1 – PREDICTED FORECS SUMMARY

| TENDON | PREDICTED BASE (kips) | 95% PREDICTED BASE (kips) | 90% PREDICTED BASE (kips) | NORMALI-ZATION FACOTR | TENDON | PREDICTED BASE (kips) | 95% PREDICTED BASE (kips) | 90% PREDICTED BASE (kips) | NORMALI-ZATION FACOTR |
|---|---|---|---|---|---|---|---|---|---|
| 61V24 | 1529 | 1452 | 1376 | -14 | 13H35 | 1373 | 1304 | 1235 | +56 |
| 12V01 | 1525 | 1449 | 1372 | -9 | 13H36 | 1484 | 1410 | 1336 | -56 |
| 12V02 | 1596 | 1516 | 1437 | -80 | 13H37 | 1368 | 1299 | 1231 | +61 |
| 45V19 | 1484 | 1409 | 1335 | +31 | 62H29 | 1421 | 1350 | 1279 | +7 |
| 45V20 | 1507 | 1432 | 1357 | +7 | 62H30 | 1413 | 1342 | 1272 | +14 |
| 45V21 | 1533 | 1456 | 1380 | -19 | 62H31 | 1475 | 1401 | 1328 | -46 |
| 61V16 | 1523 | 1447 | 1371 | -8 | D128 | 1268 | 1205 | 1141 | +53 |
| 61V17 | 1498 | 1423 | 1348 | +17 | D129 | 1287 | 1223 | 1159 | +34 |
| 61V18 | 1493 | 1418 | 1344 | +21 | D130 | 1261 | 1198 | 1135 | +60 |
| 46H20 | 1467 | 1394 | 1321 | -39 | D211 | 1305 | 1239 | 1174 | +18 |
| 46H21 | 1441 | 1369 | 1297 | -12 | D212 | 1305 | 1240 | 1175 | +15 |
| 46H22 | 1486 | 1412 | 1337 | -57 | D213 | 1312 | 1246 | 1180 | +10 |
| 51H33 | 1392 | 1323 | 1253 | +36 | D237 | 1426 | 1335 | 1283 | -104 |
| 51H34 | 1487 | 1413 | 1339 | -59 | D238 | 1348 | 1281 | 1213 | -26 |
| 51H35 | 1348 | 1281 | 1213 | +79 | D239 | 1409 | 1338 | 1268 | -88 |
| 42H45 | 1473 | 1399 | 1325 | -44 | | | | | |
| 42H46 | 1456 | 1383 | 1310 | -28 | = SURVEILLANCE TENDON | | | | |
| 42H47 | 1425 | 1354 | 1283 | +3 | = ADJACENT TENDON | | | | |

## 6.0 RETENSION TENDONS

### 6.1 DETENSIONING, WIRE REMOVAL, AND RETENSIONING OF TENDONS

6.1.1 One tendon out of each group (vertical, hoop, and dome) is selected to have a wire removed and tested. This process will be performed in accordance with the PSC supplied In-Service Inspection Procedure. In order for this to be accomplished the following will happen:

6.1.1.1 Liftoff-testing will be completed to ensure the tendon's force is at an acceptable level.

6.1.1.2 Once the liftoff has been completed, the force will be transferred to the hydraulic ram and all of the shims will be removed.

6.1.1.3 After the shims have been removed, the pressure will then be released from both ends of the tendon until there is no longer any force on it. This is the detensioning of the tendon.

6.1.1.4 While the tendon is in the detensioned state, a sample wire is removed and scheduled for physical testing as required by IWL-2523.

6.1.1.5 Once the wire has been removed, the tendon is then restored to an acceptable force by pressurizing the ram and replacing the stressing shims.

6.1.2 In order to perform an acceptable restressing operation, the following parameters must be calculated since the tendon has one less effective wire (because of the removed test wire).

6.1.2.1 The new Pre-Tension Force (PTF)

6.1.2.2 The new Overstress Force (OSF) which is 80% of the tendons Gross Ultimate Tensile Strength (GUTS)

6.1.2.3 The new elongations at each of the measurement stops and at OSF

6.1.3 All of the new restressing calculations are included in Attachment D and the parameters are summarized in Table 4 below.

**TABLE 4 : SQ 11.1 – RESTRESSING DATA**

| CRYSTAL RIVER UNIT 3 – SQ 11.1 – RESTRESSING DATA | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | PREVIOUSLY | | AT RETENSIONING | | | | | |
| TENDON | ORIGINAL PTF (kips) | ORIGINAL OSF (kips) | NUMBER OF WIRES | NEW PTF (kips) | NEW OSF (kips) | 600 (kips) | 1200 (kips) | ORIGINAL ELONGATION (in.) |
| 61V17 | 357 | 1866 | 162 | 354 | 1855 | 1.92 | 6.62 | 11.75 |
| | | | 161 | 352 | 1843 | 1.95 | 6.68 | |
| | | | 160 | 350 | 1832 | 1.98 | 6.74 | |
| 51H34 | 362 | 1866 | 162 | 359 | 1855 | 1.65 | 5.76 | 10.25 |
| | | | 161 | 357 | 1843 | 1.67 | 5.81 | |
| | | | 160 | 355 | 1832 | 1.70 | 5.87 | |
| D238 | 359 | 1866 | 162 | 357.1 | 1854.6 | 1.34 | 4.64 | 8.25 |
| | | | 161 | 354.9 | 1843.1 | 1.36 | 4.68 | |
| | | | 160 | 352.7 | 1831.7 | 1.38 | 4.73 | |

## 7.0 GREASE VOID VOLUMES

### 7.1 GREASE REPLACEMENT

7.1.1 Once all inspections have concluded, any sheathing filler (grease) that was lost during the inspections must be replaced. Throughout the inspection all grease that is removed is documented. The required methods of refilling, as well as the acceptance requirements for amount refilled, are dependent upon the percentage of the total void that is lost. In order to calculate this percentage, the grease void volume has been calculated for each selected surveillance tendon as well as both of its adjacent tendons. The grease void calculations are included in Attachment E and are summarized below in Table 5.

TABLE 5 : SQ 12.1 – GREASE VOID VOLUMES

| CRYSTAL RIVER UNIT 3 – SQ 12.1 – GREASE VOID VOLUMES | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| TENDON | NET DUCT VOLUME (GALLONS) | 10% DUCT VOLUME (GALLONS) | TENDON | NET DUCT VOLUME (GALLONS) | 10% DUCT VOLUME (GALLONS) | TENDON | NET DUCT VOLUME (GALLONS) | 10% DUCT VOLUME (GALLONS) |
| 61V24 | 144.09 | 14.41 | 13H35 | 121.77 | 12.18 | D128 | 118.31 | 11.83 |
| 12V01 | 143.97 | 14.40 | 13H36 | 121.67 | 12.17 | D129 | 116.41 | 11.64 |
| 12V02 | 144.12 | 14.41 | 13H37 | 122.18 | 12.22 | D130 | 116.12 | 11.61 |
| 45V19 | 144.51 | 14.45 | 42H45 | 121.40 | 12.14 | D211 | 115.58 | 11.56 |
| 45V20 | 144.47 | 14.45 | 42H46 | 122.57 | 12.26 | D212 | 115.99 | 11.60 |
| 45V21 | 144.05 | 14.40 | 42H47 | 121.84 | 12.18 | D213 | 116.85 | 11.69 |
| 61V16 | 144.36 | 14.44 | 46H20 | 121.37 | 12.14 | D237 | 104.93 | 10.49 |
| 61V17 | 144.74 | 14.47 | 46H21 | 122.06 | 12.21 | D238 | 102.59 | 10.26 |
| 61V18 | 144.15 | 14.42 | 46H22 | 122.43 | 12.24 | D239 | 100.43 | 10.04 |
| 34V16 | 145.50 | 14.55 | 51H33 | 121.94 | 12.19 | D336 | 107.62 | 10.76 |
| 34V17 | 145.67 | 14.57 | 51H34 | 120.88 | 12.09 | D337 | 106.08 | 10.61 |
| 34V18 | 144.97 | 14.50 | 51H35 | 122.21 | 12.22 | D338 | 103.92 | 10.39 |
| | | | 62H29 | 121.93 | 12.19 | | | |
| | | | 62H30 | 121.75 | 12.17 | | | |
| | | | 62H31 | 122.13 | 12.21 | | | |
| | | | 46H06 | 122.00 | 12.20 | | | |
| | | | 46H07 | 121.18 | 12.12 | = SURVEILLANCE TENDON | | |
| | | | 46H08 | 121.46 | 12.15 | = ADJACENT TENDON | | |