U. S. ATOMIC ENERGY COMMISSION
REGION II
DIVISION OF COMPLIANCE

VENDOR INSPECTION REPORT

Tendons for Post-Tensional Concrete Containment Building

Vendor: The Prescon Corporation
Plant 5
Simpsonville, 1/ South Carolina

Report No: Prescon 70/1

Components Inspected For: Duke Power Company
Oconee Units 1, 2, and 3

Date of Inspection: February 18, 1970

Inspector: H. C. Seidle for 3/18/70
W. D. Kelley, Reactor Inspector - Construction (In Charge) Date

C. E. Murphy, Reactor Inspector 3/18/70 Date

Licensee Representatives: G. L. Hunnicutt, Field Engineer (Civil), DPC
R. W. Simmons, Inspector, DPC

Other Persons Contacted: C. T. Johnson, Reactor Engineering Manager
Prescon Corporation, Corpus Christi Office
D. Hyatt, Quality Control Inspector, Prescon Corporation, Plant 5, Simpsonville, South Carolina

Report Reviewed By: H. C. Seidle 3/18/70
W. C. Seidle, Senior Reactor Inspector Date

G. W. Reinmuth 3/25/70
G. W. Reinmuth, Reactor Inspector Date
(Program Standards)

Proprietary Information: Entire Report

SCOPE

A special announced visit was made to the Prescon Corporation, Plant 5, Simpsonville, South Carolina, on February 18, 1970.

1/ Located near Greenville, South Carolina.

The visit was arranged through Duke Power Company and had as its specific objective the examination of Prescon Corporation's quality assurance program and quality control in the manufacturing of tendons for post-tensioned concrete containment buildings and a review of the available records pertaining to the tendons for Oconee Unit No. 1 containment building.

SUMMARY

1. Prescon specializes in the manufacture and installation of tendons for post-tension concrete. (See Section A.)

2. The tendons for nuclear applications are assembled at a new plant at Simpsonville, South Carolina. (See Section B.)

3. A quality control manual has been written and is used by Prescon which outlines its quality assurance program. It contains fabrication and manufacturing procedures, and specifies quality control check points and records that must be kept. (See Section C.)

4. The quality assurance program is implemented by a combination of line and staff organizations with a Quality Assurance Committee that is the final authority for the review of the quality assurance programs and proposed changes to the program. (See Section D.)

5. The mill test data on material for wire and stressing washers were readily available and conformed with the specifications. (See Sections E and F.)

6. Each step in fabrication and manufacturing is followed by an inspection check point that is described in the quality control manual. Each inspection point must be recorded on a QC form. (See Section G.)

7. Plant 5 has a laboratory well equipped for performing the tests designated in the quality control manual. (See Section G.4.)

8. There is a difference in the allowable width of a button head split permitted by Prescon's quality control manual and the licensee's FSAR. (See Section H.)

Management Interview - At the completion of the visit, an interview was held with Hunnicutt, Simmons, Johnson and Hyatt.

The following points were discussed:

1. Prescon has a very comprehensive quality assurance program that is structured as outlined in their quality control manual.

2. The quality control manual did not define a tendon wire bend or kink and it does not place a limit on their acceptance. Johnson stated a limit would be specified.

3. During fabrication of a tendon for Oconee Unit 1, the Region II inspector observed a tendon wire which had been bent. Johnson placed the tendon in quarantine pending the establishment of an acceptance criterion.

4. Prescon was inspecting button heads on the basis set forth in their quality control manual which permitted splits 0.060" x 0.25" maximum. The FSAR has a limit of two splits of 1/64 inch. Hunnefeut had previously stated that the 1/64-inch limit was a typographical error and that the FSAR was in the process of bei g corrected to read 0.060 inch. This correction was confirmed by L. C. Dail, the licensee's principal civil engineer, the following day.

DETAILS

A. Description of Prescon Corporation

Prescon has been in the post-tensioning field since its incorporation in April 1956. It operates fabricating plants in various parts of the United States and has sales representatives in major cities. For the specialized work involved in post-tensioning for nuclear applications, Prescon has established modern production facilities for anchorage manufacture (washers, spacers, and trumpets) in Corpus Christi, Texas, and tendon assembly in Simpsonville, South Carolina. In addition, it has organized a field services group and an engineering group in Corpus Christi, Texas, to handle the technical phases of product design, detail drawings, testing, equipment development, and jobsite technical assistance. A company organization chart for the manufacture of tendons for nuclear applications is shown in Exhibit A, and a list of personnel locations and functions for nuclear applications may be found in Exhibit B.

B. Description of Prescon Corporation Plant 5

Prescon has erected a 40,000 square foot office, laboratory, and tendon assembly area for post-tension applications. The plant has been identified by Prescon as Plant 5. The tendons for Oconee Unit 1 are the first tendons for nuclear application to be produced at this facility.

The plant is TEE shaped with the cross bay being 500 feet long and 50 feet wide and served by two overhead cranes. The leg is 250 feet long and 50 feet wide and is used to uncoil, cut, and assemble the tendon. The building is layed out for once-through production with material being received at one end of the 500-foot bay and finished tendons being shipped from the opposite end.

C. Quality Control Manual

Prescon has written a quality control manual that describes in detail its quality assurance program, material control procedures, anchor manufacture procedures, and tendon assembly procedures.

This manual has been written to guide Prescon's personnel in fabricating and manufacturing procedures and to specify those quality control checks and records that are required to assure a quality product for the life of the post-tensioned structure.

D. Quality Assurance Program

Prescon has developed a quality assurance program for the fabrication of its post-tensioning systems furnished for structures like secondary containment vessels for nuclear reactors. The program was developed to assure its customers and clients that its products meet or exceed the specifications set forth in each contract.

Prescon has effected a combined line and staff organization for implementing its quality assurance programs. This type of organization places line responsibility for developing and maintaining the quality assurance programs on the company's Engineering Department handling reactor contracts. At the same time, the company has formed a quality assurance committee which functions as the final authority review group for all quality assurance programs. The concept of this organization is to fix responsibility for development of quality assurance programs at an operating level. An organization chart depicting this concept is found in Exhibit C.

The Quality Assurance Committee is composed of five managers throughout the company appointed annually by the general manager. It meets monthly to review existing programs and suggested revisions, and to discuss general quality assurance problems. One member of the committee is selected to conduct an annual audit of the quality assurance programs.

The reactor engineering manager is responsible for developing and implementing the quality assurance programs. He is responsible for formulating the necessary procedures, checks, and controls that will result in a quality product meeting all job specifications. Such procedures, checks, and controls are then submitted to the Quality Assurance Committee for final review and approval. He also selects a project engineer to conduct a quarterly audit of the quality assurance programs.

The implementation of the quality assurance program is the responsibility of the quality control inspectors. The inspectors are selected by the general manager and they operate at each production facility and carry out the quality control checks and maintain the quality control records

as required in the QA manual. They are responsible directly to the engineering manager for the administration of the quality assurance program and work closely with production personnel in order to assure compliance with quality control requirements.

The quality control inspector at Plant 5, D. Wyatt, has been employed for six months by Prescon. He has a B.S. degree in Business Industrial Arts. Two additional employees, A. Bolt and J. C. Tayor, are training to be inspectors.

In order to prevent the quality assurance program from becoming stagnant, the quality control manual provides the following methods for amending and revising the program:

1. Any employee who feels a revision should be made to an existing quality assurance program submits a letter to the engineering manager outlining the suggested revision, how and why it should be implemented, and attaches supporting evidence that such revision will not sacrifice quality.

2. The engineering manager and quality control inspector review and evaluate the submitted revision. If the revision has merit, it is discussed in detail with the employee who submitted it. If the revision is rejected, it is answered in writing by the quality control inspector within four weeks after receipt.

3. On revisions accepted by engineering manager, the quality control inspector drafts a proposed revision to the quality assurance program. In addition, a cover letter is prepared outlining the supporting evidence indicating there is no sacrifice of quality.

4. The proposed quality assurance program revision and the cover letter are presented at the next monthly meeting of the Quality Assurance Committee for review and approval.

5. Any revision required by the Quality Assurance Committee must be made. The revision is then finalized and the quality control inspector sees to it that all outstanding copies of the quality assurance program receive the revision. A copy of the cover letter is sent to the customers involved for verification of the revision.

E. Purchase of Wire by Prescon

Johnson stated that Prescon had investigated all potential domestic, European and Japanese suppliers of wire conforming to ASTM A421-65. He stated that only the Japanese wire met Prescon requirements for corrosion resistance, ductility without splitting, heading and cleanliness.

The wire is purchased by the Prescon, Corpus Christi, Texas, office through the Swift Train Company, Corpus Christi, from Suzuki Metal Industry Company, Ltd., with an office at No. 1-18AKABANE-N TA, KITA-K', Tokyo, Japan.

Prescon Purchase Order No. 2589 to Swift Train Company for 2,200 tons of quarter-inch diameter, cold drawn, stress relieved, PC wire in accordance with ASTM Specification A421-65 for Oconee Units 1 and 2 tendons was audited. The purchase order required each coil to be marked with purchase order number, coil number, and heat number; stress-strain curves and modulus of elasticity for each heat; wire to lay straight and have no tendencies to seek an arc when laid on ground; and each coil be one continuous wire without welds.

The material was shipped from Japan to Charleston, South Carolina, where it was loaded onto truck for shipment to Prescon's Plant 5.

Inspection certificates from Suzuki Metal Industry were audited. It was specified as uncoated, stress relieved for prestressed concrete. The inspection certificate gave the carbon, silicon, manganese, phosphorus, sulphur, and copper content. A stress strained curve was supplied with each inspection certificate for each heat. In addition, the recorded test data from which the curve was derived was attached.

F. Stressing Washers

The stressing washers are manufactured at Prescon's Plant 1, Corpus Christi, Texas. Johnson briefly explained some of the manufacturing processes and quality control checks involved. No attempt will be made to describe these as they were not witnessed by the inspector.

Material for the stressing washers was purchased from Earl M. Jorgensen Company and specified as C1045HR. A certified test report was audited for stressing washer pieces 28 and 29. (Piece 29 has been shipped to the Oconee Unit No. 1 site.) The certification gave the chemical and mechanical properties which indicated that the two heats involved met the requirements for C1045 steel.

The stressing washers are shipped from Plant 1 to Plant 5 in the as-machined condition, in crates without a rust inhibitor coating. When the washers are received at Plant 5, they are stored inside the plant unit where the tendons are assembled.

G. Quality Control

1. Receiving

The coils of wire are received from Suzuki Metal Industry Company, Ltd., with three wrappings. The coil is first wrapped in a vapor phase

inhibitor impregnated paper, then in polyethylene, and finally by a protective burlap wrapping. One metal and one paper identification tag is on the exterior of each coil and one metal tag and one paper tag is inside of the burlap wrapping. Should the metal tags not be on the coils when received, the coils are put to one side and routed through the commercial tendon production. Upon receipt of material one heat is assigned a PCW number and each coil in that heat receives an individual number. Material is unwrapped and inspected just before it is placed in production and the inspection is recorded on Prescon Wire Inspection Record QC Form No. 3 (Exhibit D) in accordance with the requirements of their QC manual, Check Nos. 1, 80, 81 and 82. QC Check No. 1 is the date received and coil number, i.e., both Prescon's and the manufacturer's number. QC Check No. 80 is for the wrapping conditions and storage area. QC Check No. 81 requires the rating of the rust condition from Grades A through E. Grades A through D are acceptable for use in nuclear work while Grade E is rejected. The wire is also checked for any bent or kinked wires. All kinks are cut out of the coils. The present QC manual does not define a bend or a kink; however, the QC manual will be revised to define these items. QC Check No. 82 is to indicate that laboratory samples have been taken. These samples are cut, placed in plastic tubes marked with the PCW number and coil number, and sent to the lab for bending and tensile test. Rejected wire is removed from the building to a salvage yard in back of the building. A salvage disposition form is filled out that is submitted to the Corpus Christi office weekly. A cross-reference of Prescon's PCW number and the supplier's heat number is maintained on the PCW Material Number Records (Wire) QC Form No. 2 (Exhibit E). This form gives the PCW material number, type, purchase order number, date delivered, date certification received, wire supplier, wire description and size, heat number job code, date inspected, and has a block for the inspector's initials.

Only enough wire is stripped of its protective wrapping as would be required for 3-4 days of production at the most. An example is the Florida Power and Light Company strike where wire for Turkey Point Units 3 and 4 were unwrapped and ready for production when work was received at Prescon of the strike. The material was then routed to the commercial side of the operations.

2. Manufacturing

The coils are loaded into baskets and their PCW number and coil numbers are recorded on a tag which is attached to each coil. Normally, only one heat of wire is loaded into a basket. Occasions can arise where mixed heats will be combined in one basket, but each coil is tagged with its PCW number and coil number. Any coil is readily traceable to the supplier's heat number through the QC Form No. 2. Individual wires are not identifiable by heat number. A tendon assembly sheet (Exhibit F),

issued by engineering for each tendon, gives the tendon mark number, cutting length, wire supplier, heat number, stressing washer number, and wire POW number and coil number. The tendon mark is keyed to the tendon location. For example, in the case of Oconee tendon mark 24B99, the 24 designates the tendon is from buttrees 2 through 4, and the B99 designates the tendon hole number is 99.

The bay, where the cutting of the wires is performed, has two cutting tables along opposite walls; one is for commercial application and the other for nuclear. The cutting table's first 100-foot mark was accurately determined and a 100-foot steel tape starting at the 100-foot mark was fastened to it. Wire is withdrawn from two baskets, and rollers accelerate the wires to a velocity of 800 feet per minute down the cutting table. A decelerator with two micro switches located on the table determines the cutting length. The two wires come down the table and are decelerated; when both micro switches are depressed, the cutting operation is automatically performed. After the cutting operation, a pneumatic cylinder automatically releases the wire to a trough. After all wires for one tendon have been cut, they are moved to the lower side of the table for button heading. The wires are fed through a combing plate and a stressing washer, then cold button headed. Quality control of the button-head operation is performed in three steps. A "go or no go" gage is used to measure the diameter of each button head. The eccentricity measurement of the button head is performed on a sample made before and after the button-heading operation for each tendon. Each button head is visually inspected for splits, any splits found are measured and recorded. The QC Check List for Tendon Fabrication (Exhibit G) requires in QC Check No. 83 that the tendon mark number, cut length and eccentricity of the button be recorded. QC Check No. 84 requires that the stressing washer identification part number be recorded, and the checking of the diameter of the button head for splits be recorded and tagged.

After all wires have been button headed and inspected for splitting, the combing plate is moved down the table while revolving one revolution for each 40 feet. This operation locates the wires within the bundle. The tendons are then strapped approximately every six feet and the free end of the tendon wire is bound in quarters before removal of combing washer. The tendon is then wound into coils. After a cable puller is placed on the free end and the coil strapped for shipment, it is moved to the dipping vat, where it is dipped in NO-OX-ID, Dearborne 500, supplied by the Dearborne Chemical Company, a subsidiary of the W. R. Grace Company. The chemical analysis is considered proprietary information and was not available.

QC Check No. 85 requires the verification of the tendon mark, the wire, and the banding for shipment. Check No. 85 is the final inspection and must be initialed by the inspector and dated.

A completed tendon is required to be left in the Dearborne 500 dip fifteen minutes minimum or until no bubbles appear in the dip. In actual practice, the tendon assembly operation is such that the tendon is not removed from the Dearborne 500 for approximately 30 minutes. After removing of the tendon from the Dearborne 500 mixture, it is set in a rack and the excess allowed to run off. After the excess has dripped off the tendon is wrapped in polyethylene and stored in racks for subsequent shipment.

3. Shipping

The tendons are shipped by truck to the Oconee site. (The tendons are loaded in the reverse order from their unloading at the site.) The truck trailer is used for storing the tendons at the Oconee site and the tendons are transferred directly from the trailer to the sky climber for insertion into the tendon hole.

4. Laboratory

The two samples from each coil are placed in a plastic tube and sent to the laboratory. Each tube is marked with the ECW number and coil number. When the two samples are received in the laboratory, the diameter of one sample is measured, threaded through washers, and button headed. The wire is then tested on a 60,000-pound Tinius-Olson tensile machine equipped with a recorder which was calibrated on August 21, 1969. After the tensile test, both samples are returned to the tube and stored for future reference. Adjacent to the tensile test machine are charts for the conversion of the break strength to the psi strength. A 11,800 break strength gives a 240,326 psi tensile which would then be the minimum for the acceptable value of the wire. The Tinius-Olson verification of the machine's capacity is posted showing an accuracy of 0.4% in the range of 1,200 to 12,000 pounds, which is the testing range of the wire for the Oconee units.

Approximately 12 tensile tests were witnessed. The failures are typed as follows: Type A, failure in the free length of the wire; Type B, failure within 1/2 inch of the head; Type C, failure adjacent to the head; and Type D, shearing of the button head. In the case of the 12 tensile tests witnessed, all failures were adjacent to the head which is a Type C failure. After the test, the untested wire sample, as well as the tested sample, is placed in the plastic tube and it is stored for future reference if needed. One sample from each heat is given a "To and Fro test" which consists of bending the wire over a dye of 1¼-inch radius, 90°, and then being a reversal bend in the opposite direction of 90° until failure. One test was witnessed which requires 19 cycles before failure.

H. Button Head Splits

Prescon's quality assurance manual permits split button heads of a maximum of 0.060 inch. The FSAR permits two splits of 1/64-inch width. Prescon stated that this discrepancy will be resolved with the licensee.

Attachments:
Exhibits A thru G

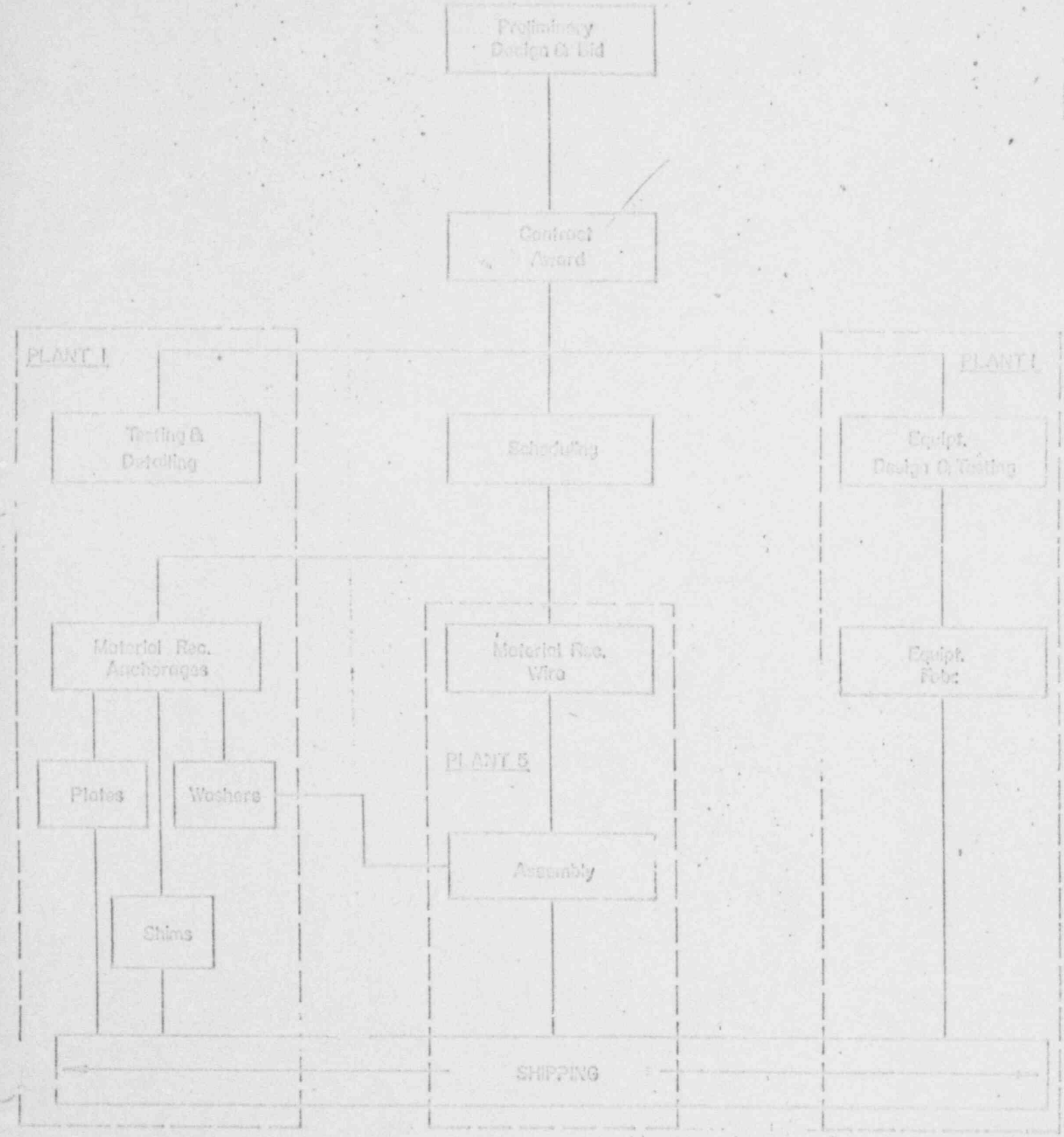
Preliminary Design & Bid
Contract Award
PLANT I
Testing & Detailing
Scheduling
Equipt. Design & Testing
Material Rec. Anchorages
Material Rec. Wire
Equipt. Fabr.
PLANT S
Plates
Washers
Assembly
Shims
SHIPPING

FIG. 1

FUNCTIONS	ADDRESS
President Reactor Department Manager Finance	THE PRESCON CORPORATION 502 C. C. State Nat'l. Bank Building Corpus Christi, Texas 78401 (512) 882-8291
Field Service Engineering Testing Quality Control Manufacturing Plant #1 (Anchorage Fabrication)	THE PRESCON CORPORATION 905 Cantwell Drive P. O. Box 4087 Corpus Christi, Texas 78408 (512) 882-6571
Assembly Plant #5 (Tendon Assembly) Quality Control Inspector	THE PRESCON CORPORATION P. O. Box 277 Mauldin, South Carolina 29662 Old Stage Road Directly behind American Monorail Simpsonville, South Carolina (803) 963-8881

FIG. 2

Exhibit B
Page 1 of 1

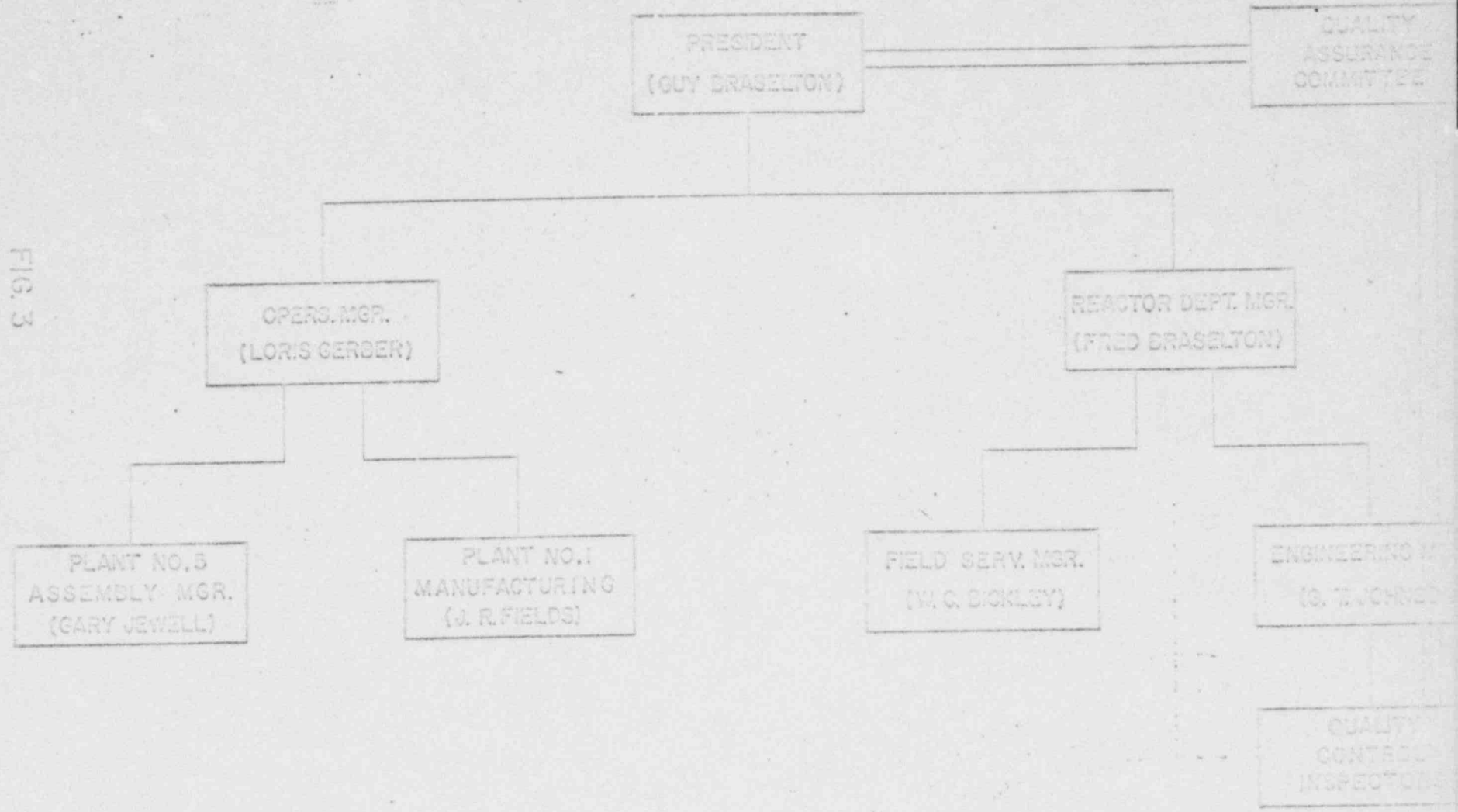

FIG. 3

ORGANIZATION CHART

FOR

ADMINISTRATING QUALITY ASSURANCE PROGRAM

1.2-2

Exhibit C
Page 1 of 1

WIRE INSPECTION RECORD

PCW ______
TO-FRO CHK.
COIL NO. ______
NO. BENDS ______

Q.C. ______

Q.C. CHECK NO. 1			QC CHECK NO. 60						QC. CHECK NO. 61							QC CHECK NO. 62				
DATE RECIEVED	COIL NO.		WRAPPING CONDITIONS					STORAGE AREA	DATE SQS	RUST GRADES					BENT WIRE	SAMPLES	DESTINATION	INSP BY	DATE	R
	PRES. CON.	MFGR.	1	2	3	4	5			A	B	C	D	E		START				

FORM NO.

PCW MATERIAL NUMBER RECORD (WIRE)

MAT. NO. (SEQUENCE)	TYPE	P.O. NO.	DATE DELIVERED	DATE CERT. REC.	COILER	HEAT NO.	DESCRIPTION AND SIZE	JOB CODE	DATE INSP.	INSP. BY

2.2-6

FORM 3
PAGE 1 OF 1

PCW ____ COIL NO. ____ PCW COIL NO. ____

SHOP ORDER No. ____________

TENDON ASSY.

DEV. BY ________ DATE ________

CHKD. BY ________ DATE ________

APPR. BY ________ DATE ________

JOB CODE ________

JOB NAME ____________________

UNIT No. ____________________

TYPE ____________________

LIFT ____________________

ON SITE BY ____________________

THE PRESCON CORPORAT

PLANT No. 5

P. O. BOX 277

MAULDIN, S.C. 29662

DATE ____________

SHEET ________ of ________

See Drwg ________ REVISION No. ____ Dated ____

See Drwg ________ REVISION No. ____ Dated ____

WORK ORDER No. ________

⬡ DATE SHIPPED ____________

Washers		No.	Dia.	Wire	
Int. Thrd.	Ext. Thrd.	Wires		Stress-relieved	Stabilized

SHIPPING RELEASE

____

Inspector's Signature (in ink)

MAY USE △

PC____ PC____ PC____

by plant		by engineering		by plant							
					COILS USED						
Wire Supplier	Heat No.	Tendon Mk.	Cutting Length	Washer mat no. / seq no.	mat no. / coil no.	mat no. / coil no.	mat no. / coil no.	mat no. / coil no.	mat no. / coil no.	mat no. / coil no.	
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△ ASSIGNED BY QC!

⬡ BY PLANT MGR.

Exhibit F
Page 1 of 1

QC FORM No

QC CHECK LIST FOR TENDON FABRICATION

JOB CODE____
UNIT No____
S.O. No____

QC CHECK NO 83			QC CHECK NO 84					QC CHECK NO 85			CHK NO. 5	INSP BY	DAT
TENDON MARK	CUT LENGTH	ECCENT.	WASHER USED	DIA.	SPLITS	QT.	TAG	TENDON MARK	WIRE	BAND			
			/										
			/										
			/										
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Exhibit G
Page 1 of 1