APPENDIX A – PRESTRESSING SYSTEMS

A. New System Proposals

The following checklist includes the minimum required information necessary for approval by METS for a new or modified post-tensioning system.

All prestressing systems that are proposed for use in the State of California must be submitted in the following form to expedite approval of the system or systems.

Seven copies of the final submittal are required by Caltrans and must be bound or stapled together with a title page indicating the name or names of the systems being submitted. The individual numbered sections must be tabbed and listed in the following order:

1. Description
   a. Current product description literature of the system or systems being proposed.
   b. Prior listing of the system. Include specific details of projects where it has been used.
   c. Complete records of tests run on the system independent of Caltrans' witness tests.
   d. Explain how seating loss is to be controlled and measured.
2. Hardware
   a. Anchor head.
      1) Detailed drawing.
      2) Mill certificates – showing material composition, strength and manufacturer.
      3) Quality control document.
   b. Bearing Plate.
      1) Detailed drawing.
      2) Mill certificate.
      3) Quality control statement.
   c. Wedges or Nuts.
      1) Detailed drawing.
      2) Mill certificate.
      3) Quality control document.
   d. Trumpet detail drawings.

3. Calculations.
   a. Stress behind bearing plate at service load after losses.
   b. Stress behind bearing plate at 95% specified ultimate tensile strength.
   c. Maximum bending stress in bearing plate of 95% specified ultimate tensile strength.
4. System.
   a. Detailed drawings of the anchorage system, jacking system, and duct and grouting details.
   b. Complete information on grouting procedures and equipment to be used.
   c. Description of how system components are protected from physical damage and corrosion.
   d. Description of tendon repair or replacement should a failure occur.
   e. Description of how qualified technical assistance is provided in the field for the Contractor performing the work.

B. Presently Used Systems

The following is a summary of the State authorized prestress systems. The summary is considered complete and includes both systems used in bridges and as ground anchors. However, it should be remembered that new developments in the prestress industry necessitate change. Therefore, the various systems may revise capacities, improve anchorages, develop new jacks, etc. Of course, changes such as these may void prior system approval. Many of the companies also have system capacities (smaller and larger) that have not been authorized for State use. Both METS in Sacramento and the Division of Engineering Services Prestressed Concrete Committee have current files for all authorized systems. Check the Structure Construction web site for a current list of those contractors with currently authorized systems.

AVAR Construction Systems, Inc.[45]
The currently used AVAR Systems utilize 0.6″ (15.24 mm) strand anchored with split wedges at both the anchor plate and the pulling head. For box-girder applications, AVAR presently uses anchorage systems utilizing 12, 19, 22, and 27 – 0.6 inch (15.24 mm) strands (see AVAR Systems sheet). In combination, these systems can deliver the precise amount of prestressing force required on the contract plans, in a combination that is economically advantageous to both the Contractor and the State. A single ACS – 27.6 anchorage provides up to 1188 kips (5290 KN) of prestressing force. AVAR also has a variety of anchorage systems utilizing fewer strands for applications other than box-girder construction.

[45] In January 2012, Schwager Davis Inc., purchased AVAR's Construction Post-tensioning Division. Schwager Davis Inc. now owns Avar's prestress jacks, equipment and approved systems.

Photo A-1 – AVAR.

Photo A-2 – AVAR Spliced Girder Stressing.

Dywidag – DSI (Dyckerhoff and Widmann, Inc.)

Dywidag systems include both deformed bar and strand systems. The Dywidag threaded bar prestressing system was developed in Europe. Its use, including a broad application as a rock anchor, has greatly expanded in this country since its introduction in the 1970's. The bars have cold-rolled, thread-type deformations continuous along two opposite sides of the bar. The continuous deformations are especially adaptable to segmental construction. The bars can be cut to any length to fit field conditions and yet retain a threaded end for splicing or anchoring. Splicing is performed very simply with threaded couplers. The deformations are also used to transfer the prestress load in the bar to the anchor nut, and to bond the bar to the structure when grouted.

The bars are available in various diameter sizes. They may be used as a single tendon (monobar) or in multiple groups. State authorized applications use 1″ (25.4 mm), 1-1/4″ (31.8 mm) or 1-3/8″ (34.9 mm) monobar. A bell-type anchorage is normally used with the monobar. The bell consists of a steel cylindrical section with a thin steel plate attached to one end. The principle behind the design of the anchor is to confine concrete within the cylinder and let the confined concrete transmit the majority of the anchor load to the structure.

Stress is applied with small, portable jacks that can be handled by one or two persons. The jacks contain a ratchet assembly that is used to advance the hex anchor nut when stressing the bar. The smaller size jack, although rated at 60 metric tons,[46] has the capacity to stress the 1-1/4″ (31.8 mm) bar to 75% ultimate. The larger jack, rated at 110 metric tons, is more rugged and is used for difficult conditions.

Dywidag strand systems typically use 0.6″ (15.24 mm) strand for 4 to 27 strand tendons. For box girders, DSI uses combinations of 9, 12, 15, 19 and 27 – 0.6″ (15.24 mm) strands (see DSI Systems sheet).

[46] A metric ton equals 2204 lbs.

Photo A-3 – Close-up of DSI 1886 Kip Jack.

Photo A-4 – DSI Anchorages and Block-out.

Photo A-5 – Stressing a DSI 27 Strand Tendon.

Photo A-6 – DSI Post-Tension.

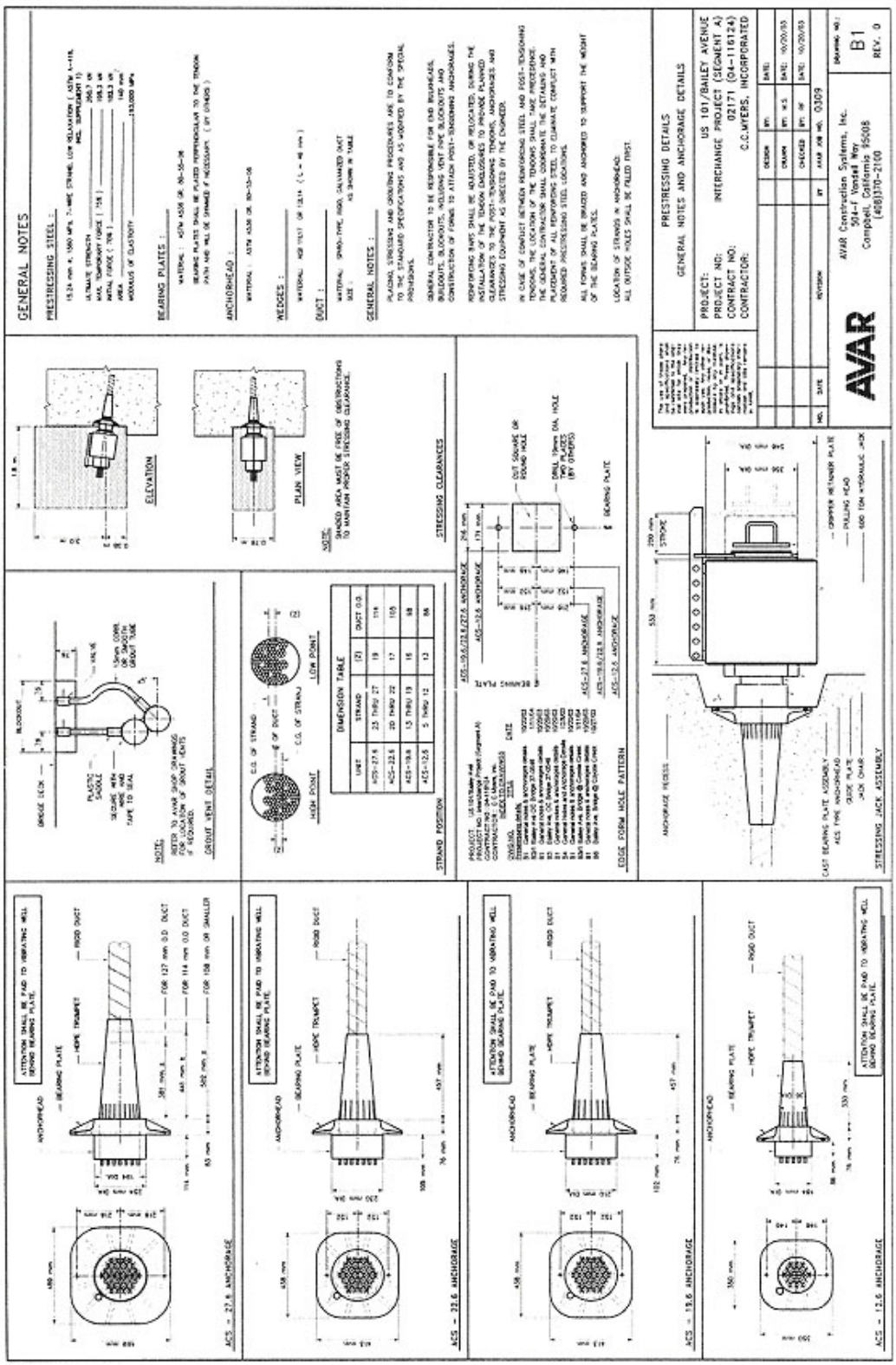

Figure A-1 – AVAR Post-Tensioning Systems Used For Box-Girder Construction.

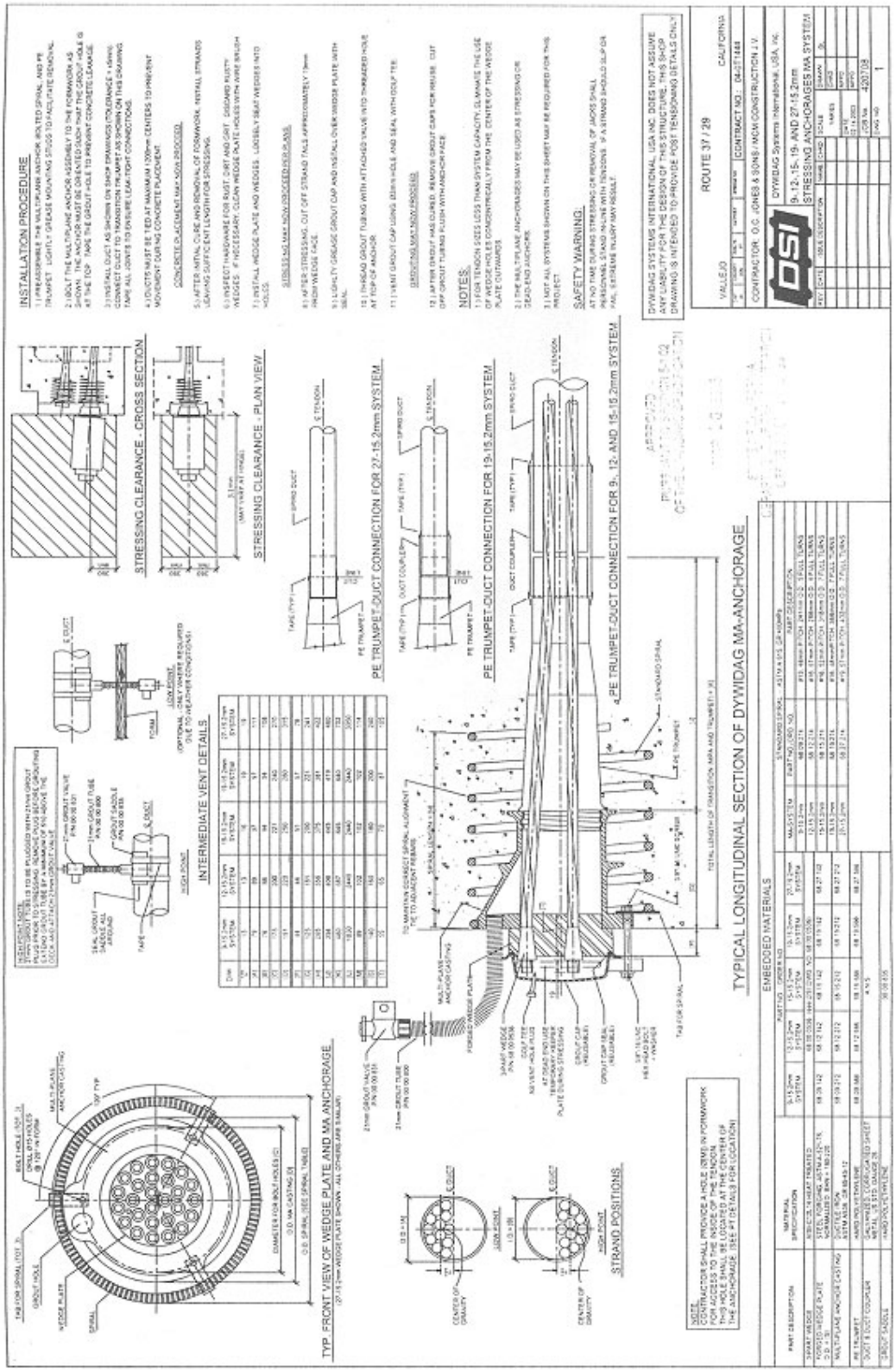

Figure A-2 – DSI Post-Tensioning Systems Used for Box-Girder Construction.

Stresstek System

Stresstek is not currently active on State projects, but is an authorized system. Stresstek anchors individual ½″ (12.70 mm) strands with a pair of split wedges at the anchor plate and three piece wedges in the pulling head. Individual strands are placed in a strand guide that is inserted into the center hole of the jack. A manually operated device, either mechanical or hydraulic, is used to initiate seating of the permanent wedges.

Anchorage systems presently used are capable of holding a maximum of 13, 19, or 31 ½″ (12.70 mm) strands. Also authorized are the Stresstek 0.6″ (15.24 mm) strand systems using 4, 7, 13, or 19 strands maximum.

Western Concrete Structures System

Western Concrete Structures, Inc. is not currently active on State projects, but is an authorized system. The Western Concrete System anchors individual ½″ (12.70 mm) strands with pairs of split wedges at both the anchor plate and jack pulling head. Western uses a center hole jack with a strand guide permanently fixed in the center hole. A power seat is not available in this system to seat the wedges. Anchorage systems presently authorized are capable of holding a maximum of 1, 4, 12, 16, 20, 24, 28, and 48 strands.

C. Ground Anchors and Soil Nails

The use of ground anchors as tie-backs, tie-downs, and soil nails for both temporary and permanent work has become increasingly common. Section 9 of the *Trenching and Shoring Manual* contains information on the design and analysis of these systems for temporary work. Specifications for installation and testing of permanent anchors are contained in the contract *Standard Specifications*[47].

The following authorized post-tensioning contractors perform tensioning on ground anchors only. Visit the METS link to obtain the current authorized list. Scroll down to *Concrete Anchorage Devices.*[48]

Case-Pacific
: Case-Pacific utilizes other authorized systems.

Foundation Constructors
: Foundation utilizes other systems.

Mahaffey Drilling
: Mahaffey also utilizes other systems previously discussed.

Malcolm Drilling Co., Inc.
: Malcolm also utilizes other systems.

Pomeroy
: Pomeroy utilizes other authorized systems.

Schnabel Foundation

[47] 2010 SS 50-1.03B(2)(c), *Anchorages and Distribution.*

[48] http://www.dot.ca.gov/hq/esc/approved_products_list/.

Although not on the METS active list, Schnabel is an authorized contractor. They utilize the LANG system that is authorized for 0.6″ (15.24 mm) strands with an anchorage capable of a maximum of 6 strands.

Wagner Construction

Wagner also utilizes other authorized systems.

Drill Tech Drilling and Shoring, Inc.

D. Girder Strengthening

Strengthening of bridge structures provides another use for post-tensioning systems. This work usually consists of pairs of single strand tendons or high strength bars, one on each side of the girder to be strengthened. These tendons are then tensioned simultaneously and later grouted. As with all previously described prestressing, only authorized systems are to be used by authorized contractors. Additional specifications will be found in the contract special provisions.