

CHAPTER 2M  
PENSTOCKS. SURGE TANKS AND TUNNEL LINERS

2M-01. GENERAL

This chapter covers the fabrication, erection, and testing of penstocks, surge tanks, and tunnel liners. The full scope would be monumental; therefore, the following items are intended only to assist the QAR in the performance of his work. Contract specifications will govern in all cases of conflict, and any conflict will be reported to your supervisor.

2M-02. APPROVALS

a. Approval of materials to be incorporated into the finished product must be made before the start of work.

(1) List approved and unapproved materials.

b. Contractor's plant layout and equipment must coincide with approved plans.

2M-03. PRELIMINARY INSPECTION

a. Damaged Material

(1) Inspect materials on arrival at site.

(2) Reject damaged items.

b. Storage

(1) Check for orderly storage and accessibility.

(2) Check that material that can be damaged by weather is stored above ground and under cover.

(3) Check that steel stored in steel yard is above ground and blocked, with safe passageways for ready accessibility.

(4) Check storage of welding electrodes in a dry, weathertight storage building, in sealed containers.

(5) Check storage of gas bottles.

(6) Check handling of materials. Damage, in handling, is cause for rejection.

2M-04. FITUP

a. Prefabrication

(1) Check that plate edges are cut to design, within allowable tolerances.

(2) Check that edges are straight, clean, end free of scale.

(3) Check curved plates for even curvature.

(4) Check excessive welding when lugs, pad eyes, blank, nuts, and strong backs are welded to plates or sections.

31 Mar 92

- (5) Check heat number on steel plates.
- (6) Check placing of root opening spacers before tack welds are made and removal before root pass is made.
- (7) Check the circumference, diameter, and length of section.
- (8) Check that sheet clamps, or cable slings that bind against plate edges when lifting plates or sections, are not used.
- (9) Check installation of spiders and/or internal bracing in penstock sections and tunnel liner sections.
  - (a) Spider rods must be tight.
  - (b) Internal braces must be secure.
- (10) Check operational procedures.
- (11) Check for positive bearing on rotation rollers when welding penstock sections.
- (12) Check that penstock sections and tunnel-liner sections are not lifted with other than approved cable slings or devices.

#### 2M-5. WELDING

Refer to Chapter 5B for additional check items.

##### a. Preparation

- (1) Check that low-hydrogen electrodes are kept heated between 250 F. to 300 F. after containers have been opened.
- (2) Check that temporary welds are kept to a minimum.
- (3) Check that arcing at ground clamp is given immediate attention and correction.

##### b. Techniques and Practices

- (1) Check that welders are familiar with welding sequence and welding procedures.
- (2) Check need for rejection for departure from specified welding procedures and/or sequence. Disqualification of welder may be necessary.
- (3) Check weld shrinkage of butt joints and correction made.
- (4) Check tack welds. Require chipping or grinding flush, and repair of excessive undercutting.
- (5) Check for approved welding procedures and sequences of welding. Check shrinkage of distortion in welds or metal adjacent to weld.
- (6) Check for protection from rain where welding is being done in the open.

(7) Check contamination of granular flux used with submerged and arc-welding machine.

(8) Verify preheat and posthead (cooling) requirements.

c. Examination of Welded Joints

(1) Check excessive weld reinforcement.

(2) Check use of radiograph.

(3) Check wearing of exposure badges by x-ray operators and assistants.

(4) Check that safe clear distances are set up and limits enforced between x-ray machines in operation and other workmen.

(5) Check taking of test coupons at known defective points in welding, or at suspected defective areas.

(6) Record all repairs made on welds as to unit seam number, direction of seam and location of repair must be examined by a radiograph.

2M-06. ERECTION

a. General

(1) Check accuracy of layout.

(a) Check all ring girders for spacing to coincide with pedestal spacing.

(b) Check anchor bolts and base plates.

(c) Check ring girders and/or saddle locations while fabrications is in progress.

(2) Check that blocking and cribbing are of hardwood; wedges must be of hardwood or iron, flat tapered.

(3) Check wire rope slings, bridles or other gear used by riggers for lifting penstock sections.

(4) Check load capacities of cranes and stiff leg derricks.

(5) Check thickness, size, and welding of temporary pad eyes.

(6) Check ventilation in tunnels and closed spaces where welding and burning are being done. Check need for blowers and exhaust fans.

b. Welded Penstock and Tunnel Liner Sections

(1) Check blocking and cribbing of penstock sections when set in position in tunnel.

(a) Check fitting up to previously placed section or embedded liner for starting.

31 Mar 92

(b) Check grade line and concentricity before completion of fitup and start of tack welding.

(c) Check root opening before welding starts.

(2) Check that spiders or internal bracing is not removed until welding of adjacent seam is completed.

(3) Recheck line, grade and concentricity after welding is completed. Check weld shrinkage.

(4) Check grade, line and stationing, before placing concrete saddles or grouting base plates for ring girders.

(5) Check that spider or internal bracing is not removed from open end of penstock until next section is set and fitup and tack welding is done.

(6) Check that butt ends of hacking bars are welded to form a continuous circumferential strip where used on outside of welded tunnel liners.

(7) Use above check items for surge tank risers and morning glories.

c. Surge Tanks

(1) Check sole plate for correct diameter, centering, and grade.

(2) Check each course for plumb and level. Check thickness of spacers for root opening in horizontal seams.

(3) Check welding of vertical seams of each course before welding the circumferential seam.

(4) Check all scaffold brackets, clips and planking. Do not allow overloading of scaffolds with materials.

(5) Check use of wind screens whenever arc is exposed to strong winds. Seams welded by arc exposed to strong winds must be spot checked by radiograph.

(6) Check bottom cushion for firmness, grade, and level.

(7) Check layout and welding sequence of bottom plates.

(8) Check where warping has occurred for cracks in welds. Use heat activated crayon such as "Templ Sticks" to control excessive heating of bottom plates.

d. Cleanup

(1) Check thorough cleaning of shell plates. Check that temporary welds are removed by chipping and grinding smooth.

(2) Check repairs to tears in plates caused by breaking off clips, pad eyes and such, as well as deep gouges.

(3) Check removal of excessive weld reinforcement.

(4) Check removal of stub ends of welding electrodes.

- (5) Check removal of all debris from inverts and bottoms.

#### 2M-07. ARTICULATING JOINTS

a. Check proficiency of welders employed on fabrication of joints.

- (1) Check that welding of joints members is made on a level floor with a securely fixed center.

- (2) Check radius of member during welding process.

b. Check that radiographic examination is made prior to placing the stainless cladding weld metal.

c. Reject joints made up to a poor fit.

d. Check cut and fit of packing.

- (1) Stagger the cut ends of square braided packing.

- (2) Use silicone grease on all working surfaces.

e. Check that joint tightening is done evenly around the circumference of joint.

- (1) Avoid excessive tightening.

- (2) Check for a smooth even fit and for uniform depth of the packing follower ring around the circumference.

- (3) Do not damage back-off bolts.

f. Check that final tightening of joints is made when joint is incorporated into penstock. Check that back-off bolts are free and under no strain while tightening is in progress.

g. Check that joints are not tightened during hydrostatic test of penstock when pressure is greater than 75% of maximum test pressure and still rising. Check procedures for tightening joints while under test.

#### 2M-08. HYDROSTATIC TESTING OF PENSTOCKS

a. Preparation

- (1) Bulkheads and manholes must be constructed as approved with welded joints of the same quality workmanship as used elsewhere.

- (2) Temporary vents with suitable valves will be installed at all high points in penstock and at top of risers. Air must not be trapped at any high point inside pressure vessel being tested.

- (3) Pressure relief valves will be set in accordance with specifications and code practices. Allow for pressure differential between gauge and relief valve.

- (4) Test gauges must be calibrated and certified as to calibration by manufacturer or testing laboratory. Gauges will be installed at designated locations. Test gauges will not be used prior to test.

31 Mar 92

(5) Temporary communication system will be installed with instruments readily available to all locations of critical inspection.

(6) Force pumps or pressure pumps must have rated head pressure equal to or greater than pressure to be encountered in making hydrostatic test. Pumps must be in sound working order and adequately powered.

b. Testing

(1) Test team must be thoroughly briefed on procedure to be followed with full consideration to communications and safety while testing is in progress.

(2) Air vents must be open while filling penstock. Do not allow any air to be trapped in penstock or risers.

(3) Close all pitot lines and/or Gibson lines at valves outside penstock.

(4) Examine all articulation joints for leaks while filling penstock and take corrective action as previously outlined if necessary.

(5) Tape and mark articulation joints before pressurizing and check measurements while test is in progress. Record time, movement and pressure when movement or changes are found.

(6) Test pressures will be increased by increments as directed. Time for holding pressure, pressure drop and increasing pressure will be as directed.

(7) Record all operations and happenings that occur while test is in progress. Record time for all pressure changes, delays, noises, and difficulties encountered. Keep a concise, accurate account of all operations in sequence of events.

(8) Visual inspections will be made at intervals as directed. Final inspection will be made after maximum pressure holding time has been accomplished and designated pressure drop made. All safety regulations set up for testing will be strictly adhered to while hydrostatic test is in progress.

(9) Air vents valves are to be opened before draining of penstock is started. Do not allow a vacuum to be created within the penstock while draining.

2M-09. TESTING SURGE TANKS

a. Surge tanks can be tested directly after completion of hydrostatic test of penstock while riser bulkhead is in place. Valves on riser air vents from penstock must be closed.

b. Drains in surge tank foundation or weep holes must be open to drain sand cushion under tank bottom.

c. Manhole covers must be securely bolted. Temporary manhole covers with pipe headers and valves must fit manhole securely. Do not allow permanent gaskets to be used on temporary manhole covers.

d. Method of filling surge tank and time for holding fill will be as directed.

e. Measure water elevation from top of surge tank and record water elevation at time tank is filled. Measure and record at designated intervals and before tank is emptied.

f. Valve on fill line to surge tank must be locked in closed position after tank is filled. Fill line should be broken at a coupling in fill line.

g. Check foundation drains for leakage in surge tank bottom.

h. Record all time and events while test is in progress. Report any leak immediately to your supervisor.