

## SECTION 02831

### FENCING

#### PART 1 - GENERAL

##### 1.1 DESCRIPTION

###### A. Scope:

1. CONTRACTOR shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install all fencing shown on the drawings or to restore existing fencing damaged by construction.
2. The extent of fencing is shown on the Drawings.
3. Existing Fencing disturbed or damaged by the CONTRACTOR'S operations shall be restored by CONTRACTOR at his own expense to as good condition as the fencing was previous to the commencement of the Work to the satisfaction of the OWNER and property owner.
4. Types of products that may be required include the following:
  - a. Galvanized steel framework.
  - b. Polyvinylchloride fusion bonded finish.
  - c. Barbed wire.
  - d. Grounding and bonding.
  - e. Auxiliary system components, gates, accessories, fasteners and fittings.
5. Materials in this section do not apply to the fencing to be provided and installed on the Hardabeck property, DB 350, PG 236. See Section 00800 for the required materials.

###### B. Related Sections:

1. Section 03300, Cast-In-Place Concrete.

##### 1.2 REFERENCE STANDARDS

###### A. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:

1. ASTM A53, Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless, Standard Specification for.
2. ASTM A90, Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings, Standard Test Method for.
3. ASTM A121, Metallic-Coated Carbon Steel Barbed Wire, Standard Specification for.
4. ASTM A123, Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products, Standard Specification for.
5. ASTM A153, Zinc Coating (Hot-Dip) on Iron and Steel Hardware, Standard Specification for.
6. ASTM A570, Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality, Standard Specification for.

7. ASTM A653, Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, Standard Specification for.
8. ASTM A780, Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings, Standard Practice for.
9. ASTM A817, Metallic-Coated Steel Wire for Chain-Link Fence Fabric, Standard Specification for.
10. ASTM A824, Metallic-Coated Steel Marcellled Tension Wire for Use with Chain Link Fence, Standard Specification for.
11. ASTM B6, Zinc, Standard Specification for.
12. ASTM D412, Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers – Tension, Standard Test Methods for.
13. ASTM D746, Brittleness Temperature of Plastics and Elastomers by Impact, Standard Test Method for.
14. ASTM D792, Density and Specific Gravity (Relative Density) of Plastics by Displacement, Standard Test Methods for.
15. ASTM D1499, Light- and Water-Exposure Apparatus (Carbon-Arc Type) for Exposure of Plastics, Standard Practice for Operating.
16. ASTM D2240, Rubber Property – Durometer Hardness, Standard Test Method for.
17. ASTM G23, Light-Exposure Apparatus (Carbon-Arc Type) With and Without Water for Exposure of Nonmetallic Materials, Standard Practice for Operating.
18. ASTM E329, Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction, Standard Specification for.
19. ASTM E548, General Criteria Used for Evaluating Laboratory Competence, Standard Guide for.
20. ASTM F552, Standard Terminology Relating to Chain Link Fencing.
21. ASTM F567, Installation of Chain-Link Fence, Standard Practice for.
22. ASTM F626, Fence Fittings, Standard Specification for.
23. ASTM F668, Poly Vinyl Chloride (PVC)-Coated Steel Chain-Link Fence Fabric, Standard Specification for.
24. ASTM F900, Industrial and Commercial Swing Gates, Standard Specification for.
25. ASTM F1043, Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework, Standard Specification for.
26. ASTM F1083, Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures, Standard Specification for.
27. ASTM F1664, Poly(Vinyl Chloride)(PVC)-Coated Steel Tension Wire Used With Chain-Link Fence, Standard Specification for.
28. ASTM F1665, Poly Vinyl Chloride (PVC)-Coated Steel Barbed Wire Used with Chain Link Fences, Standard Specification for.
29. Institute of Electrical and Electronic Engineers (IEEE), C2 - National Electrical Safety Code.
30. Institute of Electrical and Electronic Engineers (IEEE), 81 - Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System, Standard Guide for.
31. Chain Link Fence Manufacturer’s Institute (CLFMI), CLF 2445 - Product Manual.
32. Underwriters’ Laboratories, Incorporated, Standards for Safety, UL 467, Grounding and Bonding Equipment.

33. The Americans with Disabilities Act of 1990 (Public Law 101-336), Appendix A to Title 28 Code of Federal Regulations Part 36 (Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities - ADAAG).

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### 1.3 DEFINITIONS

A. Terminology used in this Specification shall comply with CLF 2445, ASTM F552 and the following:

1. The term “knuckling” shall be used to describe the type of selvage obtained by interlocking adjacent pairs of wire ends and then bending the wire ends back into a closed loop.
2. The term “gate operating cycle” shall mean one gate opening plus one gate closing.
3. The term “fencing” shall be used to describe an assembly of metal components, including wire chain-link fabric fastened to top, bottom and intermediate horizontal rails and to vertical line posts, corner posts and terminal posts. This assembly shall also include all auxiliary components, gates, fittings, fasteners and other accessories all with polymer coating and other specified protective coatings.

### 1.4 QUALITY ASSURANCE

A. Erector Qualifications:

1. Engage a single erector skilled, trained and with successful and documented experience in the installation of fencing, who is acceptable to the fencing manufacturer, and with specific skill and successful experience in the erection of the types of components required; and who agrees to employ only tradesmen with specific skill and successful experience in this type of Work. Submit names and qualification to ENGINEER along with the following information on a minimum of three successful projects:
  - a. Names and telephone numbers of owner, architects or engineers responsible for projects.
  - b. Approximate contract cost of the fencing.
  - c. Amount of area installed.

B. Testing Agency Qualifications: To qualify for approval, an independent testing agency shall demonstrate to ENGINEER’s satisfaction, based on evaluation of criteria submitted by testing agency, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work, in accordance with ASTM E329 and as documented according to ASTM E548.

C. Source Quality Control:

1. Provide fencing as a complete system with all gates, hardware, appurtenances and other components produced by a single manufacturer, including custom erection accessories, fittings, clamps and fastenings as may be necessary or required.
2. Provide fence fabric imprinted with manufacturer’s trade name, country of origin, core wire gauge, and finished outside diameter gauge.

3. Provide shipping list for materials used, endorsed with the manufacturer's voucher certifying that the material used in the fencing complies with these Specifications and with specific selections made on approved Shop Drawings.
4. Structural shapes of satisfactory sections and equal strengths may be substituted if approved by ENGINEER.

D. Performance Criteria:

1. Comply with the standards of the Chain Link Fence Manufacturer's Institute for product and installation requirements and the requirements of ASTM F567. These standards shall represent a minimum level of quality when additional information is not shown or specified in the Contract Documents.
2. Where proposed fencing framework or other structural components varies from Contract Documents, the fabricator shall provide structural calculations for the design of the proposed fencing to CONTRACTOR for submittal to ENGINEER as part of Shop Drawing review. Structural analysis shall verify that all system components including, but not limited to, supports, gates, fasteners, fittings and connections meet the requirements of governing authorities having jurisdiction at the Site. Such modifications shall be incorporated into the Work only as acceptable to ENGINEER.
3. Verify size of framing members shown or specified, and submit with Shop Drawings. Member sizes, thicknesses and weights shown or specified shall be considered minimum. Where structural analysis indicates, provide additional members, or increased member size, thickness or weight.
4. Modifications may be made only as necessary to meet Site conditions to ensure proper fitting and support of the Work, and only upon submittal of Shop Drawings and receipt of approval by ENGINEER.
5. Furnish weights of zinc coatings on wire and pipe fabrications, in compliance with CLF 2445.
6. Furnish thickness of polyvinylchloride coating on wire and pipe fabrications in compliance with CLF 2445.

E. Fabrication Tolerances:

1. Fabric, posts, rails, and other supports shall be straight or uniformly curved to provide the profiles shown, to a dimensional tolerance of 1/16 inch in 10 feet - 0 inches without warp or rack in the finished installation.

## 1.5 SUBMITTALS

A. Qualifications Data: Submit qualifications data for the following:

1. Erector.
2. Test agency.

B. Samples: Submit for approval the following:

1. Each fencing component, fastener, post, rail, support, chain-link fabric and other auxiliary and miscellaneous items labeled with identification as to use and location.

2. Each chain-link fabric material, 6-inches square; and framework members, and typical accessories, each approximately 6-inches long.
3. Full range of manufacturer's standard and custom colors.
4. ENGINEER's review will be for color and texture only. Compliance with all other requirements is the responsibility of CONTRACTOR.

C. Shop Drawings: Comply with the requirements of Section 01340 and submit the following:

1. Copies of manufacturer's technical product information, specifications and installation instructions for all fencing components, and auxiliary system components.
2. All structural calculations verifying that all system components comply with the requirements of governing authorities having jurisdiction at the Site.
3. Drawings at a scale of 1/4 inch equals 1 foot of typical fence assembly, identifying all materials, dimensions, sizes, weights, and finishes of all rails, posts, braces, supports and other fencing components. Show fence heights, and locations of gates. Show gate swing, or other operation, hardware, and accessories. Include plans, elevations, sections, with required installation and operating clearances, and details of post anchorage, attachments and bracing.
4. A list of all hardware, fasteners and accessories.

D. Test Reports: Submit the following:

1. Physical properties of polyvinylchloride protective coating in compliance with ASTM D1499.
2. Weight of zinc coating on pipe fabrications in compliance with ASTM A90.
3. On-Site Test Reports: Indicate and interpret test results for compliance of chain-link fence and gate grounding and bonding with performance requirements.

## 1.6 DELIVERY, STORAGE AND HANDLING

A. Comply with requirements specified in Sections 01610 and 01611.

B. Delivery of Materials:

1. Packaging and marking shall comply with CLF 2445.
2. Deliver materials in manufacturer's original, unopened packaging with all factory-applied tags, labels and other identifying information intact, legible and accurately representing material approved on Submittals by ENGINEER.

C. Storage of Materials:

1. Store all materials under weatherproof cover, off the ground and away from other construction activities.
2. Do not store material in a manner that would create a humidity chamber. Provide for free movement of air under protective cover and between components of the fencing.

D. Handling of Materials:

1. Handle material in a manner that is in compliance with product institute standards and that will prevent damaging coatings.

## 1.7 PROJECT CONDITIONS

- A. Site-Measurements: Take measurements at the Site and verify layout information and dimensions for fencing and gates in relation to property surveys and existing conditions.
- B. Do not begin installation and erection of the fencing until final grading is completed.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. General:
  1. Pipe sizes specified are commercial pipe sizes.
  2. Tube sizes specified are nominal outside dimension.
  3. Roll-formed section sizes are the nominal outside dimensions.
  4. Wire gauges shall conform to American Steel and Wire Company gage.
  5. Heat-form all arcs and chords before protective coatings are applied to metal.
  6. All sizes specified are given for uncoated metal. All protective coatings are in addition to specified metal dimensions, gages and sizes.
- B. Chain-Link Fence Fabric:
  1. One-piece fabric widths, complying with CLFMI product requirements.
  2. Wire mesh shall be woven throughout in the form of approximately uniform square mesh with parallel sides and horizontal and vertical diagonals of approximately uniform dimensions, of size and gage specified and in compliance with ASTM A817, Type 1, cold-drawn carbon steel wire with minimum breaking strength of 2,170 pounds and coated with polyvinylchloride (PVC) plastic resin finish over galvanized steel wire, as specified. Fabric shall be recommended by the Chain Link Fence Manufacturer's Institute for heavy industrial usage.
  3. Provide fabric knuckled to eliminate exposure of sharp edges.
  4. Fabric Gage: Provide the following:
    - a. No. 9-gage wires.
  5. Mesh Size: Provide the following:
    - a. 2-inch mesh.
  6. Privacy Slats: Provide vinyl, single wall, privacy slats for all fence to be installed at the Taylorsport Pump Station.
    - a. Color of slats to be selected by OWNER from manufacturer's standard color charts.
    - b. Manufacturer: M-Slat by Privacy Link.

### 2.2 FRAMEWORK

- A. General: The following table is provided for the convenience of CONTRACTOR and provides actual OD and equivalent nominal NPS size and trade size of round members.

<u>Actual OD</u>	<u>NPS Size</u>	<u>Trade Size</u>
1.315	1	1-3/8
1.660	1-1/4	1-5/8
1.900	1-1/2	2
2.375	2	2-1/2
2.875	2-1/2	3
3.500	3	3-1/2
4.000	3-1/2	4
6.625	6	6-5/8
8.625	8	8-5/8

- B. Pipe shall be commercial grade, plain end steel pipe with standard weight walls. Steel strip used in the manufacture of pipe shall be in compliance with ASTM F1083, Schedule 40 pipe with minimum yield strength of 25,000 pounds per square inch and protected with zinc, as specified.
- C. End, Corner, and Pull Posts: Provide end, corner, and pull posts of minimum sizes as follows:
1. 2.875 inches OD pipe weighing 5.79 pounds per linear foot.
- D. Line Posts: Provide line posts of the minimum sizes and weights as follows:
1. 2.375 inches OD pipe weighing 3.65 pounds per linear foot.
- E. Gate Posts: Furnish gate posts for supporting single gate leaf, or one leaf of a double gate installation, for nominal gate widths as follows:
1. 6.625 inches OD pipe weighing 18.97 pounds per linear foot.
- F. Top Rail: Provide top rails, unless otherwise shown, of the following:
1. 1.900-inch OD pipe weighing 2.72-pounds per linear foot.
  2. Provide in manufacturer's longest lengths, with expansion type coupling 0.051-inch thick rail sleeves, approximately 7-inches long, for each joint.
  3. Provide means for attaching the top rail securely to each gate, corner, pull, and end post.
- G. Roll-Formed Steel: Provide rolled steel shapes produced from structural-quality steel conforming to ASTM A570, Grade 45, with a minimum yield strength of 45,000 pounds per square inch. Protective coating system shall conform to ASTM F1043, as specified.

### 2.3 GATES

- A. Swing gates shall comply with ASTM F900.
- B. Gate hinges shall be of the double clamping offset type. To hold the gate in the open or closed positions, provide each gate frame with a keeper that automatically engages a gate shoe set in concrete. Gates shall have a drop latch with provision for a padlock.

1. Gate Hinges: Pressed or forged steel or malleable iron to suit gate size, non-lift-off type, 180 degree offset heavy-industrial hinges; 1-1/2 pair per leaf.
  2. Latch: Forked-type or plunger-bar type to permit operation from either side of gate, with padlock eye as integral part of latch.
- C. All gate frames shall have intermediate horizontal rails. Gate frames shall be of welded construction and shall be galvanized after fabrication. Single gates 6-feet wide or wider and double gates 12-feet wide or wider shall be provided with diagonal bracing in one direction, extending from top to bottom rail.
- D. Gate Stops: Provide gate stops for double gates consisting of mushroom-type flush plate with anchors, set in concrete, and designed to engage a center drop rod or plunger bar. Include locking device and padlock eyes as an integral part of the latch, using one padlock for locking both gate leaves.
- E. Fabricate gate perimeter frames of tubular members. Provide additional horizontal and vertical members to ensure proper gate operation and for attachment of fabric, hardware and accessories. Space so that frame members are not more than 8 feet apart. Fabricate as follows:
1. 1.900-inch OD pipe weighing 2.72-pounds per linear foot.
- F. Assemble gate frames by welding or with special malleable or pressed steel fittings and rivets for rigid connections. Use same fabric as for fence. Install fabric with stretcher bars at vertical edges. Bars may also be used at top and bottom edges. Attach stretchers to gate frame at not more than 15 inches on center. Attach hardware with rivets or by other means which will provide security against removal or breakage.
- G. Install diagonal cross-bracing on gates consisting of 1/2-inch diameter adjustable length truss rods provided with turnbuckles to ensure frame rigidity without sag or twist.
- H. Where barbed wire is shown above gates, extend the end members of gate frames 1 foot-0 inch above the top member and prepare to receive three strands of wire. Provide necessary clips for securing wire to extensions.

## 2.4 AUXILIARY FENCING MATERIALS AND ACCESSORIES

- A. Wire Ties:
1. For tying fabric to line posts, use 9-gage aluminum alloy 1100-H4, polyvinylchloride coated wire ties to match fence fabric, spaced 12 inches on center.
  2. For tying fabric to rails and braces, use 9-gage aluminum alloy 1100-H4, polyvinylchloride coated wire ties to match fence fabric, spaced 24 inches on center.

3. For tying fabric to tension wire, use 11-gage aluminum alloy 1100-H4, polyvinylchloride coated wire hog ring ties to match fence fabric, spaced 24 inches on center.
- B. Tension Wire: Provide tension wire consisting of aluminized, 7-gage, coiled spring steel wire coated with 0.40-ounces of aluminum per square foot of wire surface, minimum; in compliance with ASTM F1664.
    1. Locate at bottom of fabric only.
  - C. Barbed Wire Supporting Arms: Furnish pressed steel for three rows of barbed wire attached to each arm, complete with provisions for anchorage to posts. Supporting arms shall be integral with post top weather cap. Provide following type:
    1. Single 45 degree arm, one for each post.
  - D. Barbed Wire: Commercial quality steel, two strand, 11-gage line wire with 14-gage, 4-point twisted barbs spaced 5 inches on center, as follows:
    1. PVC-coated, complying with ASTM F1665.
  - E. Post Caps: Pressed steel, wrought iron, or cast aluminum alloy, designed as a weather-tight closure cap, for tubular posts. Provide one cap for each post unless equal protection is afforded by combination post top cap and barbed wire supporting arm, where barbed wire is required.
    1. Provide caps with openings to permit through passage of the top rail.
    2. Provide cone-type caps for terminal posts and loop-type caps for line posts.
  - F. Stretcher Bars: One piece lengths equal to full height of fabric, with a minimum cross-section of 3/16-inch by 3/4-inch. Provide one stretcher bar for each gate and end post, and two for each corner and pull post, except where fabric is integrally woven into the post.
  - G. Stretcher Bar Bands: Pressed steel, galvanized, 0.078-inches to 0.108-inches thick depending on post diameter, spaced not over 15 inches on center to secure stretcher bars to end, corner, pull, and gate posts.
    1. Bands may also be used with special fittings for securing rails to end, corner, pull and gate posts.
  - H. Truss Rods: Steel rods, 3/8-inch diameter, merchant quality with turnbuckle.
  - I. Concrete: Refer to Section 03300, Cast-In-Place Concrete.

## 2.5 FENCE GROUNDING

- A. Conductors: Bare, solid wire for No. 6-gage and smaller; stranded wire for No. 4-gage and larger.
  1. Material Above Finished Grade: Copper.

2. Material On or Below Finished Grade: Copper.
  3. Bonding Jumpers: Braided copper tape, 1-inch wide, woven of No. 30-gage bare copper wire, terminated with copper ferrules.
- B. Connectors and Ground Rods: As listed in UL 467.
1. Connectors for Below-Grade Use: Exothermic welded type.
  2. Ground Rods: Copper-clad steel.
    - a. Size: 5/8-inch by 8 feet-0 inches.

2.6 FINISHES

- A. Chain-Link Fence Fabric:
1. Polyvinylchloride (PVC) plastic resin finish over galvanized steel wire finish with not less than 11.2 ounces per square foot, complying with ASTM A392, Class I.
- B. Framework and Appurtenances: Provide the following for steel framework, auxiliary system components and miscellaneous accessories:
1. Galvanizing: Zinc for galvanizing shall be of High Grade or Special High Grade conforming to ASTM B6 with a maximum aluminum content of 0.01 percent. Galvanize metal by the "hot-dip" process in compliance with the following standards:

<u>Class of Work</u>	<u>ASTM</u>
Structural Iron and Steel Shapes.....	A123
Rolled-Form Sheet Steel.....	A653
Hardware and Accessories.....	A153
Fittings.....	F626
Pipe.....	A53

2. Provide minimum weights of zinc as follows:
    - a. Pipe: 1.8-ounces of zinc per square foot. Type A coating shall be applied both inside and outside according to ASTM F1043, as determined by ASTM A90.
    - b. Rolled-Form Sheet Steel: 4.0-ounces of zinc per square foot of surface area.
    - c. Hardware and Accessories: Zinc weights in compliance with Table 1 of ASTM A153.
- C. PVC Finish for All Fencing Components: Provide polyvinylchloride (PVC) epoxy-modified plastic resin finish, fusion bonded to heated metal, minimum 10-mil thickness.
1. Provide the following physical properties for polyvinylchloride coating:
    - a. Specific Gravity, ASTM D792: 1.30 to 1.38, maximum.
    - b. Ultimate Tensile Strength, ASTM D412: 2,600 pounds per square inch  $\pm$  5 percent.\
    - c. Hardness, ASTM D2240: Durometer A (10 second) 93  $\pm$ 3.
    - d. Ultimate Elongation, ASTM D412: 275 percent  $\pm$ 5 percent.

- e. Compression Cut Resistance, Bell Laboratories: 2,000 pounds per square inch.
  - f. Low Temperature Brittleness, ASTM D746: -20 degrees C.
  - g. Low Temperature Flexibility, (Mandrel Wrap): -40 degrees C.
  - h. Weatherometer Exposure, ASTM G23, with no change: 1,000 hours.
2. Provide polyvinylchloride (PVC) plastic resin finish over aluminized steel wire by the thermal extrusion method, in compliance with ASTM F668, Class 2b.
  3. Color:
    - a. As selected by OWNER from manufacturer's complete range of standard and custom colors.
    - b. Provide fencing with all components, including framework and accessories completely protected with color coating, in compliance with CLF 2445.
- D. Welded Joints:
1. Repair zinc coatings at welded joints by applying a zinc-rich paint, as specified in Section 09900.
  2. Repair polymer-coated steel by applying an epoxy primer, intermediate coat and urethane top coat, as specified in Section 09900, matching color and reflectivity of adjacent PVC finish.

## PART 3 - EXECUTION

### 3.1 INSPECTION

- A. CONTRACTOR and his installer shall examine the conditions under which the fencing and gates are to be erected and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

### 3.2 PREPARATION

- A. Do not begin fence installation and erection before the final grading is completed, with finish elevations established.

### 3.3 ERECTION

- A. Erect framework, fabric and accessories in accordance with ASTM F567.
- B. Excavation: Drill holes of diameters specified, for post footings in firm, undisturbed or compacted soil.
  1. For posts set in cast-in-place concrete, provide hole diameters dug or drilled a minimum of four times the largest cross section of the post.
    - a. Unless otherwise indicated, excavate hole depths approximately 3 inches lower than the post bottom, with bottom of posts set not less than 24 inches below the surface of finished grade when in firm, undisturbed soil,

plus an additional 3 inches for each foot increase in the fence height over 4 feet.

2. Spread soil from excavations uniformly adjacent to the fence line, or on adjacent areas of the Site, as directed.
  3. When solid rock is encountered at the surface, drill into rock at least 12 inches for line posts and at least 18 inches for end, pull, corner, and gate posts. Drill hole at least 1-inch greater diameter than the largest dimension of the post to be placed.
    - a. If solid rock is below soil overburden, drill to full depth required, except penetration into rock need not exceed the minimum depths specified above.
- C. Setting Posts: Remove loose and foreign materials from sides and bottoms of holes, and moisten soil prior to placing concrete.
1. Center and align posts in holes 3 inches above bottom of excavation.
  2. Posts shall be set in concrete footings, except as otherwise shown or specified. Place concrete around posts in a continuous pour, and vibrate or tamp for consolidation. Check each post for vertical and top alignment, and hold in position during placement and finishing operations.
  3. Extend concrete to 2-inches above grade or to 2-inches below grade if a cover of sod, blacktop, or other material is shown to conceal concrete. Crown to shed water away from posts.
  4. Extend footings for gate posts to the underside of bottom hinge. Set keeps, stops, sleeves and other accessories into concrete as required.
  5. Keep exposed concrete surfaces moist for at least seven days after placement, or cure with membrane curing materials, or other acceptable curing method.
  6. Grout posts set in sleeved holes, concrete constructions, or rock with grout, as specified in Section 03300 and as recommended by CLF 2445.
- D. Concrete Strength: Allow concrete to attain at least 75 percent of its minimum 28-day compressive strength, but in no case sooner than seven days after placement, before rails, tension wires, barbed wire, or chain-link fabric is installed. Do not stretch and tension fabric and wires, and do not hang gates until the concrete has attained its full design strength.
- E. Posts and Rails:
1. Line Posts: Set posts in cast-in-place concrete footings as specified, spaced not more than 10 feet on centers. Install caps on tops of all posts to exclude moisture and to receive the top rail unless equal protection is afforded by combination post top cap and barbed wire supporting arm, where barbed wire is required.
  2. Top Rails: Run rail continuously through post caps or extension arms, bending to radius for curved runs. Provide expansion couplings as recommended by fencing manufacturer to form a continuous rail between terminal posts.
  3. Brace Assemblies: Install braces so posts are plumb when diagonal rod is under proper tension. Install brace assemblies at end posts and at both sides of corner and pull post panels. Panels adjacent to gates shall have intermediate horizontal rails

and diagonal bracing. The diagonal bracing shall run from the center of the first line post to the bottom of the terminal post.

F. Chain-Link Fabric:

1. Install fabric on security side of fence, and anchor to framework so that fabric remains in tension after pulling force is released. Pull fabric taut and tie to posts, rails, and tension wires. Fasten to terminal posts and gate posts with tension bars threaded through mesh and secured with tension bands at maximum intervals of 14 inches.
2. Tie to line posts, gate frames and top and bottom rails with tie wires spaced at maximum 12 inches on posts and 24 inches on rails.
3. Connect tension bars to posts and frames by means of adjustable bolts and bands spaced not more than 14 inches apart.
4. Leave approximately 2 inches between finish grade and bottom selvage, except where bottom of fabric extends into concrete.
5. Join roll of chain-link fabric by weaving a single picket into the ends of the roll to form a continuous mesh.

G. Tension Wire:

1. Stretch tension wire taut and free of sag, from end to end of each stretch of fence and position at a height that will enable the wire to be fastened to the chain-link fabric by securing within the top 12 inches of the chain-link fabric.
2. Fasten bottom tension wire within the bottom 6 inches of the chain-link fabric.
3. Tie tension wire to each post with not less than 6-gage galvanized wire.

H. Barbed Wire:

1. Install three parallel wires on each extension arm to the security side of fence, unless otherwise indicated
2. Pull wire taut to remove all sag and firmly install in the slots of extension arms to prevent movement or displacement.
3. Secure wire to terminal posts utilizing terminal post band arms or brace bands.
4. Extend vertical members of gates to receive the barbed wire.

I. Stretcher Bars: Thread through or clamp to fabric 4 inches on center, and secure to posts with metal bands spaced 15 inches on center.

J. Gates: Install gates plumb, level, and secure for full opening without interference. Install ground-set items in concrete for anchorage, as shown on approved Shop Drawings. Adjust hardware for smooth operation and lubricate where necessary.

K. Tie Wires: Use U-shaped wires conforming to diameter of pipe. Clasp pipe and fabric firmly with ends twisted at least two full turns. Bend ends of wire to minimize hazard to persons or clothing.

L. Fasteners: Install nuts for tension band and hardware bolts on side of fence opposite fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

### 3.4 GROUNDING AND BONDING

- A. Fence Grounding: Install at maximum intervals of 1500 feet except as follows:
  - 1. Ground fencing within 100 feet of buildings, structures, walkways, and roadways at maximum intervals of 750 feet.
    - a. Gates and Other Fence Openings: Ground fence on each side of opening.
      - 1) Bond metal gates to gate posts.
      - 2) Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2-gage wire and bury it at least 18 inches below finished grade.
- B. Protection at Crossings of Overhead Electrical Power Lines: Ground fencing at location of crossing and at a maximum distance of 150 feet on each side of crossing.
- C. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2, unless otherwise shown.
- D. Grounding Method: At each grounding location, drive a ground rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6-gage conductor. Connect conductor to each fence component at the grounding location, including the following:
  - 1. Each Barbed Wire Strand: Make grounding connections to barbed wire with wire-to-wire connectors designed for this purpose.
- E. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.
- F. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
  - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
  - 2. Make connections with clean, bare metal at points of contact.
  - 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
  - 4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
  - 5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

### 3.5 SITE QUALITY CONTROL

- A. Acceptance Testing:
  - 1. Ground-Resistance Testing Agency: Engage a qualified independent testing agency to perform Site quality-control testing.
  - 2. Ground-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure ground resistance not less than two full days

after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by two-point method according to IEEE 81.

3. Desired Maximum Grounding Resistance Value: 25 ohms.
4. Excessive Ground Resistance: If resistance to ground exceeds desired value, notify ENGINEER promptly. Include recommendations to reduce ground resistance and proposal to accomplish the recommendations.
5. Report: Prepare test reports, certified by testing agency, of ground resistance at each test location. Include observations of weather and other phenomena that may affect test results.

### 3.6 ADJUSTMENT AND CLEANING

- A. Adjust fencing and leave in good working condition.
- B. Repair coatings damaged in the shop or during erection on-Site by recoating with manufacturer's recommended repair compound, applied in accordance with manufacturer's directions.
- C. Gate: Adjust gate to operate smoothly, easily, and quietly, free from binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- D. Lubricate operating equipment and clean exposed surfaces.
- E. Repair and replace all broken or bent components.
- F. Protect fencing and accessories from construction traffic until acceptance of the Work.

++ END OF SECTION ++