

# COMMODORE 5 TUNNEL REHABILITATION SEGMENT 6

## TECHNICAL SPECIFICATIONS



PREPARED FOR:

TETRA TECH, INC.  
1560 BROADWAY, SUITE 1400  
DENVER, CO 80202

JOB No. 20C26033.04

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## SECTION 02412 – UNDERGROUND WORK

### PART 1 - GENERAL

#### 1.1 DESCRIPTION

- A. This section applies to the rehabilitation of the existing Commodore Level 5 Tunnel from just past the Del Monte Raise to Station 77+84 near the Berkshire Shaft. Where there is a conflict between the drawings and these specifications, the drawings shall control. Notice To Proceed on the various parts of this work is governed by other contract documents.
- B. The means and methods of construction including safety, excavation, installation, and observation of all support shall be the sole responsibility of the Contractor.
- C. Mobilization at Portal Area. The work will include:
  - 1. Install temporary facilities as needed for construction
  - 2. Install construction fencing and signage at limit of heavy equipment access as shown on the drawings.
- D. Segment 6: Sta 52+43 to Sta 77+84
  - 1. Scale, muck and remove timber and debris.
  - 2. Spot bolt as needed for safety.
  - 3. Install hangers at 10' OC for phone and transducer cable. Provide and install 1 internal phone station at location directed by OSC. The transducer cable has been installed by others and shall be protected during construction.
  - 4. Rail (24" gauge) has been rehabilitated and/or replaced up to the starting station for this Segment. Beyond that point, replace occasional rail ties, add spacers, local ballast, and locally replace rail to maintain rail access up to approximately STA 76+06. Fully replace rail, ties and ballast where shown on drawings or as needed. Installation of rail beyond STA 76+06 to facilitate contractor's means and methods is allowed but not required.
  - 5. Install steel sets as shown on drawings.
  - 6. Install single post bolted steel sets as shown on drawings.
  - 7. Install steel stulls as shown on drawings.
  - 8. Remove rotted timber and timber identified on drawings, transport to site entrance for disposal by others.
  - 9. Secure raises with 1 or 2 post steel sets and lagging per the drawings. Fill raises with 10' of mine foam and install drain pipes at maximum 10' on-center.
  - 10. Secure ore chutes with steel stulls and lagging or steel sets per the drawings. Fill chutes with 10' of mine foam and install drain pipes at maximum 10' on-center.
  - 11. Backfill deep invert section near Berkshire Shaft using on-site materials.
  - 12. Install and remove any utilities needed to perform the work.
- E. The project is located within an inactive mine. Occupation Safety and Health Administration (OSHA) regulations will apply.
- F. Contractor shall not enter the Nelson Tunnel.

#### 1.2 RELATED WORK

- A. Section 02442 – Mine Support
- B. Section 03661 - Shotcrete

### 1.3 QUALIFICATIONS

- A. The Contractor and his field superintendent shall demonstrate and document their qualifications for this project by their experience on projects of similar type and complexity:
  - 1. Contractor's project experience shall include at least three tunnel/mine rehabilitation projects in the last 10 years totaling at least 5,000 LF.
  - 2. Contractor's project experience shall include at least one tunnel/mine rehabilitation project in the last 3 years totaling 1,000 LF.
  - 3. Contractor's project experience shall include at least one project using the excavation and support methods proposed for use on this project.
  - 4. Contractor may submit other information demonstrating his qualifications for this project for review by the OSC, General Contractor, and Engineer.
  - 5. Underground superintendent(s) shall have at least five years of recent experience (within last 15 years) in responsible charge of the overall tunneling/mining operation, including experience in similar rock formations and ground support types using the methods proposed by the Contractor. Shift supervisors shall have at least 3 years of recent experience (within last 10 years) in responsible charge of a tunneling/mining shift in similar rock formations and ground support types using the methods proposed by the Contractor.

### 1.4 REFERENCES

- A. General:
  - 1. The publications listed below form a part of this specification to the extent referenced.
  - 2. Where a date is given for reference standards, the edition of that date shall be used. Where no date is given for reference standards, the latest edition to the date of this document shall be used.
- B. Code of Federal Regulations (CFR): U.S. Department of Labor, Occupational Safety and Health Administration, Construction Standards and Interpretations, 29 CFR Part 1926, Subpart S, Section 1926.800.

### 1.5 SUBMITTALS

- A. Proposed methods of fall protection when working around vertical openings.
- B. Proposed method of working safely under raises where material may drop down from significant heights with little to no warning
- C. Work experience resumes of proposed tunnel superintendent(s) and shift supervisors.
- D. Shift reports during rehabilitation. Submit reports no later than 12 hours after end of the shift. Include the following minimum information:
  - 1. Pre-work inspection notes.
  - 2. Number and classification of crew members and equipment used.
  - 3. Progress reports. For each shift, include the beginning and ending time and station and summary of the work performed.
  - 4. Unusual ground conditions encountered (roof fall, slabbing, water inflow, etc...) or other observations
  - 5. Deformations or distress of the existing and installed support.
  - 6. Air quality in working areas per OSHA requirements.
  - 7. Time, duration, equipment, and operations affected by down time due to interruptions or delays. Describe, in detail, the nature and cause of the down time.
  - 8. Results of inspections or testing as detailed in other parts of the project documents.
- E. Certificates of compliance for all materials permanently incorporated into the work.

## 1.6 DEFINITIONS

- A. Support – Ground support consisting of rock bolts, stulls and steel sets as shown on the drawings.
- B. Unsuitable Materials: Materials that do not comply with the quality standards specified for the permanent work.
- C. Muck: Material of any composition from tunnel excavation and clean up.
- D. Back: crown, roof, or top of tunnel.
- E. Rib: side walls of the tunnel/decline.
- F. Winze: vertical or near-vertical opening sunk from a point inside a mine for the purpose of connecting with a lower level or of exploring the ground for a limited depth below a level.
- G. Raise: vertical or near-vertical opening driven upward from a level to connect with the level above, or to explore the ground for a limited distance above one level.
- H. Shotcrete: Concrete pneumatically projected at high velocity on to a surface so as to achieve compaction.

## 1.7 QUALITY ASSURANCE

- A. Provide safe access for Engineer to the underground to observe the work. The Engineer will endeavor, but is not required, to enter the underground workings at times when it will not disrupt the Contractor's operations and is convenient for the Contractor.
- B. Dewatering: The Contractor shall maintain the existing drainage ditch in the Commodore 5. Contractor shall not drain water from the Nelson Tunnel.

## **PART 2- PRODUCTS**

### 2.1 EQUIPMENT

- A. Equipment selection is the Contactor's responsibility. Equipment shall be capable of installing adequate support for the rehabilitation and achieving progress rates necessary to complete the work within the specified time of completion.
- B. Equipment shall be compatible with the existing mine rails once maintenance and track rehabilitation has been completed.

## **PART 3 - EXECUTION**

### 3.1 GENERAL

- A. Before commencing mine rehabilitation operation, the Contractor shall obtain all necessary statutory approvals for the work.
- B. In case of any emergency or stoppage of work which is likely to endanger the mine, the Contractor shall maintain sufficient qualified personnel, as required, for 24 hours per day, including weekends and holidays, to cope with the emergency or hazardous condition until it is concluded.
- C. The Contractor shall furnish, install, and maintain temporary electrical, compressed air, and ventilation systems as needed to perform the work in accordance with local, state, and federal requirements.
- D. The Contractor shall maintain clean and safe working conditions inside the rehabilitated working and shall remove muck, foam, debris, spills, and other materials not directly used in the work.
- E. Contractor's ventilation systems (if used) and air quality measuring program shall meet OSHA requirements.

### 3.2 TUNNEL SUPPORT

- A. Tunnel support shall be furnished and installed as specified in Section 02442, 03361, and shown on the Drawings.

### 3.3 SCALING AND CLEANING

- A. Before entering an area, the Contractor shall inspect the rock surface and scale all material that is loose or "drummy."
- B. Remove loose material on the exposed rock surfaces to expose clean undisturbed surfaces before installing the support shown in the drawings for that area.

### 3.4 TUNNEL SURVEY

- A. During rehabilitation, painted intermediate tunnel station markers shall be provided:
  1. At all 100' stations from the Del Monte Raise to Station 78+00 near the Berkshire Shaft.
  2. Minimum lettering heights of 8."
  3. Color to contrast to background.
  4. Locate markers on the same side of the tunnel throughout its length and with respect to the centerline of the tunnel.
  5. Set markers at approximately eye level near the spring line and keep unobstructed by utilities.

### 3.5 MUCK AND DEBRIS DISPOSAL

- A. All muck timbers, and other debris that need to be removed to complete the rehabilitation within segment 6 shall be transported to the site entrance for disposal by others OSC.

**END OF SECTION**

## SECTION 02442 - MINE SUPPORT

### PART 1 - GENERAL

#### 1.1 DESCRIPTION

- A. This section applies to the rehabilitation of the existing Commodore Level 5 Tunnel from the Del Monte Raise to Station 77+84 near the Berkshire Shaft. The work has been designated as Segment 6, as shown on the drawings.
- B. Support shall be as shown on the drawings. Where there is a conflict between the drawings and these specifications, the drawings shall control.
- C. The means and methods of construction including safety, excavation, installation, and observation of all support shall be the sole responsibility of the Contractor.

#### 1.2 RELATED WORK

- A. Section 02412 – Underground Work
- B. Section 03361 - Shotcrete

#### 1.3 REFERENCES

##### A. General:

- 1. The publications listed below form a part of this specification to the extent referenced.
- 2. Where a date is given for reference standards, the edition of that date shall be used. Where no date is given for reference standards, the latest edition available on the date of this document shall be used.

##### B. ASTM International:

- 1. ASTM A36, Specification for Structural Steel.
- 2. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
- 3. ASTM A325, Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
- 4. ASTM A563, Carbon and Alloy Steel Nuts.
- 5. ASTM A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
- 6. ASTM C1107, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
- 7. ASTM D635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
- 8. ASTM D3647, Standard Practice for Classifying Reinforced Plastic Pultruded Shapes According to Composition
- 9. ASTM E84 19a, Standard Test Method for Surface Burning Characteristics of Building Materials
- 10. ASTM F432, Specification for Roof and Rock Bolts and Accessories.
- 11. ASTM A572 / A572M - 15 Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.

##### C. American Institute of Steel Construction (AISC):

- 1. AISC 360 Specification for Structural Steel Buildings

2. AISC Standard Code of Practice

D. American Welding Society (AWS):

1. AWS D1.1 2010. Structural Welding Code - Steel

E. US Army Corps of Engineers (CRD):

1. CRD C661-06, Specification For Antiwashout Admixtures For Concrete
2. CRD C621, Specification for Non-Shrink Grout.

1.4 SUBMITTALS

- A. Manufacturer's product data and certification for all materials proposed to be incorporated in the work.
- B. Shop drawings for all fabricated materials showing bending radii and full dimensions of each member and layout of entire support systems. Show details of anchorage system, end hardware, connections, shim plates, longitudinal connectors, and other accessories. Show details of rock reinforcement, including bars, bearing plates, washers, resin cartridges, and nuts.
- C. Mix design and product data for any cement or resin grouts used for rock dowels and rock bolts.
- D. Records of all support erected in the tunnel, including stations, spacing, lengths, types, thicknesses, weights, and number. Include this information in each shift report.
- E. Proposed test equipment and procedures for rock bolt testing, including a sample field testing log.
- F. Torque to tension curve provided by manufacturer.

1.5 DEFINITIONS

- A. Support: Ground support as shown in the Drawings.
- B. Rock Reinforcement: A general term applying to support systems utilizing rock dowels, rock bolts, and other appurtenances whereby the reinforced rock mass is self-supporting.
- C. Rock Bolt: Rock reinforcement element consisting of a tensioned, fully encapsulated steel bar, anchorage, and associated hardware recommended by the manufacturer.
- D. Rock Dowel: Rock reinforcement element consisting of an un-tensioned, fully encapsulated steel bar, anchorage, and associated hardware recommended by the manufacturer. Note that dowels on this project are limited to hangers, steel set anchors, etc.
- E. Ground Load: Equivalent rock height to be used in design of support, expressed in relation to the tunnel diameter.
- F. Pattern Rock Bolt: Rock bolt that is installed in a prescribed pattern or spacing.
- G. Spot Rock Bolt: Rock bolt installed to secure a local unstable block.
- H. Steel Set: Steel structure consisting of cap and one or two posts with steel lagging, blocked against the excavated rock surface
- I. Steel Stull: beam installed perpendicular to footwall and hanging wall to maintain opening. Steel lagging may be run between stulls.
- J. Blocking: wood wedges or small wood blocks to wedge steel sets or stulls against ground

- K. Cribbing: beams stacked above steel sets or stulls to provide contact with high areas of back. On this project steel and fiberglass reinforced plastic cribbing are acceptable. Wood cribbing is acceptable only for temporary support where it will be encased in foam upon project completion. If wood cribbing is contemplated in areas not on the drawings, OSC approval is required.

## 1.6 QUALITY ASSURANCE

- A. Rock bolts selected by the Engineer shall be proof load tested as follows:
  - 1. First 5-rock bolts installed.
  - 2. 15% of the following 100-rock bolts.
  - 3. 1% of the remaining rock bolts.
- B. The Contractor shall test under the oversight of the Engineer.
- C. A certified testing laboratory shall be used to calibrate jacks and test gauges used for the load tests. Calibration records shall be submitted to the Engineer.
- D. If acceptable proof test results are not obtained, the installation and testing procedures shall be repeated and an additional rock bolt shall be installed within 1' of the unsatisfactorily tested bolt at no additional cost to the OSC.
- E. Methods for proof testing rock bolts:
  - 1. The Contractor shall provide the personnel and equipment to set-up and operate the test equipment and provide access to test locations.
  - 2. The jack shall be oriented so that the rock dowel/bolt is not eccentrically loaded.
  - 3. Loads shall be applied in at least 3 increments to the maximum required test load. Maintain load for at least 3 minutes.
  - 4. A proof test result is acceptable if the following criteria are satisfied, as determined by the Engineer:
    - a. The rock dowel or rock bolt develops and holds a load equal to 1.25 times the design working load.
    - b. Continued movement does not occur at a sustained load equal to 1.25 times the design working load.
- F. All support elements shall be installed in accordance with the recommendations of the manufacturer. The manufacturer's technical representative shall be available to answer questions and assist with solving any problem relating to the installation.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Resin grout cartridges shall be installed in accordance with the manufacturer's recommendations with the expiration date clearly marked on the cartridge packaging. Resin shall be kept from freezing.
- B. Steel fasteners, including rock bolts, nuts, and washers shall be protected from the weather to prevent rusting prior to use.
- C. Mortar shall be kept dry until use.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Rock Bolts:

1. Commercially available products complying with the requirements below.
2. Manufactured by Williams Form Engineering, Dywidag Systems International, Jenmar, Minova, or approved equal.
3. Minimum nominal bar size - #8.
4. Allowable anchorage systems:
  - a. Threaded bar and resin cartridge.
  - b. Threaded bar with anchor and cement grout.
5. Threaded Bars:
  - a. Continuously threaded steel bars conforming to ASTM A615, Grade 75.
  - b. Provided in maximum practical lengths.
  - c. Tips on resin rock bolts shall be shaped as recommended by resin manufacturer.
  - d. Hardware assemblies such as nuts, couplers and washers shall be as recommend or provided by the bar manufacturer and shall meet or exceed the ultimate strength of the bolt.
  - e. Use lubricant as recommended by the manufacturer

B. Resin Cartridges:

1. Non- shrink polyester resin cartridge system for rock bolt anchorage and encapsulation. The resin grout shall be "Lokset", "FASLOC", "J-Lok", or approved equal.
2. Resin in cartridge form with a casing constructed of a saturated polyester providing resistance to moisture but easily fractured to enable mixing during installation.
3. Resin grout cartridges of the diameter and number recommended by the manufacturer for the actual hole and bar diameter being used.
4. Each batch of resin cartridges shall be inspected prior to insertion to verify that the polyester resin components have not hardened or the expiration date has not been exceeded. Do not use cartridges that are older than the manufacturer's recommended expiration date, or those which have hardened in storage.
5. The polyester resin cartridge system shall be utilized in strict accordance with the manufacturer's recommendations and as provided herein.
6. Gel time for the resin material at 60 to 70 degrees F will be 1 to 2 minutes for the anchorage interval (minimum 1 minute) and 15 to 30 minutes for the encapsulation interval.

C. Cement Grout:

1. Prepackaged, requiring only addition of water, and conforming to ASTM C1107, Grade B.
2. Nonmetallic and free of chlorides or other elements or compounds corrosive to steel.
3. Mixed with Water: Pumpable, nonshrink, nonbleeding, and nongas forming.
  - a. Time of Efflux: 20 to 30 seconds as determined in accordance with CRD-C611 when initially mixed.
  - b. Extended Working Time: Fluid and capable of completely passing flow cone of CRD-C611 for at least 1 hour.
4. Cube Strength: Minimum 2,500 psi at 1- day and 7, 000 psi at 28- day when sampled and tested in accordance with CRD-C621.

D. End Hardware:

1. Steel Bearing Plates:
  - a. Supply the plates recommended by the rock dowel/bolt manufacturer in accordance with ASTM F432.
  - b. See drawings for plate dimensions

2. Nuts and Washers:
  - a. Conform to ASTM A563.
  - b. Bevels or hemispherical washers to provide uniform bearing at right angles to the longitudinal axis of the rock bolt.
  - c. Threads on both rock bolt and nut shall be free of rust and burrs, and are free running in the thread of the rock bolt.
  
- E. Mortar for constructing rock bolt pedestals shall be Quikcrete Commercial-grade fast-set repair mortar or approved equivalent.
  
- F. Steel Sets, Stulls, Lagging and Framing:
  1. Installed in accordance to plan set drawing.
  2. Structural steel wide flange shapes shall conform with ASTM A572 Grade 50.
  3. Structural steel plates, channel and angle shall conform with ASTM A36.
  4. High strength bolts shall conform with ASTM A325. Design is based on snug tight fit-up unless noted otherwise on the drawings.
  5. Structural steel with fracturing due to repair, straightening, or any other cause shall not be accepted.
  6. Fabrication shall conform to AISC 360 and Standard Code of Practice.
  7. Welding shall conform to AWS D1.1.
  
- G. Steel Set Lagging:
  1. Lagging panels shall be C Channel of size and weight shown on drawings
    - a. Minimum lagging length shall lap flange supports by 1 1/2-inches.
    - b. Lagging shall be secured by welding or shims of wood or steel to prevent shifting during backfilling.
  
- H. Mine Foam:
  1. Urea silicate foam specifically developed for underground void filling
  2. De neef Organosol 660 FR, Minova GeoFoam, BASF MasterRoc MP 367 or approved equal
  
- 2.2 EQUIPMENT
  - A. Rotary-percussive type drilling equipment shall be used for drilling rock bolt holes.
  - B. Bar spinning chucks shall be provided for resin mixing, as appropriate.
  - C. When an impact or hydraulic wrench is used to tighten the nut, the wrench shall have a control device that can be set so that the required torque is not exceeded. Wrenches shall be calibrated periodically as recommended by manufacturer.
  - D. The Contractor shall provide and maintain in good working condition a full set of pull-out test equipment, including:
    1. Hydraulic jack with a capacity of no less than 125% of the ultimate tensile strength of the rock bolts and having a center bore in the ram for installation of the jack concentrically over the longitudinal axis of the bolt.
    2. Means for attaching the jack to the end of the rock bolt.
    3. Hydraulic pump.
    4. Pressure gauge assembly compatible with the testing system.

## **PART 3 -EXECUTION**

### **3.1 GENERAL**

- A. The Contractor shall be solely responsible for the safety of the work.

### **3.2 ROCK BOLT INSTALLATION**

- A. Rock bolts shall be installed as shown on the Drawings and as necessary to safely support the ground.
- B. Rock bolts shall consist of fully encapsulated resin anchored, or cement grouted continuous thread bars.
- C. Holes shall be drilled to the diameter recommended by the rock bolt manufacturer and the resin manufacturer. Drill the same diameter for each rock dowel/bolt for the entire length of hole.
- D. All holes shall be cleaned of all drill cuttings, sludge, and debris. Avoid damage to the projecting end of the rock bolts.
- E. Holes shall not be over drilled. Bolts shall be installed to touch the end of the hole. Where bolt stick out beyond the rock surface is inadequate to properly install the bearing plate, washers and hex nut and tension the bolt, an additional bolt shall be installed within 12" of the unsatisfactory bolt at no additional cost to the OSC.
- F. Installation procedures shall avoid damage to the threads and fittings. One bearing plate, appropriate washers, and a hex nut shall be placed over the projecting end of each bolt.
- G. The plate, when combined with the washer conical seat and hemispherical hex nut or beveled washers, shall bear on the rock surface without binding the bolt or bridging across irregularities to the extent that the plate would be deformed if the nut is torqued to the specified tension, otherwise a grouted pedestal pad shall be provided.
- H. Lubricant shall be applied to the final tensioned portion of threads before the nut is tightened.
- I. Bolt length refers to the embedded length in the rock. Contractor shall provide sufficient lengths of bar to allow for the installation of end hardware.
- J. Resin-Grouted Rock Bolts
  - 1. Resin-grouted rock bolts shall be installed in accordance with manufacturer's recommended procedures. Appropriate resin cartridges shall be used considering set times and prevailing temperatures in the tunnel. A sufficient number of resin cartridges shall be inserted into each drill hole to assure the rock bolt is fully encapsulated for its entire length.
  - 2. Where voids are encountered in the rock, additional cartridges shall be utilized to provide the excess polyester resin required for completely encapsulating the bolt.
  - 3. Rock bolts required to be fully grouted will be rejected if, after the end of the initial installation and spinning, excess resin material does not project from the hole collar. In this case, an additional rock bolt shall be installed within 1' of the unsatisfactory installation at no additional cost to the OSC.
  - 4. Rock bolts shall be spun in a direction such that the threads force resin into the hole, in accordance with the resin manufacturer's recommended procedure.
  - 5. Cartridges shall be placed in the hole such that each makes contact with the preceding cartridge, and the first cartridge is in contact with the end of the hole. In vertical or inclined holes, the contractor may use appropriate methods recommended by the manufacturer, to push and hold the cartridges in place until the bolt is spun into place.
- K. Cement-Grouted Rock Bolts

1. If Contractor elects to use cement grouted rock bolts, bolts shall have mechanical anchors that will allow bolts to be tensioned prior to grouting.
2. For solid bars, grout injection and vent tubes shall be extended for the full depth of the hole. Injection and vent tubes shall be sealed in the collar of the hole with grout when the rock bolt is installed.
3. Rock bolts shall be rigidly supported during the grouting operation and until the grout hardens.
4. The space between the rock and rock bolt along the full length of the bolt shall be completely filled with grout. The return flow of grout through the vent tube shall be checked to indicate that the hole has been completely filled. Grouting pressure shall be no more than is required to fill the hole with grout.

L. Tensioning

1. Rock bolts shall be tensioned to 67% of yield strength by torquing. A calibrated controlled torque impact wrench or calibrated mechanical torque wrench shall be used to tighten the nut, and the wrench shall have a control device that can be set so that the required range of torques is not exceeded.
2. Bolts shall not be tensioned before the design strength of the anchorage (fast setting) resin has been attained.
3. Before the encapsulating (slow setting) cartridges or cement grout have begun their set, the bolt shall be stressed by torque wrench.
4. If required tension cannot be achieved, a new bolt shall be installed within 1' of the original bolt at no additional cost to the OSC.
5. Tensioning shall be completed and locked into encapsulating resin or grout during installation of initial support.

3.3 STEEL SET INSTALLATION

- A. Have all materials, equipment, tools, and labor for installing steel sets readily available.
- B. Cement mortar or grout foot blocks shall be used under footers
- C. Cutting and welding of steel may be required to field fit.
- D. Welding shall conform to AWS D1.1.
- E. Install steel and timber blocking between the steel sets and the rock to evenly distribute ground loads onto the steel set. Blocking shall be installed to the satisfaction of the Engineer. Timber cribbing shall not be used except for temporary support prior to foam installation
- F. Provide temporary bracing, shoring, tie rods, and other accessories as needed

3.4 STEEL STULL INSTALLATION

- A. Have all materials, equipment, tools, and labor for installing steel stulls readily available.
- B. Stulls shall be anchored into the ground using steel connection "hitches" or "bull horns," as shown on the drawings.
- C. Stulls shall be field cut to fit into opening and wedged in place with primarily steel shims until both ends make positive contact with the ground. Final wedging can be completed with wood.

3.5 INSTALLATION OF MINE FOAM

- A. Mix and install mine foam per manufacturer recommendations using equipment provided by or approved by manufacturer.

- B. During first day of foaming, manufacturer representative shall be on site to train crew.
- C. Foam shall be installed so as to fully fill the space above the steel sets to the height shown on the drawings.
- D. Foam shall not block the ends of the drain pipe.
- E. Drain pipe material shall be selected to be compatible with the mine foam for both chemical and thermal properties.

3.6 MAINTENANCE OF SUPPORTS

- A. Improper installation of support systems shall be corrected within 48 hours or as directed by the Engineer. The Engineer may shorten this time if, in his opinion, the safety or integrity of the ground is threatened.
- B. The Contractor shall inspect the conditions and the competence of all tunnel supports daily.
- C. The Contractor shall immediately notify the Engineer of any supports that fail to conform with the requirements of the design of this specification, and promptly rectify the non-conformance. Where necessary, the Contractor shall reinstall shims, blocking, and wedges; tighten bearing plates snug against rock; replace rock reinforcement.

**END OF SECTION**