

STANDARD SPECIFICATIONS
SECTION 02441
MICROTUNNELING

PART 1 GENERAL

1.1 DESCRIPTION

- A. Section includes requirements for installing casing pipe by use of a Microtunneling operation as defined herein.
- B. Contractor.
 - 1. Responsible for selection of Microtunneling means and methods subject to review by Engineer.
 - 2. Furnish labor, equipment, and material required to complete work by Microtunneling including but not limited to; Microtunneling system, spoil transportation and separation, hoisting, lifting, safety, and control equipment.
 - 3. Furnish labor, equipment, and material for jacking and receiving pit construction, complete in place including, but not limited to:
 - a. Sediment Controls
 - b. Re-handling and disposal of unsuitable materials,
 - c. Dewatering,
 - d. Utility adjustments/support,
 - e. Tests,
 - f. Excavation,
 - g. Sheet piling and shoring,
 - h. Backfilling,
 - i. Cleanup,
 - j. Security,
 - k. Restoration of surface features,
 - l. Other related work necessary for construction as specified or as shown on Drawings.

1.2 DEFINITIONS

- A. Microtunneling: Installation of casing pipe by jacking pipe behind a remotely controlled, steerable, guided Microtunnel Boring Machine (MTBM) which fully supports excavated face with either slurry or earth pressure balance at all times.
- B. Casing Pipe: Pipe capable of withstanding installation forces due to jacking and other construction or temporary loads in addition to permanent live and dead loads.
- C. Jacking and Receiving Pits: Working pits between which casing is installed by means of Microtunneling technique for Microtunnel jacking and equipment retrieval.

- D. Drive: Section of casing pipe installed by Microtunneling from Jacking Pit to Receiving Pit.
- E. Slurry Pressure Balance System.
 - 1. Microtunneling system that mixes excavated material with slurry in a chamber located behind cutting head.
 - 2. Low pressure slurry is used to balance ground and water pressure at face of tunnel, limit settlement and to convey cuttings back to ground surface.
 - 3. Cuttings are removed or separated and slurry is re-circulated back to MTBM.
- F. Earth Pressure Balance System.
 - 1. Microtunneling system which incorporates a continuous flight auger enclosed in a separate casing inside casing pipe being jacked.
 - 2. Positive pressure is maintained at excavated face by regulating volume of cuttings removed relative to advance rate of MTBM.
- G. Spoil: Excavated material that has been mixed with either water or slurry and pumped to surface to be separated and recycled or disposed.
- H. Tunnel: Microtunnel casing pipes complete in place.

1.3 QUALITY ASSURANCE

- A. Supervision.
 - 1. Microtunneling and work associated with microtunneling:
 - a. Supervised by at least 1 person with previous experience of microtunneling process.
 - b. See submittals herein for minimum requirements.
- B. Operators.
 - 1. Personnel experienced in microtunneling with prior knowledge and ability in proper operation of systems being employed.
 - 2. See submittals herein for minimum requirements.
- C. Operation.
 - 1. Operate systems following manufacturer's instructions.
 - 2. Make available at all times copies of operations manuals to Engineer and operational personnel on site.
- D. Run Test: Test full system on completion of set up and before commencing drive.
- E. Drive Start Up.
 - 1. Before commencement of any drive, demonstrate to Engineer that required set up procedures and system checks are complete and required materials are at hand to commence drive.
 - 2. Do not commence drive until construction of Receiving Pit has been completed.

1.4 SUBMITTALS

- A. Submit following Section 01330.
 - 1. If modifications are required during construction, submit for approval information illustrating such modifications, including reasons.
 - 2. Microtunneling Qualifications for Contractor Performing Microtunneling Work:
 - a. Cover sheet: Date, company name, address, telephone and fax numbers, email address, and contact person.
 - b. Resumes of managerial, supervisory and operational key personnel:
 - 1) Experience in a minimum of 3 previous Microtunneling projects of similar size and scope.
 - 2) Detailed descriptions of their Microtunneling Projects.
 - c. Summary sheet of previous projects performed using Microtunneling that demonstrates expertise and experience. Named projects may be used more than once under separate paragraphs if their criteria apply.
 - 1) Minimum of 3 years experience performing Microtunneling of similar size and scope.
 - 2) List 3 separate projects completed that used either a Slurry or Earth Pressure Balance based system.
 - d. Submit for each named project above, and in same order, following detailed information.
 - 1) Date, full name of project, and location.
 - 2) Owner's name, address, telephone and fax numbers, email address, and contact person.
 - 3) Client's name, address, telephone and fax numbers, email address, and contact person.
 - 4) Employees in charge of work at both head office and site.
 - 5) Description of relevant work successfully completed, including ground conditions.
 - 6) Features under which pipe passed, depth below the water table, photos, and published articles if available.
 - 7) Additional information as necessary.
 - e. Equipment.
 - 1) Supply full details of Microtunneling System to be employed.
 - 2) Manufacturer and date(s) of manufacture.
 - 3) Type and model number for whole system if from single source or separate details for each element of system.
 - 4) Confirmation from manufacturer that machine set up is suitable to limit annular space, as specified, for external diameter of casing pipe proposed.
 - 5) System of alignment monitoring and steering control and activation.
 - 6) Hydraulic jacking system maximum capacity and method of limiting jacking capacity to that of maximum capacity of specified casing.
 - f. Procedures.
 - 1) Supply full details of procedures and resources that will be employed to carry out work including method and sequence.

- a) Establishment of drive line of MTBM and elevation at base of shaft.
 - b) Casing Pipe handling and connections.
 - c) Maintaining line and grade, and reestablishment of line and grade as required.
 - d) Spoil separation and disposal.
 - e) Spoil and slurry containment during Microtunneling work.
 - f) Installation of carrier pipe, including placement of grout between carrier pipe and casing pipe, and procedures to prevent floatation during grouting.
 - g. Materials.
 - 1) Supply full details of following materials.
 - a) Design mixes for all concrete, grout, or flowable fills.
 - b) Casing pipe including manufacturer, grade, and specification, outside diameter, thickness, and any coatings, if required.
 - h. Calculations that clearly state:
 - 1) Maximum calculated jacking resistance for installing complete casing.
 - 2) Maximum allowable face pressure or slurry pressure that can be exerted at tunnel face without fluid loss to surface, other structures or features or heave of ground.
 - 3) Relationship between hydraulic jacking pressure and force applied to casing pipe during jacking.
3. Jacking and Receiving Pits.
- a. Submit station specific Working Drawings to include but not limited to:
 - 1) Jacking and receiving pit configurations.
 - 2) Design and construction of jacking and receiving pits.
 - 3) Details for ground support system.
 - 4) Special requirements for jacking and receiving pit penetrations, thrust blocks, backstops or other reactions required for Microtunneling, casing pipe jacking or any other jacking.
 - 5) Full calculations supporting maximum jacking capacity that jacking pit will withstand without movement exceeding 0.5 inches with an appropriate factor of safety.
 - 6) Areas for storage, material and spoil handling, dewatering, ground stabilization if required, excavation procedures, and backfilling following Section 02315.
 - 7) Dewatering and ground water control plans for all jacking and receiving pits.
4. Settlement Monitoring Plan.
- a. Submit surveying and monitoring plan for review before construction. Identify location of settlement monitoring points, reference benchmarks, survey schedules and procedures, and reporting formats.
 - b. Submit Building and Structures Assessment Plan for review before construction.
 - 1) Furnish pre-construction and post-construction assessment for building and structures located within a distance of 100 feet from centerline of proposed tunnel, and jacking and receiving pits.

- 2) Include photographs or a video of existing damage to structures near alignment.

1.5 RECORD DRAWINGS

- A. Maintain at construction site a complete set of field drawings for recording of as-built conditions.
- B. Mark or note thereon up-to-date as-built conditions properly dated.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Unload and handle materials with equipment of adequate capacity, equipped with slings to protect materials from damage.
- B. Store materials on site in individual pieces and bundles with safe walking space between to allow full view for inspection purposes in a reasonably level well-drained area free from brush.

1.7 PROJECT CONDITIONS

- A. Perform Microtunneling so as not to interfere with, interrupt or endanger surface and activity thereon, and minimize subsidence of surface, structures, and utilities above and near tunnel.
- B. Repair and restore damaged property from tunnel operation settlement to its condition before being disturbed at no cost to Commission.
- C. Review available geotechnical reports in order to enable proper design to alignments and locations shown on Drawings and other requirements of Contract Documents.
 1. Where necessary, make additional investigations to satisfy ability to complete work under Contract.
 2. Project geotechnical report and boring logs are provided for information only.
 3. Contractor responsible to judge geotechnical conditions and their effects on means, methods, and progress of work.
- D. Follow applicable ordinances, codes, statutes, rules, and regulations of State of Maryland, MSHA, applicable County building codes, affected Railroad Company, and applicable regulations of Federal Government, OSHA 29CFR 1926, and applicable criteria of ANSI A10.16-1995 (R2001), "Safety Requirements for Tunnels, Shafts, and Caissons."

1.8 ADDITIONAL CRITERIA FOR WORK UNDER RAILROADS

- A. Do not schedule tunnel construction within and adjacent to Railroad property until Engineer and Railroad approve submittals, including proper Railroad insurance.

1. Approval shall not relieve Contractor of responsibility for adequacy and safety of procedure.
- B. Give Railroad advance written notice as described in permit and copied to Engineer before entering and working on Railroad property.
- C. Place in effect, before work proceeds, all safety, precautionary and protective devices, and services required by Railroad.
- D. Follow AREMA or other applicable railroad specification and permit requirements.
- E. At railroad crossing, Contractor may be required, at his own expense, to submit an additional permit pipeline crossing application for approval by railroad.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Casing Pipe.
 1. Steel pipe.
 - a. Smooth walled with minimum yield strength of 36,000 psi (ASTM A1011 Grade 36).
 - b. Minimum wall thickness 3/8 inch or as indicated on Drawings.
 - c. Joints fully welded around circumference of pipe.
 - d. No coating required on casing pipe.
 - e. Weld of sufficient strength to withstand all forces at pipe joints without any distortion of pipes.
 - f. Minimum welds shown on Standard Details.
 - g. Modifications to design of steel casing pipe for MTBM compatibility.
 - 1) Make request to Engineer.
 2. Other Pipes: Submit following Section 01630.
- B. Carrier Pipe.
 1. Meet requirements specified in Sections 02510, and 02530.
- C. Surface Settlement Markers.
 1. Within Bituminous Concrete Paved Areas: "p.k." nails.
 2. Within Nonpaved Areas: Wooden hubs.
- D. Subsurface Settlement Indicator: See Standard Detail M/7.0.
- E. Grout: Three parts sand, ASTM C144, to 1 part of cement, ASTM C150 to fill annular space between casing pipe and carrier pipe.
 1. Cement: ASTM C150, Type II.
 2. Water: See Section 03300.
 3. Sand: ASTM C404, size No. 1.

4. Design Mix For Grout: Minimum compressive strength of 100 psi attained within 24 hours.
- F. Dielectric Material.
1. Thermoplastic having a minimum strength of 400 volts for each mil, and water absorption less than 0.02 percent (24-hour period).
- G. Equipment.
1. Microtunneling System.
 - a. Closed face capable of providing positive supporting pressure to full excavated area (face) at all times and capability of controlling and measuring pressure at face.
 - b. Achieve balancing of earth and ground water pressures by use of slurry pressure, auger-earth pressure balance, or a combination of the two.
 - c. System capable of any adjustment required to maintain face stability for anticipated ground conditions.
 - d. Control slurry pressure systems, using slurry spoil transportation, earth and groundwater pressure at the face by use of variable flow slurry pumps, pressure control valves and minimum of 2 flow meters, 1 on feed side and 1 on return side.
 - e. For earth pressure balance systems using a screw auger spoil transportation from the face, control excavated material by maintaining an earth pressure balancing plug of material at the face with advance of system being matched with excavation removal through auger.
 - 1) Control soil through auger by use of pitch spacing and/or an auger gate or throttle.
 - f. Sufficient power and ability in normal operation to cut or crush hard material of sizes up to 1/3 internal diameter of pipe and up to 30,000 psi compressive strength.
 - g. Ability to control axial rotation to within 3-degrees of normal operating datum.
 - h. Ability to articulate and steer to correct vertical and horizontal deviation from alignment datum by remote activation.
 - i. Means to inject lubricant over lead pipe, if required.
 - j. Spoil transportation system that has capacity for removal of spoil in balance with excavation and advance.
 - k. Slurry system.
 - 1) Spoil separation system with sufficient capacity to remove solids from flow while system is excavating spoil.
 - 2) Discharges safely with negligible remaining fines, the re-circulated or excess fluid.
 - l. Overall control system that enables remote control of all main operating functions of system from one location, either at surface or within jacking shaft.
 - m. Main jacking pit capable of exerting uniform load to casing pipe at a speed commensurate with speed of excavation advance.
 - 1) Set jacking hydraulics to relieve pressure at maximum safe working capacity of casing pipe.

PART 3 EXECUTION

3.1 GENERAL

- A. Site soil investigation reports and data obtained for tunnel design are available for review.
 - 1. Interpret this material and investigate work site soil conditions before bidding.
 - 2. Encountering rock or water will not entitle Contractor to additional compensation.

- B. Dewatering: When water is encountered, develop and maintain dewatering system of sufficient capacity to remove water continuously, keeping excavations free of water until backfill operation is in progress.
 - 1. Keep removal of soils particles to minimum.
 - 2. Dewater into sediment trap following Section 01570.
 - 3. Observe to detect settlement or displacement of surface facilities due to dewatering.
 - 4. Should settlement or displacement be detected, notify Engineer immediately and act to maintain safe conditions and prevent damage.

3.2 DAILY ACTIVITY LOG

- A. Maintain a daily activity log during jacking operations for casing and submit to Engineer for record purposes on a daily basis.
 - 1. Start and finish time of casing pipe advancement.
 - 2. Total length of casing pipe installed.
 - 3. Horizontal and vertical alignment deviation at not greater than 1 foot intervals or period not exceeding 5 minutes, whichever is most frequent.
 - 4. Maximum jacking force exerted during installation of each casing pipe section including forces required to re-initiate jacking following periods of system shutdown.
 - 5. General description for each discernible ground condition mined.
 - 6. Settlement monitoring readings.

- B. Where Microtunneling system utilizes an electronic data logger, set up so that the above information is recorded and can be readily identified.
 - 1. Identify known errors with recorded data and explain in daily log submittal.

3.3 PREPARATION

- A. Maintain clean working conditions inside jacking operation area and remove spoil, debris, equipment, and other material not required for operations.

- B. For construction below railroads, highways and utilities perform installation to prevent interference or disruption with normal operation of these facilities.

- C. During construction, maintain access to private and commercial properties at all times, unless approval from both property owner and Engineer has been obtained.

1. Any costs associated with providing alternative access will be at no additional cost to Commission.
- D. Provide power generation equipment and any other equipment operating on or with fuel or lubrication oils with suitable barriers and safeguards to ensure no loss of oil to drains or waterways or to contaminate ground.

3.4 JACKING AND RECEIVING PIT CONSTRUCTION

- A. Responsible for design, construction, maintenance and removal, including any damage attributed to jacking and receiving pit construction.
- B. Jacking and Receiving Pits: See Working Drawings.
- C. Excavation, Backfill, and Grading: See Section 02315.
- D. Approximate Locations of Jacking and Receiving Pits: See Drawings.
- E. Responsible for necessary utility relocation or supporting of utilities for jacking and receiving pits construction.

3.5 MICROTUNNELING OF CASING PIPE

- A. Tolerances.
 1. Place casing pipe to within 1 inch of vertical and horizontal alignment shown on Drawings.
 2. Limit annular space, between excavated material and outside diameter of casing pipe, to maximum of 0.5-inch.
 3. Outside diameter of MTBM not to exceed outside diameter of casing pipe by more than 1 inch.
 4. Redesign of pipeline or associated structures if jacked casing pipe is off design line or grade, will be at no additional cost to Commission.
- B. Obstructions During Microtunneling.
 1. Responsible for selection of type of MTBM and type of cutting.
 2. Remove, clear, or otherwise make it possible for Microtunneling system and casing pipe to progress past or through any obstructions encountered.
 3. Removing, clearing or otherwise making it possible for Microtunneling System to progress past any obstructions encountered will be at no additional cost to Commission.

3.6 INSTALLATION OF CARRIER PIPE

- A. Follow Sections 02315, 02510, and 02530, Standard Details, and Drawings.

B. Use thermoplastic or other dielectric material (except wood) between carrier pipe and tunnel liner plate or steel sleeve to prevent metal-to-metal contact and damage to pipe and coating during placement.

C. Bulkhead: Follow Drawings.

3.7 DETECTION OF MOVEMENT: See Section 02420.

PART 4 MEASUREMENT AND PAYMENT

4.1 MICROTUNNELING OF CASING PIPE

A. Measurement: By linear foot of casing pipe installed in place as shown on Drawings measured horizontally along the centerline of tunnel between interior face of the jacking pits to the interior face of receiving pits.

B. Payment: At unit price per linear foot listed in Bid Schedule.

1. Payment includes labor, materials, tools and equipment, excavation and backfill outside the limits of the normal trench width, disposal of excess excavated material, receiving and jacking pits, casing pipe, necessary grouting, bulkheads at each end on the casing pipe, subsurface settlement indicators, settlement markers, and other work involved in the Microtunneling of casing pipe following Contract Documents.
2. Carrier pipe installed inside the casing pipe will be measured and paid for as described elsewhere in specifications.

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