

1015 - Horizontal Directional Drilling (HDD)

Effective 7/1/2020

[1. GENERAL](#)

[2. OVERVIEW OF HDD EVALUATION AND IMPLEMENTATION PROCESS](#)

[3. OPEN CUT VS. DIRECTIONAL DRILLING EVALUATION](#)

[4. HDD CLASSIFICATION AND DESIGN REQUIREMENTS](#)

[5. BORE PATH PLANNING](#)

[6. HDD EQUIPMENT REQUIREMENTS](#)

[7. DRILLING FLUID REQUIREMENTS](#)

[8. PIPE REQUIREMENTS](#)

[9. PROJECT EXECUTION REQUIREMENTS](#)

[10. REPORTING GUIDELINES FOR INADVERTENT RETURNS](#)

[11. HIGHWAY ENCROACHMENT PERMITTING REQUIREMENTS](#)

[12. REFERENCES](#)

[FORMS AND REFERENCES](#)

1. GENERAL

1. This procedure supplements [Procedure 1010](#) of the DESC Gas Operations Design & Installation Manual (Construction Specifications - Boring & Directional Drilling) by establishing requirements for the installation of underground gas mains and services using the horizontal directional drilling (HDD) method of installation. For procedures related to auger boring reference "Installing Pipe by Auger Boring" section in the TEIC Document, [AG-DC-G-050-001 Installing Pipe by Auger Boring](#).

Note: This document is for minimal/general guidelines for all Tiered HDD classifications. The Dominion Energy TEIC SOP [AD-BP-G-050-001 Mainline Horizontal Directional Drill Best Practices and Tiered Classification](#) supersedes any conflicts or less stringent guidelines outlined in this document.

2. This document establishes horizontal directional drilling (HDD) requirements, best practices, and guidelines for both DESC Gas Operations and its contractors. The contents are organized as follows:

1. [GENERAL](#) - This section includes a document overview, establishes quality assurance and contractor qualifications, and establishes contractor submittal requirements.
2. [OVERVIEW OF HDD EVALUATION AND IMPLEMENTATION PROCESS](#) – Evaluation of Project Trenchless Technology.
3. [OPEN CUT VS. DIRECTIONAL DRILLING EVALUATION](#) – This section will cover the evaluation process and guidelines to determine the typical risks and considerations when deciding whether to perform an HDD or to install pipelines via open cut.
4. [HDD CLASSIFICATION AND DESIGN REQUIREMENTS](#)
5. [BORE PATH PLANNING](#)
6. [HDD EQUIPMENT REQUIREMENTS](#) - This section establishes equipment requirements for HDD contractors.
7. [DRILLING FLUID REQUIREMENTS](#) - This section establishes drilling fluid product requirements for the HDD contractors.
8. [PIPE REQUIREMENTS](#) - This section establishes internal guidance for DESC engineering regarding pipe selection for HDD applications.
9. [PROJECT EXECUTION REQUIREMENTS](#) - This section establishes miscellaneous requirements that the contractor should adhere to as he executes the work.
10. [REPORTING GUIDELINES FOR INADVERTENT RETURNS](#) – This section provides guidance on how to report inadvertent returns.
11. [HIGHWAY ENCROACHMENT PERMITTING REQUIREMENTS](#)
12. [REFERENCES](#) - As a source of additional technical information, this section lists the various references that were used to develop this procedure.

3. Quality Assurance / Contractor Qualifications

1. The contractor must use adequate numbers of skilled workmen who are thoroughly trained and experienced, and who are completely familiar with the specified requirements and the methods needed for proper performance of the work.
2. Upon request, and especially on projects deemed critical by the Dominion Engineer, the directional drilling contractor or sub-contractor must be able to document the successful installation of at least 5 similar HDD crossings of the same diameter carrier pipe.
3. All directional drilling sub-contractors and operators are subject to approval by the Dominion Engineer.
 1. When a DESC contractor utilizes an HDD subcontractor, the DESC Inspector will hold the project Foreman and his Superintendent responsible for ensuring that the subcontractor complies with the requirements set forth in this procedure and all other specifications.

4. Pre-Construction Submittals (When Required by DESC)

1. At its discretion, DESC reserves the right to request pre-construction submittals from the contractor prior to any installation of pipe by directional drilling methods - especially for bid projects, bores > 500 ft in length, complex bores, and bores that involve critical crossings (i.e., interstate crossings, major road crossings, railroad crossings, major waterway crossings, etc.)
2. When pre-construction submittals are requested by DESC, the contractor shall submit the pre-construction submittals described herein within

3. When required, HDD pre-construction submittals must include the following information

1. Name and experience record of the HDD subcontractor and the operator who will perform the work
2. Make and model of the drilling rig that will be used, along with maximum thrust/pull-back force, maximum torque, and rated drilling fluid pumping capacity.
3. Documentation indicating that drill rig is equipped with an electrical strike package.
4. Length, diameter, and bending radius of the drilling rods.
5. Make, model, depth range, and accuracy of drillhead locator / guidance system.
6. Device information for downhole pressure monitoring.
7. Make, model, and volumetric capacity of mud mixing system.
8. Make and model of vacuum truck to be used.
9. Make, model, type, and size of proposed reamer(s).
10. Planned source of make-up water.
11. Drilling fluid manufacturer and name of field representative.
12. Proposed drilling fluid composition (recipe).
13. Make, model, % accuracy, pin configuration, and break-away value of proposed break-away connector.
14. Disposal plan for spent fluids, along with any landowner agreements (if applicable).
15. Proposed start date of the planned bores (+/- 1 day)

5. Post-construction HDD As-Built Submittals:

1. Except for driveway apron bores, the contractor must submit the following data to the DESC Inspector for each directional bore within 1 calendar week after completing the bore (not within 1 week of completing the overall project). If the DESC Inspector is on-site upon completion of the bore, the Inspector may request any portion of this as-built information on the same day.
 1. Completed [DESC HDD As-Built Form](#) (attached at the end of this procedure),
 2. An as-built drawing showing the location of the gas main (plan view), and
 3. A completed as-built depth profile (either a completed Vermeer Atlas printout when an engineered bore plan is required per Section E of this procedure, or a simple bore depth log for short, typical bores that do not require steering other than at entry and exit).

2. OVERVIEW OF HDD EVALUATION AND IMPLEMENTATION PROCESS

See SOP section 4.3 in [GD-BP-G-050-001 Mainline Horizontal Directional Drill Best Practices and Tiered Classification.pdf](#)

3. OPEN CUT VS DIRECTIONAL DRILLING EVALUATION

See SOP section 4.3.2 in [GD-BP-G-050-001 Mainline Horizontal Directional Drill Best Practices and Tiered Classification.pdf](#)

4. HDD CLASSIFICATION AND DESIGN REQUIREMENTS

See SOP section 4.2 in [GD-BP-G-050-001 Mainline Horizontal Directional Drill Best Practices and Tiered Classification.pdf](#)

5. BORE PATH PLANNING

1. A pre-determined bore path plan is required for gas mains and services that are to be installed using a directional drilling machine if 1) steering is required other than entry and exit or 2) if a SCDOT HDD permit is required. This section establishes internal guidelines for the Dominion Engineer to follow during the development of the bore plan.

1. Separation from Other Utilities:

1. Bore paths should be designed with a minimum separation of 36" from other utilities (measured from centerline of bore path to outside of adjacent utility) in order to account for the +/- 1 ft allowable variance of the drill head in relation to the planned bore path, the radius of the reamer, and to provide a minimal error margin.
2. If additional utilities are discovered in the field, or if potholing reveals that certain utilities are at significantly different depths that was assumed when the bore path was created, the Dominion Engineer or Inspector must be notified so that a revised bore path plan can be generated prior to the start of the drill.

2. Bore Path Geometry

1. When generating a bore path plan, the drill entry angle will be limited by the drilling machine, but should generally be designed between 10-12° from horizontal if drilling into existing grade. If drill entry is into an excavated pit, shallower entry angles may be desirable.
2. The drill exit (pipe entry) angle should be limited to 5° from horizontal, when possible. Increased drill exit (pipe entry) angles up to 10° may be approved by the Engineering Manager on a case-by-case basis.

3. Minimum bending radius

Unless specified, see below for general requirements for minimum bending radius for steel and plastic pipelines.

1. For plastic pipe, the actual minimum bending radius for boring should be at least 50 times the nominal pipe diameter (although a bending radius of 25 times the nominal diameter is allowed for above-ground pipe coils and pipe strings prior to pullback). However, for HDD installations involving plastic pipe, this bending radius can never be achieved because the minimum bending radius is normally limited to that of the drilling rods (usually 100-110 ft, depending on the rod). Although the bending radius of the rods may be used if necessary, a 200 ft bending radius should be used for plastic pipe when possible to limit pullback forces, provide room for corrections and a margin for error, and to facilitate a smooth bore.
2. For steel pipe, the minimum safe bending radius should be such that the bending stress does not exceed 75% of SMYS, calculated as:

$$\text{Safe Bending Radius (R, ft)} = (29,000,000 \times D) / (2 \times 0.75 \times \text{SMYS} \times 12),$$

where D = pipe O.D. in inches. However, a bending radius of 100 ft per inch of nominal pipe diameter should be used when possible to limit pullback forces, provide room for corrections and a margin for error, and to facilitate a smooth bore.

4. The tensile load (pull-back force) should be calculated on all directional drills that exceed 500 ft in length to ensure that the estimated pullback forces do not exceed the allowable tensile load of the pipe that is to be installed. This calculation should be performed using the method outlined in ASTM F 1962-05, reduced by an applied design factor of 0.75 (safety factor of 1.33) to conservatively account for borehole imperfections and geological unknowns. If necessary, HDPE pipe and/or heavier wall pipe may be required or it may be necessary to fill the pipe with water to reduce friction with the top of the borehole.
5. Bore path plans and related requirements should be discussed with the contractor during the project pre- construction meeting.

3. Depth

1. Roadside ditches shall have a minimum cover of 3 ft.
2. When directionally drilling under a ravine, or other water body, the pipe should be installed at least 10 ft below the lowest cross-sectional depth unless otherwise approved by the Engineering Manager.
3. For navigable waterways, the pipe shall be installed at least 15 ft below the lowest cross-sectional depth unless otherwise approved by the Engineering Manager.
4. Minimum pipe depth under roads should be 48", except in the vicinity of a shallower existing main that the new main or service will be connected to.
5. Pipe installed under railroads and railroad rights-of-way should be installed at a depth of 10-25 ft, depending on the requirements of the specific railroad company.

4. External Loads

1. The Dominion Engineer should consider the impact of external loads such as soil weight, drilling fluid weight, and groundwater weight on the carrier pipe. Calculations should be performed for depths > 10ft.

5. Staking/Field Marking

1. The Dominion Engineer should field mark the planned entry point, exit point, and other points of interest along the bore path, as required, to clearly communicate the desired path.
2. Wooden stakes with yellow ribbon, or white paint on the ground should be used along with the defined station number, where determined necessary by the engineer.

6. HDD EQUIPMENT REQUIREMENTS

1. Drilling Rigs

1. Drilling rigs must have a hydraulically powered system to rotate, push, and pull hollow drill pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a trackable and guideable drill head.

2. Drilling rigs must have electrical grounding capabilities for use during drilling and pull-back operations.
3. Any significant mechanical deficiencies identified by the DESC inspector on a previous project must be repaired prior to starting a new project

2. Tracking / Guidance Systems

1. The contractor shall utilize a guidance system of a proven, accurate type with an interface meeting the following requirements:
 1. Must provide a continuous and accurate determination of the location of the drill head during the drilling operation.
 2. Probe must provide immediate information on the tool face, azimuth (horizontal direction) and inclination/pitch (vertical direction) and must be accurate to $\pm 5\%$ of the vertical depth of the bore hole.
 3. System must be setup and operated by personnel trained and experienced. Operator must be aware of any geo-magnetic anomalies and must consider such influences in the operation of the guidance system if using a magnetic system.
 4. A downhole mud pressure monitoring tool should be used on all Tier 3 and Tier 4 HDDs. (for pilot hole)

3. Drilling Fluid Mixing Systems

1. The contractor shall utilize a self-contained, closed drilling fluid mixing system of sufficient size to mix and deliver drilling fluid composed of bentonite clay, potable water and appropriate additives. Refer to DESC list of approved additives.
2. The mixing system must be able to molecularly shear individual bentonite particles and polymers from the dry powder to avoid clumping and ensure thorough mixing.
3. The system must be able to continually agitate the drilling fluid during drilling operations.
4. Any significant mechanical deficiencies identified by the DESC inspector and/or contract inspector on a previous project must be repaired prior to starting a new project

4. Pipe Rollers

1. Appropriate action should be taken to ensure pipeline is adequately supported in a manner that allows movement when necessary and will not damage pipe or coating. Plastic pipes 4" and larger should be on rollers when pulled. Steel pipes 2" and larger should be on rollers when pulled.

5. Mechanical Breakaway Connectors

1. The contractor must provide and use a mechanical breakaway connector for all HDD pipe installations. The mechanical breakaway connectors must meet the following requirements:
 1. Must have a breakaway value that is less than or equal to the safe allowable tensile load (ATL) associated with the carrier pipe that is being pulled in (See Section D of this procedure).
 2. The connector's breakaway value must be guaranteed to $\pm 5\%$ of the stated value by the manufacturer for pipe $> 2"$ in diameter, or guaranteed to $\pm 10\%$ of the manufacturer's stated value for all pipe $< 2"$ in diameter.

3. Most manufacturers of mechanical break-away connectors recommend in their instructions that break-away pins/screws be discarded after each use. However, DESC will allow contractors to re-use the pins/screws on bores < 100 ft in length at their own discretion and at their own risk.
4. Break-away connectors other than the makes and models specified below must be approved in advance by DESC.
5. Referenced manufacturers are DCD Design & Manufacturing for all pipe $\geq 1\frac{1}{4}$ " in diameter and Condux International breakaway swivels for pipes < 2" in diameter (both manufacturers may be used for $1\frac{1}{4}$ " pipe), or approved equals.
 1. DCD Design & Manufacturing 00560-010 Breakaway Pins are to be used for 1 $\frac{1}{4}$ " - 6" IPS Pipe and DCD 00560-020 Breakaway Pins are to be used for 8" IPS Pipe. See [DI 1015 - Breakaway Connector Setup](#) (attached at the end of this procedure) for the manufacturer's suggested breakaway connector setup for each pipe size.
 2. Condux International 7/8" breakaway swivel part numbers are based on pipe diameter and max. allowable tensile load indicated in [Section 4 \(Pipe Requirements\)](#) of this document.
 1. 08018100 for $\frac{1}{2}$ " CTS (150 lbs)
 2. 08017600 for $\frac{3}{4}$ " IPS (300 lbs)
 3. 08018700 for $1\frac{1}{4}$ " IPS (800 lbs)

6. Reamers

1. The contractor must use an appropriate reamer type (e.g., barrel, spiral, fluted, etc.) that is designed for the specific soil type that it will encounter.

7. Testing Equipment

1. The contractor shall furnish the following testing equipment needed to document the physical and chemical properties of the drilling fluid:
 1. Slurry test kit (to test viscosity and density)
 2. pH test strips (to test the make-up water)
 3. Hardness test strips (to test the make-up water)

7. DRILLING FLUID REQUIREMENTS

1. Make-up water must be from a well or from a public water system, and should be free of sodium (salt) taste, chlorine taste, and chlorine odor.
2. The composition of all drilling fluids proposed for use should be submitted to DESC for approval. Any additives to be used must be on the list of approved additives and the contractor is required to confirm with DE that the additive is acceptable before use. No fluid will be approved or utilized that does not comply with permit requirements and environmental regulations.
3. Documentation of all drilling fluid products proposed for use should be maintained at the jobsite and be available for review by DESC and governing authorities. Documentation should include complete manufacturer's literature and Safety Data Sheets (SDS).

8. PIPE REQUIREMENTS

1. This section establishes internal guidelines for the Dominion Engineer to follow when selecting and specifying pipe to be used for HDD installations.

1. Plastic Pipe & Tracer Wire

1. Polyethylene Pipe used in DESC directional drilling installations should be MDPE (PE2406) unless estimated pullback force calculations indicate that the allowable tensile load may be exceeded. In such cases, HDPE may be used.
2. MDPE and HDPE pipe shall be manufactured in accordance with the latest published edition of ASTM D2513.
3. MDPE pipe shall have a minimum MAOP (maximum allowable operating pressure) of 76 psi at 73 oF, calculated using the plastic pipe design equation found in [49 CFR Part 192, Section 192.121](#) and using a design reduction factor of 0.32.
4. All joints on plastic pipes installed via directional drilling shall be performed using butt fusion methods. No couplings of any kind are allowed to be pulled through the borehole.
5. The following allowable tensile loads should be used for all MDPE pipe, as calculated based on Performance Pipe Technical Note 803 - Pull In applications using a tensile yield factor of 0.4 (safety factor of 2.5):

Nominal Pipe Diameter	Dimension Ratio (DR)	Allowable Tensile Load (ATL)
1/2" CTS (5/8" OD)	7	156 lbs
3/4" IPS	11	307 lbs
1-1/4" IPS	10	811 lbs*
2" IPS	11	1,524 lbs*
4" IPS	11.5	5,254 lbs*
6" IPS	13.5	9,838 lbs*
6" IPS	11.5	11,389 lbs*
8" IPS	13.5	16,675 lbs*
8" IPS	11.5	19,303 lbs*

* If using DCD 00560 Series breakaway connectors for 1-1/4" - 8" IPS, refer to the [pin configuration diagram](#) provided at the end of this procedure.

** For pull-in durations of >1 hour but less than 12 hrs, the additional load duration factor of 0.95 is negligible compared to the tensile yield design factor, and therefore was not included in these values.

6. For HDPE pipe, refer to Performance Pipe Technical Note 803 to obtain allowable tensile loads.

7. For MDPE or HDPE carrier pipes > 8" that are installed under state or federal roadways, a plastic or steel casing pipe must be used unless a waiver is granted by SCDOT. A casing is not required for plastic carrier pipes 6" and less. 8. For all instances when plastic pipe and tracer wire are pulled in using a HDD rig, #12 Copper Clad Steel Hard Drawn tracer wire from Copperhead Industries is preferred (due to higher tensile strength than standard tracer wire, but more economical than #10 stainless steel tracer wire). #10 stainless steel tracer wire may also be used for HDD applications, if approved by the Engineering Manager.

2. Steel Pipe

1. Steel pipe used in DESC directional drilling installations should have a specified minimum yield strength (SMYS) of at least 42,000 psi (X42) for pipe smaller than 4" nominal diameter, and at least 52,000 psi (X52) for pipe with a nominal diameter of 4" or larger.
2. Steel pipe shall be manufactured in accordance with the latest published edition of API5L.
3. Steel pipe must be designed with a MAOP (maximum allowable operating pressure) greater than or equal to the highest anticipated pressures, calculated using the steel pipe design equation found in [49 CFR Part 192, Section 192.105](#) using a design reduction factor of 0.5.
4. No couplings of any kind are allowed to be pulled through the borehole.
5. For steel pipe used in directional single-coat FBE (16 mils average thickness, 14 mils minimum) with an Abrasion Resistant Overlay (ARO) coating should be used (minimum of 20 mils for standard applications, and a minimum of 40 mils when hard rock is to be encountered).
6. Coating of welded joints:
 1. Weld bead buttons (raised area where weld bead was started or stopped) and any weld splatter beads or nubs that can result in a potential area of thin coating on their ridge shall be ground off prior to coating.
 2. Girth Weld on directional drilling applications shall be coated using a minimum of 20 mils of approved epoxy bore coating. (Reference O&M [Ch 8-C Protective Pipeline Coatings](#)) When rock is expected, a minimum of 40 mils shall be used. The allowable tensile load for steel pipe shall be calculated based on SMYS multiplied by cross-sectional pipe wall area, using a tensile yield factor of 0.4 (safety factor of 2.5). The following table provides calculated ATLs for typical steel pipes used by DESC Gas Operations.

Nominal Pipe Diameter	Wall Thickness (in)	SMYS (psi)	Allowable Tensile Load (ATL)
3/4"	.113	52,000	6,915 lbs
2"	.154	52,000	22,339 lbs
4"	.188	52,000	52,946 lbs
4"	.219	52,000	61,233 lbs
6"	.188	52,000	79,038 lbs
6"	.219	52,000	91,627 lbs

7. For steel pipe installed under state roadways, federal roadways, or railroads, a casing pipe must be used unless an adequate number of the following additional protective measures are provided (as determined by the entity issuing the permit):
 1. Increased wall thickness (wall thickness greater than that required to provide the required MAOP)
 2. Additional coating thickness (anything > 12-16 mils FBE)
 3. Increased depth (48 inches minimum depth under roads and 10-25 ft deep under railroads, depending on railroad permit requirements).
 4. Pipeline markers on both sides of the crossing
 5. Pipe must be cathodically protected and a test point shall be installed on one side of the crossing
 6. Provide valves each side (applies to railroad bores only)
 7. X-rav all welds (applies to railroad bores only)

9. PROJECT EXECUTION REQUIREMENTS

1. Utility Damage Prevention

1. The contractor must call in a locate using the state one-call system (PUPS). Any utilities that are not a member of PUPS must be contacted directly by the contractor.
2. The contractor shall be responsible for verifying the exact location and depth of all utilities that cross the bore path or run within 2 ft parallel to the bore path.

2. Required Accuracy

1. For Tier 1 and Tier 2 HDDs the drill head should pass within a target area of 1 ft +/- vertical and horizontal relative to the planned bore path, resulting in a target cylinder that is 2 ft in diameter.
2. DESC may, at its discretion, require re-installation or refuse full payment for HDD installations that do not meet the accuracy requirements stated above.

3. Bell Holes

1. When used, bell holes for bored approaches should not be dug closer than 3 ft to the edge of pavement without approval of the Engineering Manager.

4. Traffic Control & Work Zone Safety Requirements

1. Contractors must comply with SCDOT work zone safety guidelines, as well as the flagger's handbook to ensure a safe work zone.
2. DESC reserves the right to shut down the job if work zone safety is deemed unsatisfactory or potentially unsafe.

5. Minimum Drilling Fluid Volume Guidelines

1. The volume of drilling fluid used per foot for each pass (excluding pullback) should be greater than or equal to the unit hole volume multiplied by an appropriate mud factor based on the soil type:

$$\text{Min. } V_{\text{mud}} \text{ per ft (gallons) per pass} = (f_{\text{mud}} \times D_{\text{borehole}}^2) / 24.5$$

1. Inspectors should utilize the attached [Required Drilling Fluid Volumes Charts](#) as needed.
2. Except when a mud motor is utilized for drilling rock, the selected mud factor (f_{mud}), or fluid to soil ratio, shall vary between 1 to 5, depending on soil type and length of bore. Mud factors may be recommended by the drilling fluid manufacturer, by the Dominion Engineer, or selected by the HDD contractor based on the following list:
 1. Use 1.0 - 3.0 for fine-medium sands
 2. Use 1.0 - 4.0 for coarse sands, sandy clay, silt, and loams
 3. Use 1.0 - 5.0 for gravel & cobble

4. Use 3.0 - 5.0 for clays
5. Consult drilling fluid manufacturer for rock
3. The minimum volume of drilling fluid prescribed above is for a single pass and should be repeated for each pilot hole or reaming pass to determine the total minimum amount of drilling fluid that should be used to complete the installation.
4. For any reaming pass that includes pipe pullback, the minimum required drilling fluid volume should be adjusted by subtracting the volume of the pipe from the volume of the borehole. The resulting revised formula for this condition is provided below:

$$\text{Min. } V_{\text{mud per ft (gallons)}}]_{\text{DURING PULLBACK}} = f_{\text{mud}} \times (D_{\text{borehole}}^2 - D_{\text{pipe}}^2) / 24.5$$

6. Drilling Fluid Pumping Rate Guidelines

1. Since the required fluid pumping rate is dependent upon the thrust/pullback speed, minimum fluid pumping rate is typically expressed on a volume per rod basis. The minimum volume of drilling fluid to be used per rod is equal to the minimum volume of drilling fluid used per foot for the individual pass (pilot hole, pre-ream, or pull-back ream) multiplied by the rod length, L_{rod}.

$$\text{Min. Volume per rod (gal/rod)} = \text{Min. } V_{\text{mud per foot}} \times L_{\text{rod}}$$

2. When determining the actual mud pumping rate, consideration should be given to the fact that the flow meters on most drilling rigs (when provided) are calibrated for a fluid viscosity of 60 sec/qt at sea level. For significantly higher or lower viscosities, the actual mud pumping rate should be verified by measuring the tank drawdown rate.

7. Penetration (Thrust) Rate & Pullback Speed Limitations Guidelines

1. The maximum penetration and pullback speeds (i.e., minimum time per rod) will vary depending on the actual fluid pumping rate, and may be calculated as follows:

$$\text{Min. Minutes Per Rod} = (\text{the minimum volume of drilling fluid required per rod, gal/rod}) / (\text{actual pumping rate, gpm})$$

1. Inspectors should utilize the attached [Minimum Thrust/Pre Ream Time Chart](#) and [Minimum Pullback Time Chart](#) as needed.

8. Reaming

1. A reamer must be used to achieve the minimum required borehole diameter on all directional bores prior to pullback unless the drill bit diameter (when rotating) is large enough to achieve the minimum required borehole diameter.
2. The minimum required borehole diameter should be at least 150% of the nominal diameter of the intended carrier pipe, but no less than 4" in diameter larger than the carrier pipe, as outlined in the following table:

Nominal Diameter of Carrier Pipe	Minimum Required Borehole Size
2"	6" (4" larger)
4"	8" (4" larger)
6"	10" (4" larger)
8"	12" (4" larger = 150%)
10"	15" (150%)
12"	18" (150%)

3. A swab pass (pre-ream with no pullback) is recommended on all directional drills, but is only required in the following situations:

1. All bores for 4" pipe that are > 250 ft in length
2. All bores for pipe 6" and larger that are > 150 ft in length
3. All directional bores > 500 ft in length, regardless of pipe size

9. Return Fluid Density

1. The density of the return fluid with cuttings should be maintained at less than 12 lbs/gal. The fluid pumping rate should be increased and/or the penetration/pullback speed should be decreased as necessary to control the density of the return fluid.

10. Double-Drilling

1. When the drill bit is pushed through an area as part of a steering adjustment, the bit must be pulled back so that the borehole can be fully drilled out in the area where the steering adjustment was made.

11. Tail Ditch Limitations

1. Pipe shall be pulled in as one continuous piece unless the length of the tail ditch is restricted.
2. A line tamer must be used when pulling back coiled pipe > 4" in diameter.

12. Stopping & Re-starting

1. The contractor should make every attempt to complete a pass with minimal stopping and re-starting.
2. Any time the drilling fluid pump is stopped (even after changing rods), the drill string should be rotated before re-starting the pump to break the fluid gel strength and allow the fluid to become more flowable.

13. Protection From Installation Loads

1. Except when the rated pulling strength of the drilling rig is less than the allowable tensile load (ATL) of the pipe, as listed in Section 4 of this specification, a break-away connector with a pin configuration that results in a break-away value less than or equal to the ATL of the pipe shall be used on all directional bores to ensure that the pipe is not damaged during installation.
2. The contractor must immediately notify the DESC Inspector any time that a break-away connector breaks. If the contractor claims that the bore path plan was the reason for the breakage, then the Dominion Engineer will provide calculations for the estimated pull-back force. If the calculations indicate that the bore path plan should not have exceeded the ATL with a properly developed bore hole, the contractor will not be reimbursed for any delays.
3. Any time that a break-away connector breaks during pullback, the contractor may, on his own time, attempt to retrieve the pipe from the other end of the borehole using another breakaway connector. If attempts to retrieve the pipe in this manner are successful, the pipe may be re-used. However, if attempts to retrieve the pipe are unsuccessful, the contractor will be responsible for the cost of the pipe and any other additional costs.
4. The contractor can shave off the external fusion beads on plastic pipe at his own expense, if he desires.

5. In some situations where calculations indicate that the required pullback force may exceed the allowable tensile load of the pipe, the contractor may be asked to fill the pipe with water during the bore in order to reduce the required pullback force. When this precaution is deemed necessary by the Dominion Engineer, any resulting additional labor charges should be negotiated in advance between the contractor and the Engineering Manager. Furthermore, the contractor may elect to fill the pipe with water on any bore in order to lessen his own risk, provided that it results in no additional cost to DESC.
6. For installation of plastic pipe by directional drilling, the contractor must test the tracer wire for continuity after the pipe is pulled into the borehole.
7. Care shall be exercised when inserting pipe into a bored hole so as not to damage the pipe or its protective coating.
8. Steel pipe must be checked for "holidays" prior to installation on the day of the pullback.
9. Plastic pipe that has been pulled into the borehole may be rejected by the DESC Inspector if scratches or gouges exceed 10% of the wall thickness, or if the ring deflection (ovalization) exceeds 5%.
10. Steel pipe that has been pulled into the borehole may be rejected by the DESC Inspector if scratches or gouges have penetrated the pipe coating to the degree that bare steel is observable, or if ovalization exceeds 5%.

14. Allowance for Tensile Stress Relief

1. When pulling in plastic pipe, an overpull equal to at least 5% of the total length of the fused pipe shall be left extending out of the bore hole to allow for shrinkage during tensile stress relief.
2. For plastic pipe, the minimum wait time (before tie-in) for tensile stress relief shall be dependent upon the anticipated maximum pullback force, as indicated by the following table:

Anticipated Pullback Force (Calculated or Based on Safe ATL of the Pipe)	Required Minimum Wait Time Before Tie-in
<1,000 lbs	15 minutes
1,000 - 2,000 lbs	1 hour
2,000 - 5,000 lbs	6 hours
5,000 - 10,000 lbs	12 hours
> 10,000 lbs	24 hours

15. Site Restoration , Environmental Protection, & Frac-out Contingency Plan

1. The work site must be restored to near original condition once drilling operations are terminated.
2. Contractor shall be responsible for removal and disposal of any drilling mud used on the job.

Drill fluid/mud must be disposed of by an approved method, per DESC Environmental group.
3. Pre and post-construction photographs or videos of the entire bore path, including entry and exit points are recommended but not required.
4. Except in cases where the permitting agency has approved bore pits to contain drilling fluids, silt fencing is required between all drilling operations and any major drainage outfall, wetland, waterway, or any other area designated on the SWPPP.

5. Inadvertent Return Response Plan

1. Reference Dominion Energy HDD SOP section 4.3.6 for onsite monitoring roles and responsibilities
2. Reference Dominion Energy HDD SOP section 4.3.8 for inadvertent return response plan requirements
6. Evaluate groundwater infiltration risk during project planning and the inclusion of groundwater imitation planning in IRC plans.

10. REPORTING GUIDELINES FOR INADVERTENT RETURNS

Reference Dominion Energy HDD SOP sections 4.3.9, 4.3.10, and 4.3.11 for inadvertent return notification requirements.

11. HIGHWAY ENCROACHMENT PERMITTING REQUIREMENTS

1. For any Tier 1 and Tier 2 HDDs, the DESC Engineering Department will apply for all permits. For Tier 3 and Tier 4 HDDs, permits can be included in the project scope of work on a per project basis.
2. For all HDDs, the encroachment permit package should include the following items for each directionally drilled pipe installation:
 1. Location map
 2. Construction drawing that includes the following information:
 1. A plan view of the bore path
 2. The equipment setup area
 3. The proposed pipe size
 4. The proposed pipe material
 5. The proposed wall thickness or SDR
 6. The proposed pipe's specified minimum yield strength, or SMYS (if steel)
 7. The pipe's manufacturing specification
 3. DESC Design & Installation Manual Procedure 1015 - Horizontal Directional Drilling (this document)
 4. Copy of DESC Performance Bond
 5. Copy of USDA Soil Analysis Report generated and printed from the web-based USDA Web Soil Survey (<http://websoilsurvey.nrcs.usda.gov/app/>)
 6. Map showing the proposed detour route in case of emergency

12. REFERENCES

1. Plastic Pipe Institute (2008), "Handbook of PE Pipe," Chapter 12. Second Edition.
2. ASCE (2005), "ASCE Manuals and Reports on Engineering Practice No. 108, Pipeline Design for Installation by Horizontal Directional Drilling."
3. HDD Consortium (2004), "Horizontal Directional Drilling Good Practices Guidelines.
4. AGA (2001), "Plastic Pipe Manual for Gas Service." Seventh Edition.
5. ASTM (2008), ASTM F 1962-05, "Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossings."
6. ASTM (2009), ASTM F 1804-08, "Standard Practice for Determining Allowable Tensile Load for PE Gas Pipe During Pull-In Installation."
7. Baroid Industrial Drilling Products, "Pocket Reference Guide."
8. Cetco Drilling Products & Tarheel Contractor's Supply (2007), "Horizontal Directional Drilling Fluids."
9. Petroff, Larry - Performance Pipe (2008), powerpoint presentation entitled "Directionally Drilled Polyethylene Gas Pipe."
10. Whittle, Mark - Baroid (2009), notes and handouts from Mini Mud School presented for DESC.
11. Performance Pipe Technical Note 803.
12. SCDOT, "A Policy for Accommodating Utilities on Highway Rights-of-Way," Section 8.4.

FORMS AND REFERENCES [PDF files]

- [DI 1015 - Breakaway Connector Setup](#)
- [DI 1015 - Directional Drilling As-Built Form](#)
- [DI 1015 - HDD Emergency Response Checklist](#)
- [DI 1015 - HDD Pre-Bore Checklist](#)
- [DI 1015 - Minimum Drilling Fluid Requirements](#)
- [DI 1015 - Minimum Pullback Time](#)
- [DI 1015 - Thrust and PreReam Time](#)

(UNCONTROLLED IF PRINTED)