Application of Tennessee Gas Pipeline Company for a Certificate of Public Convenience and Necessity

FERC Docket No. CP09 -

300 LINE PROJECT

Pennsylvania and New Jersey

VOLUME II

FINAL ENVIRONMENTAL REPORT

APPENDIX G

HORIZONTAL DIRECTIONAL DRILL CONTINGENCY PLAN

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1.0 INTRODUCTION

The purpose of this document is to establish procedures for addressing potential impacts associated with a release of drilling fluid through hydraulically induced fractures during the horizontal directional drilling (HDD) process. In addition, this document establishes the criteria by which Tennessee Gas Pipeline (TGP) and the appropriate regulatory agencies would determine when a proposed HDD is unsuccessful and must be abandoned in favor of the approved alternate crossing method. Alternate crossing methods would be evaluated on a case-by-case basis, as needed.

2.0 HDD PROCESSES AND POTENTIAL CAUSES OF FAILURE

In the HDD process, there are three basic steps to install a pipeline crossing: pilot hole, hole reaming, and pullback. This section addresses the HDD process and describes some potential causes of failure associated with each installation step. Upon confirmation that an HDD has failed, TGP would evaluate the next conservative crossing method.

2.1 Pilot Hole Process

The pilot hole is the first step in the HDD process. The pilot hole is drilled along a predetermined alignment in which the entry and exit points are located using traditional survey methods. Control of the drill bit is achieved by using a non-rotating drill string with an asymmetrical leading edge. This leading edge creates a steering bias to be held in a precise position during drilling. The pilot hole would be surveyed downhole and along the ground surface as the hole is advanced.

The pilot hole consists of drilling the initial hole beneath the proposed crossing. The pilot hole is drilled using either a downhole displacement mud motor connected to a tri-cone rotary bit or a jetting assembly. Drilling fluid is pumped through the annulus of the drill pipe aiding the mud motor or jetting assembly in cutting the soil or rock strata. The drilling fluid also helps lubricate the drill stem, suspend and carry the drilled cuttings to the surface, and form a wall cake to keep the hole open.

A successful pilot hole provides pertinent data to aid in determining the possible success of the crossing. Data obtained from the pilot hole includes the rate of penetration to be expected and confirmation of the geotechnical strata. The HDD Contractor can then better determine a plan for enlarging the hole to the required diameter. The diameter required to install the pipeline will vary depending on the confirmed geotechnical strata and the HDD Contractor's judgment.

2.1.1 Failure During Pilot Hole Process

The failure mode that can occur during the drilling of the pilot hole is the hole collapsing on the drill pipe string. This is typically caused by either not being able to maintain a good bentonite wall cake to keep the hole stable or an unfavorable drilling stratum containing glacial till, highly fractured rock, noncohesive alluvial material, or cobbles. If the hole collapses on the drill pipe and creates high friction on the drill pipe surface, the torque required to rotate the drill pipe would increase. The increased friction can become great enough to prevent the drill pipe from being moved. In an effort to free the drill pipe, torque and tension are applied to the drill pipe by the drill rig. Under the right conditions, the combined stress load exerted upon the drill pipe would exceed the strength of the drill pipe, and would cause the drill pipe to either shear or twist into two pieces. Multiple changes in strata and long drill lengths contribute to the probability of this type of failure.

Typically the HDD installation method would be considered a failure if there are two unsuccessful attempts at completing the pilot hole. If this happens, the HDD Contractor will demobilize its equipment from the site after approval from TGP.

2.2 Hole Opening Process

The second step consists of one or more hole reaming passes. There are two types of tools that enlarge the pilot hole: flycutters, used for most soil formations, and rock hole opening tools, used for very dense soil or rock formations.

Typically, the flycutter or hole opening tool is attached to the drill pipe string that drilled the pilot hole and is then rotated and pulled back towards the drill rig from the exit point.

- In soil formations, typically there would only be two or three hole opening passes. Depending on the stability of the hole, the HDD Contractor may use a barrel reamer, typically several inches smaller than the outside diameter of the final hole opening tool, and pull it through the hole immediately prior to pullback. This is typically referred to as a swab pass. The purpose of the swab pass is to ensure the establishment of a good drilling fluid wall cake, a clean hole, and a hole full of drilling fluid with the proper density.
- In rock formations, there would be several passes with increasing pipe diameters of 6-inch to 12-inch increments until the desired diameter is achieved. The diameter of each pre-ream pass is typically predetermined, but may be altered in the field by the HDD Contractor after approval by TGP.

Drill pipe is typically added behind the tool at exit to keep drill pipe in the hole for the entire length of the crossing. The process of pulling the flycutters or hole opening tools to the drill rig while increasing the tool size with each pass continues until the hole is at the appropriate diameter to install the pipeline. The HDD Contractor may choose to ream away from the drill rig.

If so, reamers inserted into the drill string at entry are rotated and thrust toward the exit point by the entry side rig, while receiving pulling assistance at exit with a large dozer, a trackhoe, a stationary pulling unit, or a second HDD rig.

The hole opening process may require a significant length of time to enlarge the hole to the required diameter. As the length of time to complete this process increases, the probability of failure also increases. This is especially true when drilling in soil stratum that is loose or unstable (cobbles). At times, the loose material can be drilled very quickly, but maintaining an open annulus throughout the loose or unstable soil strata over an extended period of time can be very difficult. With excessive time, the stability of the hole may degenerate, resulting in an inadequate hole for the installation of the pipeline.

2.2.1 Failure During Hole Opening Process

If the hole opening process takes a long time in unconsolidated formations, there is one main type of failure that could result in the material falling into the hole due to the lack of adequate bentonite wall cake. Each time a tool passes through the hole, the large volumes of drilling fluids being dispersed through the tool tend to wash out caverns in the annulus of the drilled hole. Because of the inability to bridge the soils, the hole becomes unstable and can lead to the prevention of drilling fluid returning to the surface at entry or exit. If the drilling fluid is no longer able to carry the drilled cuttings out of the hole, an excess quantity of cuttings would remain in the hole. The cuttings would slowly build up in the bottom of the hole, increasing the friction on the drill pipe, and creating additional wear on the drill pipe. Wearing would decrease the wall thickness of the drill pipe and can potentially cause the drill pipe to fail. The increased friction can cause the drill pipe to slow or stop rotation to a point where the drill rig cannot supply enough torque to continue drilling without causing drill pipe failure. The drill pipe may fail by shearing or twisting into two pieces due to excessive torque being exerted upon it.

In rock formations, there are two main types of failure: the hole opening tool can fall apart due to excessive wear on the tool and/or weathered rock or cobbles can fall into the hole. If the penetration rates are extremely slow, excessive wear can occur on the arms holding the roller cutting cones. If the wear is too excessive, the roller cones can separate from the tool, leaving the tool unable to cut or rotate. If the tool can still be removed from the hole, and the missing pieces fished out of the hole with special fishing tools, the hole opening pass can resume.

The HDD installation method would be considered a failure if there is an unsuccessful attempt at retrieving tools or equipment downhole and it has been determined that the hole opening pass cannot be completed. If failure occurs, the HDD Contractor would demobilize its equipment from the site after approval from TGP.

2.3 Pullback Process

The last step to complete a successful installation is the pullback of the prefabricated pipeline into the enlarged hole. The pullback process is the most critical step of the HDD process. A reinforced pullhead is attached to the leading end of the pipe and to a swivel that is connected to the drill pipe. The swivel is placed between the drill pipe string and the product pipe to minimize rotation and torsion from being passed through to the pipeline. The pipeline would be buoyant in the drilling fluid and therefore would be filled with a calculated amount of water to keep the pipeline as close to neutral buoyancy as possible. If no water were added to the pipeline during the pullback process, the pipe may float in the drilled hole, pressing itself against the top of the hole causing the following problems:

- Skin friction of the pipeline would be increased, which would increase the load the drill rig has to pull. The pipeline could be damaged if an excessive amount of pull tension has to be applied to the pipe to continue the pullback process.
- The leading edge of the pullhead could dislodge a cobble or rock fragment, binding the pipeline and making it impossible to move the pipeline in either

direction.

- The external coating could be damaged by sharp and/or protruding material and highly abrasive material (coarse sands).

The pull section is supported with a combination of roller stands, pipe handling equipment, and/or a floatation ditch to minimize tension and prevent the carrier pipe from being damaged during pullback.

2.3.1 Failure During Pullback Process

Failure of the pullback process occurs when the pipe becomes lodged in the hole and is unable to be moved in either direction. If the pipeline encounters an obstruction preventing further movement, the pull of the drilling rig may increase to a level causing the drill pipe to fail. This can result in the greatest setback because the only alternative is to abandon the drilled hole and pipeline, relocate the pipeline alignment, and restart the drilling process from the beginning.

The HDD installation method would be considered a failure if there is one failed attempt at completing the pullback unless the pipe can be removed from the hole. Then a second attempt would be made after the hole has been reopened and reconditioned with any necessary hole opening passes as determined jointly by the HDD Contractor and TGP. If failure occurs, the HDD Contractor would demobilize its equipment from the site after approval from TGP.

3.0 DRILLING FLUID SYSTEM

The HDD process involves use of a drilling fluid (also referred to as drilling mud) made up primarily of water and bentonite, with pH values between 8 and 10. Bentonite is a naturally occurring, non-toxic, inert substance that meets National Sanitation Foundation/American National Standards Institute (NSF/ANSI) Standard 60 and 61 Drinking Water Additives Standards and is frequently used for drilling potable water wells.

The primary purpose of drilling fluid is to remove the cuttings from the borehole, stabilize the borehole and act as a coolant and lubricant during the drilling process. The water and clay drilling fluid consists of 1 to 5 percent active clays and from 0 to 40 percent inert solids with the rest being water. The primary active clay component is bentonite.

The drilling fluid is first prepared in the mixing tank with both new and clean recycled drilling fluid. The fluid is pumped at 100 to 1,000 gallon per minute rates through the center of the drill pipe to the cutters. Return flow is through the annulus created between the wall of the boring and the drill pipe. The cuttings are then carried to either the entry or exit pit, depending on a combination of elevation difference and drilling/hole opening direction. Once in the entry pit, the fluid moves into the pickup pit to be pumped to the fluid processing equipment. Typically, shaker screens, desanders, and desilters remove increasingly finer cuttings from the drilling fluid. The cleaned and recycled fluid is returned to the mixing tank and pumps for reuse in the borehole. Cuttings and bentonite mud (clay) is often desirable for agricultural applications and would either be made available to landowners for their use or disposed of in a landfill.

3.1 Drilling Fluid Seepage

The HDD method has the potential for loss of seepage of drilling fluid into the geologic formation through which the drill passes. In some cases, the drilling fluid may be forced to the surface resulting in what is commonly referred to as an inadvertent release or “frac-out”. Therefore, while the intent of the HDD method is to avoid surface disturbance, surface disturbance may occur when there is an inadvertent release of drilling fluid (all surface releases should be cleaned up to the extent practicable). Drilling fluid releases are typically caused by pressurization of the drill hole beyond the containment capability of the overburden soil material. Providing adequate depth of cover for the installation is a design consideration intended to mitigate this potential. In some cases, an inadvertent release of drilling fluid can be caused by existing conditions in the geologic materials (e.g. fractures) even if the downhole pressures are low.

3.2 Drilling Fluid Release Prevention

Prevention of drilling fluid release is a major design consideration when determining the profile of a HDD crossing. Some of the driving factors in selecting the pipeline crossing profile are the type of subsurface material and the depth of cover material. Cohesive soils, such as clays, dense sands, and competent rock are considered ideal materials for HDD. The second factor to be considered in developing a profile is adequate overburden material. Generally, a minimum depth of cover of 25 feet in competent soils should be maintained to provide a margin of safety against drilling fluid seepage.

As the drill and hole opening assembly enters the ground and nears the ground surface on the other side of the waterbody, it passes through the area that presents some potential for drilling fluid release. Because prevention is the most effective contingency plan, each drill hole has been designed to reduce the potential for hydraulic fracturing or “frac-out” in these areas. In the event of a frac-out, subsequent containment of the drilling fluid would be managed as described in this Plan. Containment dikes in the form of berms, silt fence and hay bales are used to contain any seepage and minimize migration of the drilling fluid from the work area.

The geometry of the pipeline profile can also affect the potential for drilling fluid release. Profiles that require the pipe to make compound or excessively tight radii create downhole pressures that increase the potential for frac-outs. The profiles for the 300 Line Project HDD crossings minimize this potential, with very smooth and gradual vertical curves. In addition, horizontal curves have been eliminated from most HDD profiles. Therefore, the potential for pressure buildup caused by pipeline geometry has been minimized.

4.0 RESPONSIBILITY OF HDD CONTRACTOR

The HDD Contractor is responsible for execution of the HDD operation, including actions for detecting and controlling drilling fluid seepage. TGP would closely supervise the progress and actions of the HDD Contractor through the use of on-site inspection teams.

5.0 PRE-DRILLING PREPARATION

Prior to initiating construction, Contractor personnel and the TGP inspection staff will be adequately trained to identify frac-out conditions and to use appropriate response materials.

The following list identifies some materials and equipment that will be maintained at each HDD site in sufficient quantities to ensure containment of any inadvertent releases of drilling fluid:

- Straw or hay bales (certified weed free)
- Stakes to secure bales
- Straw logs (wattles or fiber rolls)
- Silt fencing
- Sand bags
- Shovels
- Pumps with leak-free hoses
- Coffer Dam

As applicable, the following additional materials and equipment may be maintained at a nearby location in sufficient quantities to ensure containment of any inadvertent release of drilling fluid:

- Light tower(s) would be available if necessary so that cleanup work could continue after dark.
- On-Call vacuum truck(s) and agreement(s) for an approved drilling fluid disposal site(s).
- A boat with appropriate personal safety equipment in the case of major waterbody crossings.
- Flexible plastic piping for potential mitigation where small creeks or drainages are involved.
- Heavy equipment such as backhoes that may be utilized to control and clean up drilling fluid seepage.
- Portable spill containment booms and turbidity curtains.

A sufficient pumping system would be in place to accommodate all drilling fluids at the bore entry and exit location to contain all drilling fluids within the bore entry and exit pits.

6.0 MONITORING FOR DRILLING FLUID RELEASE

During the drilling operations a spotter will required to monitor the crossing at all times for visual frac-out indicators. In addition to the visual monitoring the drill operator will monitor all mud pressure gauges and will immediately cease all operations and dispatch additional crews to assist in the detection of a frac-out should equipment gauges indicate a loss of pressure or if a loss of circulation is encountered. HDD is a technically advanced process involving skilled operators. The detection of drilling fluid seepage is highly dependent upon the skills and experiences of the drilling crew. Each drilling situation is unique in that the behavior of the subsurface material is highly variable and difficult to predict. There is no in-hole monitoring equipment that can detect if drilling fluid is seeping into the surrounding formation. Instead, drilling experts use a combination of factors, which must be properly interpreted, and may indicate conditions that can have the potential for resulting in a frac-out.

A seep occurs when there is a failure to maintain pressure in the hole. The most obvious signs of a drilling fluid seepage are when the mud becomes visible on the surface or a loss of drilling fluid circulation is observed. One of the functions of the drilling fluid is to seal the hole to maintain the downhole pressure. The loss of returning drilling fluid is a sign that pressure is not being contained in the drilled hole and seepage may be occurring outside of the hole. If there is a reduction in the quantity of drilling fluid returning to the drilling site (loss of circulation), this could be a warning sign. However, some loss of drilling fluid is also normal in the drilling process. There can be instances in the drilling process that a loose sand, gravel layer, or rock fracture is encountered. These occurrences would require additional drilling fluids to fill in the voids. Consequently, drilling fluid loss in and of itself is not an indication of a potential frac-out. It is the loss of drilling fluid in combination with other factors that may indicate a potential frac-out condition. For example, if there is a loss of drilling fluid and the return cuttings do not show a large quantity of gravel then this could indicate a loss of containment pressure within the hole.

During the drilling process, the HDD Contractor monitors a pressure gauge located in the control cab. The Contractor monitors the torque, down hole pressure, and drilling fluid returns. The drillers are knowledgeable regarding the appropriate volume of returns. The HDD Contractor measures the drilling fluid, calculates the volumes and monitors the viscosity and gel strength. Indications of an inadvertent loss begin with warning signs, starting with the minimization of returns, composition of returns, followed by increased torque and pressure values.

The detection of a potential seep prior to it actually occurring is dependent upon the skill and experience of the HDD crew. It is for this reason that TGP will be using a contractor that specializes in HDD to perform the proposed crossings. The selection and supervision of the HDD Contractor will be the responsibility of TGP.

7.0 CORRECTIVE ACTION FOR DRILLING FLUID RELEASE

In addition to previously stated measures to avoid and minimize frac-out related impacts, the following response measures will be implemented upon discovery of the loss of drilling fluid into streams or wetlands:

- Directional drilling will stop immediately.
- Drilling fluids will be contained through the application of straw bales, sediment fencing, 55-gallon drums, culvert, sandbags or other pre-approved containment methods. It is up to the TGP Environmental Inspector (EI) to determine the appropriate containment method in order to best protect the site-specific resource.
- The following entities will be contacted by phone immediately, but no later than 24 hours; United States Army Corp of Engineers (USACE), New Jersey Department of Environmental Protection (DEP), New Jersey State Department of

Fish and Wildlife (DFW), and FERC. National Marine Fisheries Service (NMFS) and United States Fish and Wildlife Service (USFWS) will also be contacted in the event of potential impacts to federally listed species.

- In flowing streams, qualified fisheries biologists will be on call to conduct fish salvage operations (under the appropriate permits acquired prior to construction) in the reach upstream of bentonite removal activities. Block nets will be employed to ensure no fish or other aquatic species re-enter the affected area until after the sediments are removed.
- In delineated wetlands, qualified wetland scientists will be on-site to identify resources and monitor effects.
- Commercially available non-toxic polymers may be used in an attempt to seal the fracture.
- If a fracture cannot be sealed, where practical, the drill pipe will be removed from the existing drill hole to a point where a new drill path can be attempted by drilling out of the existing hole and creating a new hole. TGP's EI and the Contractor's Environmental Coordinator would review all information pertaining to the frac-out and then make a decision to abandon the existing hole and initiate a new bore hole. If the original drill path cannot be utilized, the drill rig would be moved to a new, adjacent location. Staff will verify that the new, adjacent location meets the requirements of all applicable project permits and approvals.
- If a frac-out occurs during "pull-back", adjustments to the pull-back operations action will be taken to minimize inadvertent returns.

In flowing streams, the following approach will generally be followed after the frac-out has been isolated and the flow has stopped. Due to the unpredictable nature of the location and environment in which frac-outs may appear, this description cannot encompass all possible approaches to clean up under all conditions. Agency staff and other experts will be consulted to the extent practicable to develop ad hoc clean up techniques as required. The following are standard response techniques that may be applied:

- If the bentonite material flows overland prior to entering the stream, installation of silt fencing or sandbag dams at the point of entry will be used to reduce or stop the flow; if the vent is directly into the stream, other means to isolate the vent site from the flowing stream will be used.
- Using a vacuum truck or pump(s), with a sufficient hose, personnel will remove the bentonite, working from downstream to upstream, to allow maximum visibility. Hand tools may be used to scarify the sediments and ensure removal to the maximum extent practicable.
- If necessary, water may be diverted using a coffer dam to isolate the impact area. Only a portion of the stream will be diverted to minimize dewatering impacts. Water will be able to pass through the site in its natural condition.

- If it is impracticable to remove the drill fluid from the creek, a clear, written explanation will be submitted to the USACE. The USACE would coordinate this effort with the USFWS. Any fluids left in the stream channel will require a written approval from the USACE.
- Any disturbed soils will be stabilized immediately.
- Exposed mineral soils will be seeded with native vegetation immediately.
- Disturbance of vegetation will be kept to a minimum and all disturbed vegetation will be restored and/or replanted with native species, to eventually recreate the functional values of the lost vegetation.
- Damaged riffle and pool sediment strata will be re-contoured to the extent practicable under the direction of Agency personnel.

In the event of an unintentional release of drilling mud under pressure into dry ephemeral streams, a response plan similar to the above described will be implemented, with the following exceptions:

- Fisheries personnel will not be required to respond unless the frac-out produced sufficient flow to introduce bentonite into downstream perennial streams.
- Qualified wetlands scientists will be on-site to evaluate conditions, and to assist with minimization of further impacts resulting from cleanup activities (e.g. equipment entering sensitive wetland areas).
- Mitigation will only be required for material that must be left as permanent fill in a delineated wetland.

7.1 Water Quality Monitoring Procedures

The USACE, DEP, and the USFWS have requirements for monitoring during HDD operations in the event of an inadvertent release of drilling fluid and if increased turbidity is observed downstream of the crossing.

HDD crossings will be visually inspected for inadvertent release of drilling fluid. If there is an inadvertent release of drilling fluid, turbidity monitoring using a turbidimeter that is properly calibrated according to the operator's manual will be initiated.

7.1.1 Ecological Requirements

At a minimum and dependent upon the individual state regulatory agencies standards, turbidity samples would be taken both upstream and downstream of the release. Samples will be taken immediately after the release, 1 hour after the release and 2 hours after the release. If visual monitoring or water quality samples show an increase of more than 5 NTU (10 percent of background if background is greater than 50 NTU), at the sampling location downstream, the following actions may be taken:

- The EI will immediately assess the efficacy of the site environmental Best Management Practices (BMPs) and add, update, or improve the BMPs as required to reduce the rate of activity.

- Sampling at the point of compliance will commence and continue as scheduled to provide an early warning of potential turbidity exceedances.

If the inadvertent release creates noncompliance at the point of compliance, drilling activities will be suspended and sampling will continue every 2 hours. Sampling will continue until samples show that downstream turbidity at the point of compliance is not greater than 5 NTU over background (10 percent for streams with background over 50 NTU).

Drilling operations may resume when all measures have been taken to stop the inadvertent release of drilling fluid. If, at any time, visual monitoring indicates an increase in turbidity, sampling will commence according to the schedule provided above.

7.1.2 USFWS Requirements

The USFWS requires monitoring downstream of the crossing to be conducted along a transect extending perpendicular to the stream flow.

The USFWS also requires monitoring of background turbidity levels if an increase in turbidity has been observed downstream. The following thresholds have been provided by the USFWS for which, if exceeded, sediment-generating activities must cease and the FERC must reinitiate consultation:

- When background NTU levels are exceeded by 34 NTUs at any point in time.
- When background NTU levels are exceeded by 13 NTUs for more than 3 hours, cumulatively, in 1 day.

8.0 TGP AND AGENCY APPROVAL

TGP would provide on-site inspection during the HDD process to maintain adequate daily progress reports, as-built information, and other applicable construction documentation that would describe the events leading up to an HDD failure. TGP would submit this documentation to the appropriate agencies, notifying them of the HDD failure and the subsequent schedule for implementing the approved alternate crossing method. The HDD Contractor would not demobilize until TGP approval has been received. The alternative crossing method would not be implemented until TGP has received confirmation that appropriate agencies have received the documentation of HDD failure.