WATER AGENCIES' STANDARDS

Design Guidelines for Water and Sewer Facilities

SECTION 12.3
PIPE BURSTING

12.3.1 PURPOSE

The purpose of this section is to provide guidelines for the use of pipe bursting in pipeline replacement installations where standard open cut excavation methods are not feasible or desired.

12.3.2 STANDARD TERMS AND DEFINITIONS

Wherever technical terms occur in these guidelines or in related documents, the intent and meaning shall be interpreted as described in the Standard Terms and Definitions.

12.3.3 GENERAL

Pipe bursting is a process by which the bursting unit splits and/or fractures the existing pipe while simultaneously installing a new high density polyethylene pipe (HDPE) or other pipe material (e.g. PVC, steel) of the same or larger size into the annulus created by the forward movement of the bursting tool. Pipe bursting is an alternative to the replacement of underground infrastructure by open cutting.

The most commonly used pipe bursting methods are pneumatic or percussive, hydraulic and static. The main difference between methods is the manner in which the force is generated and transferred to the host pipe during the bursting operation. Static systems are hydraulic, while impact systems generally involve a combination of pneumatic and hydraulic technology.

The success of the pipe bursting project is highly dependent on soil conditions, existing pipe material and condition. Burst length coupled with soil conditions, depth and new pipe diameter are critical factors in the planning of the pipe bursting process.

The International Pipe Bursting Association (IPBA) classifies pipe bursting work into three classifications. These classifications are meant to be used as a general guideline when considering online replacement of an existing pipe by pipe bursting:

1. Routine

Depth Of Pipe:	<12 feet
Existing Pipe Diameter:	4 – 12 inches
New Pipe Diameter Options:	Size for Size to 1 Up size
Burst Length:	0 – 350 feet

2. Challenging To Moderately Difficult

Depth Of Pipe:	>12 feet and <18 feet
Existing Pipe Diameter:	12 – 20 inches
New Pipe Diameter Options:	2 Up size
Burst Length:	350 – 450 feet

3. Difficult To Extremely Difficult

Depth Of Pipe:	>18 feet
Existing Pipe Diameter:	20 – 36 inches
New Pipe Diameter Options:	3 or more Up sizes
Burst Length:	>450 feet

The typical advantages of this method include reduced surface disturbance compared to open-cut replacement, ability to replace an old pipe with new pipe of equal or larger diameter and capacity, and low project costs under favorable conditions. Potential pitfalls include associated ground movement and vibrations, the need for significant laydown areas, the potential to damage nearby or crossing utilities, and a propensity for surface heaving.

12.3.4 GUIDELINE

It is the responsibility of the user of these documents to make reference to and/or utilize industry standards not otherwise directly referenced within this document. The Engineer may not deviate from the criteria presented in this section without prior written approval of the Agency.

12.3.5 METHODS OF PIPE BURSTING

The most commonly used methods for pipe bursting are static and impact force. Static systems are hydraulic, while impact systems generally involve a combination of pneumatic and hydraulic technology. The main difference between methods is the manner in which the force is generated and transferred to the host pipe during the bursting operation.

The pipe bursting tool shall be designed and manufactured to force its way through existing pipe materials by fragmenting the pipe and compressing the old pipe sections into surrounding soil as it progresses. The bursting unit shall generate sufficient force to burst and compact the existing pipeline. The outside diameter size of tool to be used shall be equal to or greater than the outside diameter of the proposed pipe, or per manufacturer’s specifications.

The pipe bursting tool shall be pulled through the existing pipeline by a winch or rod located at the upstream manhole or pit. The bursting unit shall pull the polyethylene (PE) pipe with it as it moves forward. The bursting head shall incorporate a shield/expander to prevent collapse of the hole ahead of the new pipe insertion. The pipe bursting unit shall be remotely controlled. Replacement pipe that is sectional shall be pushed as well as pulled behind the bursting head.

The bursting action of the tool shall increase the external dimensions sufficiently, causing breakage of the existing pipe at the same time expanding the surrounding ground sufficiently to pull or pull/push in the new pipe.

12.3.6 PIPE BURSTING TYPES/EQUIPMENT

Various types of specialized equipment are utilized in pipe bursting projects. The various types of equipment are generally unique to each of the generic methods. The main difference between methods is the manner in which the force is generated and transferred to the host pipe during the bursting operation.

A. Static Pipe Bursting

Static Pipe Bursting uses forces that are generated using potential energy. A pulling force is applied to a tapered or blunt nosed bursting head through the rods, chain or cable and is simply pulled through the old pipe. This causes the pipe to fail in tension by the radial force applied to the pipe wall from by bursting head within the pipe. As the bursting head advances, the old pipe is fragmented and the new pipe line is simultaneously installed.

The static pipe bursting winch equipment is modeled after high-powered hydraulic jacks, mounted horizontally, or a high tension drum type winch. Winching forces of up to 225 tons are typical for this method. This method is used in pipes 4-inches to 40-inches in diameter or larger.

B. Pneumatic Pipe Bursting

Pneumatic Pipe Bursting is done by creating an impact load in the pipe by applying a "hoop" stress into the pipe causing it to burst in tension. This technique uses a pneumatic bursting head with a properly sized expander, and relies on percussive hammering action to break out the old pipe in which the tool travels. Simultaneously the new replacement pipe is installed into the space created by the pneumatic bursting head and expander.

A winch cable is attached to the nose of the bursting pulling head to maintain correct line and grade by providing constant pulling tension and enhancing the percussive force. Winching forces up to 20 tons are typical for this method. This technique is primarily aimed at the replacement of gravity pipes as well as pressure pipes, and has been used in diameters ranging from 4-inches to 54-inches or larger.

C. Hydraulic Pipe Bursting

Rather than the pipe being burst from the transfer of a pulling or hammering radial force into the plane of the pipe diameter, the bursting head diameter expands, fragmenting the pipe from the inside.

The bursting head is equipped with "petals" which open and close under hydraulic pressure. Using hydraulic cylinders, the bursting head first expands to crack the host pipe, then contracts to allow the winch to pull the pipe string forward, while tension is applied to the nose of the head using a winch cable to maintain directional stability. Hydraulic bursting is primarily used for on-line replacement of gravity pipelines 6-inches to 20-inches in diameter or larger.

12.3.7 Pipe Materials

The new pipe shall be sufficient in diameter and thickness to renew the required flow capacity and pressure. The pipe shall be of virgin materials and be homogeneous throughout, and shall be free of visible cracks, holes, foreign material, blisters, or other deleterious faults. The wall thickness of the new pipe shall conform to the recommendations of the Pipe Manufacturer or as approved by the Agency.

A. High Density Polyethylene Pipe (HDPE)

HDPE shall meet the applicable requirements of ASTM F714 Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter or AWWA C906, ASTM D1248 and ASTM D3350.

B. Steel Pipe

Steel Pipe shall meet the requirements of AWWA C200.

C. Ductile Iron Pipe (DIP)

Ductile Iron Micro Tunneling Pipe shall meet the requirements of AWWA C110 and shall be specifically designed for jacking by the pipe manufacturer.

D. Polyvinyl Chloride (PVC) Pipe

PVC Pipe shall be a restrained joining type such as Certa-Lok or Yelomine and conform to the requirements of ASTM D2241 and/or AWWA C900 or C905, with a DR11 rating.

12.3.8 Parameters and Conditions

A. Host Pipe Suitable for Bursting

1. Vitrified Clay Pipe (VCP) in diameters 4-inch to 42-inch commonly used in sewers and other utilities is very brittle and can be readily burst. The ability to fracture the pipe and compact the fragments into the surrounding soil make it an ideal pipe to burst. It should be noted that concrete encased point repairs, and at times concrete adjacent to the manholes or structures, may slow-up or stop the bursting process.

2. Concrete Pipe of all sizes has been used in all utilities except gas service, and may or may not have steel reinforcement cage. Normally, 12-inch diameter and less is non-reinforced concrete pipe and fractures similar to VCP. The amount of reinforcement, i.e. single or double cage, will dictate the burst type selection and success.

3. Cast Iron Pipe (CIP) has been used in all utilities except telephone service and can be very brittle but slightly different than VCP. Although fracturing easily, it does require special lead equipment to protect the winch rope from possible damage. Bell and spigot type joints for CIP require a blade-type nose extension to help crack the large cross section of material contained in the joint, i.e. lead, jute or hemp, asphalt and/or elastomeric materials. A HDPE new pipe should have a DR 17 or lower to prevent sharp fragments from damaging the pipe.

4. Asbestos Cement Pipe (ACP) has been used on all utilities and has good bursting features, similar to VCP. ACP contains asbestos material which is carcinogenic. Therefore, pipe bursting is much safer than dig-up and replace.

5. Plastic Pipes (i.e. PVC, PE, ABS, et al) possess varying degrees of material characteristics. Most plastics must be split longitudinally using special cutting blades on nose extensions. This may not permit sufficient soil expansion causing higher friction on the new pipe being pulled in. Normally the fragments are strips and do not cause damage to the new pipe.

6. Steel and ductile iron pipe (DIP) must be split by blades. This process is used in lieu of ripping, bursting or tearing the metal pipe. The new pipe is then pulled into the expanded host pipe

B. Host Pipe Size

Host pipe size will affect both hammer/expander combinations and winch selection. Small diameter host pipe in difficult soil conditions can present problems because larger, more powerful hammer will not fit inside the host pipe. Special nose tools can be adapted to solve these problems.

C. Host Pipe Depth

The depth of the host pipe affects the bursting process in a number of ways, such as:

1. Existence of groundwater or more groundwater depth requires dewatering or additional dewatering.

2. Soil expansion subsequent to the pipe burst may become more difficult due to the additional soil weight.

3. Depending upon the type of soil, upsizing new pipe may require additional soil expansion.

4. Entrance and exit pits will require additional shoring due to required safety procedures.

5. The magnitude of an allowable bend in alignment may require reduction due to the additional soil load.

D. Surrounding Soil Types

The type of soil surrounding the host pipe shall be identified. Some soil types are easily expanded and remain in the expanded size permitting relative ease for new pipe pull-in. Other soils may be loose and/or running, and may require the use of Bentonite or polymers that provide some structural support, permitting the new pipe pull-in. Very weak soils may not support the weight of the pipe bursting equipment and these should be avoided. A certified Geotechnical firm shall perform geotechnical investigations and produce a soils report to determine soil types.

E. New Pipe and Size

Most pipe bursting projects utilize fused lengths of HDPE pipe. The HDPE wall thickness is identified by the use of its dimensional ratio (DR) for a given size. The DR number is obtained by dividing the wall thickness (t) into the pipe's outside diameter (OD) value (i.e. – the lower the DR, the greater the wall thickness). Other pipe material types have been used and these are shown in Section 12.3.7 of this Water Agencies' Standards Design Guide.

All fittings will need to accommodate the odd outside diameter size of the new HDPE pipe including all tapping and service saddles.

The ability to up size or install a new pipe larger in diameter than the host pipe is unique to pipe bursting. The amount of up size is limited by a combination of all the host pipe parameters. Generally, one or two up sizes can be accomplished (i.e. – 6-inch to 8-inch or 8-inch to 10-inch constituting a 33% to 67% increase in diameter).

F. Service Excavations

It is recommended that all service laterals be located and exposed prior to bursting to reduce damage and permit a reduction in time for service reinstatement. Excavation of the service lateral pits shall allow for equal 360 degree expansion or bursting of the existing pipe. All service reconnections shall be per manufacturers recommendations.

G. Launching and Exit Pits

Pits are usually located outside of heavy traffic areas, e.g. intersections, etc., and generally near manholes to permit gradual entry of the burst equipment and new pipe into the host pipe.

Launch pits in length should, as a rule of thumb, be 2.5 times the depth of the existing pipe. Steep entries may put excessive strain and friction on the new pipe.

Exit pits must be sized to permit pipe bursting equipment removal and allow manhole connections to the new pipe.

The pipe shall be bedded and installed within the launching and exit pits to correct line and grade.

H. Burst Length

Pipe burst lengths are heavily dependent on the size of the old pipe, up sizing, depth and soil conditions. For a general guideline for burst lengths, see Section 12.3.3.

I. Lubricants

Lubrication, as recommended by the equipment manufacturer, shall be used if such lubrication is determined necessary to ensure the successful completion of the job. General guidelines for the use of lubricants are as follow:

1. When the new pipe is equal to or greater than 2 times the diameter of the existing pipe.

2. Burst length exceeds 300 feet.

3. Diameter of new pipe exceeds 12 inches.

4. Host pipe is under groundwater.

5. Free flowing soil conditions.

6. As recommended by the pipe bursting equipment manufacturer.

J. Contractor Qualifications

To ensure a safe, efficient, high-quality project, the Contractor will be required to have a minimum qualifications outlined in the project specifications. Minimum qualifications shall include but not limited to the following:

1. Number and list of pipe bursting projects successfully completed by the Contractor.

2. The Contractor shall furnish a list of references where pipe bursting was used in similar ground conditions.

3. The Contractor shall be trained and certified to operate the required pipe bursting equipment and systems. The Contractor shall provide certifications of training and proficiency in the use of the equipment.

4. The Contractor must be an existing licensee to perform pipeline replacement operation using the pipe bursting methodology.

K. Submittals

Submit manufacturer's specific technical data with complete information on physical properties of pipe and pipe dimensions pertinent to the job. A certificate of compliance with specifications or suitable alternative shall be furnished for all materials to be supplied. Manufacturer's recommendations for handling, storage, and repair of pipe and damaged fittings should also be included.

Submit complete calculations including lists of parameters, all formulas and all other data showing the design of the new pipe.

Submit detailed drawings and written descriptions of the entire construction procedure to install pipe, bypass flow, pit, sizes, pit construction and shoring, dewatering and service reconnections.

12.3.9 Sub-Surface Conditions

When Pipe Bursting is specified, all necessary information associated with existing conditions shall be gathered and verified. The minimum depth of cover over the installed pipe shall be ten times the amount of displacement from the diameter of the existing pipe or 3 feet from the top of the existing pipe to finished grade, whichever is greater.

Settlement or heaving of the ground surface during or after installation of new pipe will not be allowed. However, at the discretion of the Agency, if soil conditions are not favorable and pipe up-sizing is required, a minimal amount of ground heaving may be allowed.

12.3.10 Pipe Joining

The HDPE pipe or fusible PVC installation shall be designed to be assembled and joined at the site using butt-fusion method to provide a leak proof joint. Threaded or solvent-cement joints and connections are not permitted. All equipment and procedures shall be in strict compliance with the manufacturer’s recommendations.

Fusion shall be preformed by technicians certified by a manufacturer of pipe fusion equipment.

The butt-fused joint shall be a true alignment and shall have uniform rollback beads resulting from the use of proper temperature and pressure. The joint shall be allowed adequate cooling time before removal of pressure. The fused joint shall be watertight and shall have tensile strength equal or greater than that of the pipe. All joints shall be subject to testing each day and acceptance by the Agency prior to insertion.

Terminal sections of pipe that are joined within the insertion pit shall be connected with a mechanical coupling (e.g. a full circle stainless repair clamp), Electro Fusion Couplings (e.g. Central Plastics or equivalent) or a non-shear restraint coupling. All fusion bonding shall be recorded through a data recorder and a printout shall be submitted to the Agency. All connections shall be in conformance with the manufacturer’s installation procedures.

12.3.11 Summary of Design/Project Considerations

The following variables should be considered when planning a pipe bursting project, method and the length of run:

A. The depth of the existing pipe and the replacement pipe: The minimum depth of cover over the installed pipe using this process shall be two to three times the diameter of the replacement pipe or three feet, whichever is greater.

B. Host pipe material, and accurate condition assessment.

C. Diameter and profile of host pipe.

D. Soil condition and types.

E. Topography of the ground subsurface above the line to be replaced.

F. Adjoining utilities and services: Minimum clearance from the other utilities shall be approximately two feet or greater. All interfering and crossing utilities must be located and may need to be exposed prior to bursting.

G. Service excavations.

H. Product pipe material.

I. HDPE to unlike materials shall be flanged or restrained, and requires special transition fittings.

J. Hydrostatic testing and allowable water loss shall be per manufacturer's recommendations or as specified by the Agency.

END OF SECTION