Australasian Society for Trenchless Technology

Standard for Pipe Bursting

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1.0 BACKGROUND

The Australasian Society Trenchless Technology has developed this Standards to assist industry users in Australia and New Zealand in utilising Pipe Bursting.

This document does not replace any existing relevant manuals or standards. It remains the users responsibility to ensure that all relevant laws, standards and specifications are adhered to during the course of a Works.

Additional Pipe Bursting information can be obtained from the Australasian Society Trenchless Technology website, they are:

- Guideline for (Horizontal Directional Drilling, Pipe Bursting, Microtunnelling and Pipe Jacking).
- Specification for Pipe Bursting.
- National Utility Contractors Association Trenchless Assessment Guide, a web-based tool that can be used for identifying trenchless construction methods suitable for a particular set of project attributes (i.e. diameter, length, depth, geological conditions, and so on).

2.0 DEFINITIONS

A number of abbreviations and technical terms have been used in this standard:

ASTT - Australasian Society for Trenchless Technology (www.astt.com.au).

CCTV - Closed Circuit Television. The use of video cameras to visually inspect the works. Often used where man entry not feasible/ possible.

Client - Person or company requiring the Works to be undertaken.

Environmental Impact Assessment - assessment of the possible impact-positive or negative-that a proposed project may have on the environment; considering natural, social and economic aspects.

Contractor - Person or company undertaking the Works required.

Entry Chamber - Also called insertion, thrust, drive or launching chamber/shaft.

Exit Chamber - Also called reception chamber/shaft.

Feasibility Study - Preliminary design and study to ascertain whether commencing the works would prove logical.

GBR - Geotechnical Baseline Report for all anticipated conditions.

Guideline - General information about an item, process, method, material, system or service.

HDD - Horizontal Directional Drilling. A steerable trenchless method of installing underground pipes, along a prescribed path by using a surface launched drilling rig.

HDPE - High Density Polyethylene.

MTBM - Microtunnelling Boring Machine. Mechanized excavating equipment that is remotely operated, steerable, connected to and shoved forward by the jacked pipe or mechanical rods.

NUCA TAG - National Utility Contractors Association Trenchless Assessment Guide.

PB - Pipe Bursting. A trenchless method of replacing pipes. Involves bursting the existing pipe by use of a bursting head while simultaneously installing the new pipe.

PE - Polyethylene.

PVC - Polyvinyl Chloride.

Specifications - Specific set of requirements for an item, process, method, material, system or service.

Standard - A document that provides uniform technical criteria, methods and processes. Often establishes an engineering norm.

TT - Trenchless Technology. Technology for installing pipelines or creating bores without the need of full surface excavation.

Work - The project / task to be completed by the Contractor on behalf of the Buyer.

3.0 SYSTEM DESIGN CONCEPT AND PARAMETERS

Consideration of a Pipe Bursting (PB) process for any Works shall encompass conventional design practices and shall ensure that the following criteria are adequately addressed:[1]

- Design operating flows, pressures and temperatures;
- Flow variations (peak, start-up, minimum flows);
- Construction materials requirements (Corrosion protection [internal and external], wear considerations, load parameters, design and maximum thrust allowable);
- Equipment requirements (operating requirements, capabilities, suppliers and manufacturers equipment constraints);
- Site layout (access to site, entry and exit chamber excavation, locations of equipment and pipe material storage);

- Area of operation (existing utilities, nearby dwellings, heritage sites, wildlife habitats and fauna & flora).

The contractor shall take the following steps in planning a PB process:

- Perform all required feasibility studies, Environmental Impact Assessment and surveys, site protection plans, geotechnical report (or GBR), risk assessments and contingency planning;
- Detail each step of the process including but shall not limited to mobilisation, winch installation, pipe bursting operations, including old (installed) pipe specifications;
- Confirm bursting winch specifications including but not limited to an adequate anchoring system, pull forces and torques required;
- Proposal of a water supply for operation (if required);
- Compile replacement pipe specification (size, grade, quantity, joint types);
- Compile Contingency Plans in regards to failure to complete the Works, surface heave, striking of other utilities, loss of the bursting head, and other possibilities identified in the associated Risk Assessment.

4.0 MATERIALS AND EQUIPMENT

4.1 Equipment Requirements

Pipe bursting requires the use of a bursting head and winch capable of applying sufficient force to rupture and displace the host pipe into the surrounding area. Equipment commonly required for PB include an anchoring system to secure the winch, a bursting head to clear the old pipe and a cutting tool which is attached to the bursting head. In the case of replacing ductile pipelines a variety of additional cutting tools are available in different forms and sizes. These cutting tools enhance the bursting process of ductile pipe materials by cutting through pipe materials such as PVC, Ductile Iron Pipe, and Galvanised steel pipe. A coupling or swivel is connected to the set of new pipes forming the string with the bursting head.

4.1.1 Pulling Device

The pulling device shall be either a continuous tension winch installed at (or in) the exit chamber. On special circumstances such as when the new pipe diameter increase by more than 88% of the host pipe, a Horizontal Directional Drill (HDD) rig should be considered to replace the winch as the pulling device.

An HDD rig, which is a machine normally used for HDD applications, is suitable for particular PB applications, e.g. particularly larger diameter pipe installations.

The pulling device shall be capable of generating sufficient force to be able to pull the bursting head and new pipe string through the existing pipe and to cause the existing pipe to be burst outwards into the surrounding soil.

A continuous tension winch system is essentially a winch unit situated at the entry chamber, located on the surface, which is attached to the bursting head in the exit chamber via a cable or chain. When utilising a continuous tension winch system, the cable or chain and winch shall be situated in an enclosed environment ensuring safe operation in order to minimise risk of injury to the working crews and public, and to minimise risk of damage to crossing utilities or property.

A system of guide pulleys and bracing at the exit chamber shall be provided to minimise the potential risk of the winch cable sustaining damage by coming into contact with the existing pipe, before the bursting head reaches the exit chamber. This is also to ensure that the winch cable does not become entangled with any debris that could add additional frictional forces to the winch cable when pulling the bursting head. The trench shoring supports that are used in the entry chamber shall be installed such that they cannot make contact with the cable, burst head or replacement pipe[2] during the process.

A winch supporting frame, with a length of between one to two meters, shall be setup at the exit chamber between the continuous tension winch system and the old pipe, away from the trench shore, to act as a buffer and spacing to ensure the bursting head has sufficient space to exit the exit chamber. This also allows some extra new pipe to be pulled through into the exit chamber for reconnecting to the old pipe.

4.1.2 Bursting Head

A bursting head is considered one of the most important components of any PB Works. A bursting head is required to fragment and compact the existing pipe into the surrounding soil, enlarge the bore, and pull through the replacement pipe with the help of a pulling device. There are ranges of different PB systems available from different industry manufacturers.

4.1.2.1 Pneumatic Bursting

The most common type of bursting head in use is pneumatic, which utilises a percussive fracture mechanism. Using compressed air, the bursting head is able to develop a hammering rate of 180 to 580 blows per minute. The cone shape bursting head is driven through the soil like a nail being driven into a wall. Each blow impacted by the bursting head into the pipe creates an impact load, applying a “hoop” stress into the pipe causing it to burst under the tension.

Pneumatic bursting has been used to install pipes under 600mm in diameter. During pneumatic pipe bursting, the pipe bursting tool is guided through a

fracturable host pipe by a constant tension winch. As the tool travels through the pipe, its percussive action breaks apart the old pipe and displaces the fragments into the surrounding soil. Depending on the specific situation, the tool is equipped with an expander that displaces the host pipe fragments and makes room for the new pipe. As the tool makes its way through the host pipe, it simultaneously pulls in the new pipe.

If the effects of percussion created during pneumatic pipe bursting are likely to have negative effects on adjacent pipes, then a hydraulic bursting head shall be chosen over the pneumatic.

4.1.2.2 Hydraulic Bursting

Hydraulic bursting is a process similar to pneumatic bursting. The difference is in the method of bursting. The bursting head is pulled into the existing pipe then the bursting head expands laterally to burst the pipe. The new pipe is connected to the rear of the hydraulic bursting head, when the bursting head expands, it creates a cavity that allows the winch to pull the new pipe forward in small increments. Hydraulic bursting is used primarily for on-line replacement of sewers and gravity pipelines.[3]

4.1.2.3 Static Bursting

Static bursting utilises a geometrically cone shaped bursting head to develop radial bursting forces when the cone head is pulled through the existing pipe. The cone shaped head forces the fragmented pipe into the surrounding soil while simultaneously pulling in the new pipe. The static bursting method uses either a cable or rod and a winch system to force the bursting head through the existing pipe. Static Bursting is capable of replacing metallic pipes and the replacement of pre-chlorinated pipes. This cone shaped bursting head that is connected to the cable is about to burst the metallic pipe material easier.

In some situation where sectional pipe such as concrete, clay or Glass Reinforce Pipe is the preferred new pipe, a rod (pulling or pushing) and winch system is use. Ladder rods are connected via quick couplings and this ensures a traction and thrust resistant joint. Each rod is generally short and light weight to provide easy access and working within a smaller chamber. The process means that there are frequent stops to add more rods. If a winch system is used instead of a rod assembly, the pulling process continues with minimal interruption once the pipe bursting operation commences. However, winch systems limit the force available for the pipe bursting operation.[1] The rod system has more pulling and pushing force as it is setup inside the chamber, as compared to the cable system that is setup on the surface via a pulley system.

4.1.2.4 Pipe Splitting

Pipe Splitting is similar to the static pipe bursting method. In this case the bursting head has specially designed bladed rollers. As the bladed rollers are pulled through, they split the host pipe as opposed to ripping or tearing it. This is a cleaner process and prevents potential damage to the replacement pipe. Pipe Splitting is normally utilised for the replacement of old pipes made of ductile material such as steel, galvanised or cast iron, or the installation of pre-chlorinated replacement pipe.

4.1.3 Other PB Methods

Four other pipe bursting methods are listed this section. They are namely pipe implosion, pipe eating, pipe ejection & extraction, and pipe reaming.

Pipe Implosion (Crushing)

This method is suitable for replacing defective (partially collapsed or ruptured) pipes. Pipe implosion involves fracturing the defective pipe inwards by using a steel blade crushing head which is cylinder-shaped, and slightly larger than the existing pipe. A steel cone (situated behind the crushing head) then displaces the pipe fragments outwards into the soil, making room for the new replacement pipe that is installed while pulling in during the process.

Pipe Eating

Pipe eating is a technique based on Microtunnelling, where the defective pipe is excavated together with the surrounding ground. This method would be considered when a new installation is required. The pipe-eating shield is pushed forward along the route of the existing pipeline using hydraulic jacks, located in the drive shaft. Cutting teeth and rollers cut the pipe, and additional cutting arrangements close to the edge of the shield cut the surrounding ground to the required diameter for the new pipe. The new pipe is connected to the back of the tunnelling shield. The pipe-eating shield is recovered at the reception shaft, leaving the new pipe in place of the defective pipe when the process is completed. The advantages of this system are that all of the old pipe material is excavated, and the line and level of the new pipe can be accurately controlled. This method is mostly commonly used for the replacement of old existing concrete sewer pipes.

Pipe Ejection and Extraction

Pipe ejection (a modified form of pipe jacking) and pipe extraction (a modified form of static pull) are both pipe replacement methods, whereby the unbroken existing installed pipe is physically removed from the ground at the same time as the new pipe is installed. For this reason, these techniques shall only be applied to replace existing pipes capable of withstanding the push or pull forces

developed during the process. Due to high frictional forces needed to push or pull the existing pipe out of the ground, this method is generally only suitable for short length of pipe replacement.

Pipe Reaming

Pipe reaming is an adaption of the HDD technique, specially adapted for pipe replacement. A drill string is inserted through the existing pipe to an exit point further along the pipeline. Next, a specially designed reaming tool is attached to the drill string and pulled back through the pipe by the drill rig. During this pulling process, the existing pipe is ground and pulverised by the cutting teeth of the reamer tool, while simultaneously a new pipe is installed behind the reaming head. Drilling fluid is used to lubricate the process and remove the old pipe material as spoil. The advantage here is that one piece of equipment with relatively minor modifications can be used for two very different trenchless techniques. There is also no need for major entry chamber excavations.

This technique is limited to non-metallic pipeline replacement and is capable of handling ground conditions such as rock, concrete encasements, service taps, and collapsed or misaligned pipes.

4.2 Standard Guide for Method Selection

Pipe bursting is suitable for replacing brittle pipes. Table 4.1 is a general standard to selecting the correct pipe bursting method when considering pneumatic, hydraulic or static methods. Other less common PB methods shall be consider based on a case-by-case basis as each project is unique and those less common methods have limited capabilities.

EXISTING PIPE MATERIALS	PNEUMATIC / HYDRAULIC	STATIC
Metallic pipes including aluminium, copper, ductile iron, wrought iron, steel, or stainless steel	No	Yes
Plastic pipe, including HDPE or MDPE,PVC,CIPP, or fibreglass	Yes	Yes
Prestressed or bar-wrapped concrete cylinder pipe (PCCP or BSCCP), corrugated metal pipe (CMP), or corrugated plastic pipe	No	No
Fracturable pipes, including asbestos cement (AC), RCP or reinforced concrete pipe, CI, VCP, or Orangeburg	Yes	Yes
Valves, stainless steel clamps or repair bands, point repairs	No	No
Pulling in pre-chlorinated replacement pipe	No	No

TABLE 4.1 – GENERAL STANDARD FOR SELECTION OF PNEUMATIC/ HYDRAULIC OR STATIC PIPE BURSTING METHODS[4]

The Contractor shall identify the locations of all existing point repairs made to the pipeline prior to commencing any work from As-Builds or records. Table 4.2 indicates the types of information required for documentation prior to PB when identifying the point repair along the old pipe.

TYPE	INFORMATION REQUIRED
Type and size of affected pipe	Type, Diameter
Adjacent pipe condition	Describe
Cause of leak or damage	Describe
Length of repair or replacement	Length
Clamp required, type and size	Type, Diameter, Length
Pipe required, type and size	Type, Diameter, Length
Solid sleeve required for pipe, type (CI or DI), and size	Type, Diameter, Length
Backfill material	Concrete, Stone, Flowable Fill, Other

TABLE 4.2 – REQUIRED INFORMATION FOR PREVIOUS POINT REPAIR LOCATIONS[4]

It must be noted that the selected pipe bursting equipment may not be suitable to break through or out any previous point repairs, in which case other cutting heads, equipment or processes may be required.

4.3 Replacement Pipes

Replacement pipes shall have a nominally flush exterior and be suitable for trenchless installation as per the manufacturer's recommendation. New PVC pipes shall be joined by hot fusing prior to installation. If there is insufficient space for this operation when using PVC replacement pipe, then pipes are to be connected with spline locking joints. If the preferred replacement pipes are ductile iron pipes then special flush joints are to be used[4]. Joints shall be water tight as per the manufacture specification.

4.4 Entry and Exit Chamber

PB Works require excavation chambers at the head (entry) and tail (exit) end of the pipe and must be of sufficient size to accommodate the bursting rig. Additional access chambers maybe required at bends in the pipe alignment, as well as lateral connections.

Smaller potholes for accessing crossing utilities shall be considered for locating and prevention of damage to other existing utilities.

5.0 INSPECTION AND TESTING

Pipe inspection and testing shall be performed to the client's specification and the amount of testing required will be agreed to prior to commencing the Works.

The new pipe will be hydrostatically pre-tested prior to installation. Post installation pressure tests will also be performed on the pipeline.

CCTV inspection should be undertaken to ensure the internal pipe is integrally sound. Any defects that may be structurally detrimental to the completed installation shall be repaired or replaced.

Individual pipe joints shall be tested using low-pressure air methods in accordance with ASTM C828.

6.0 CONSTRUCTION

6.1 Construction Sequencing and Programming

All the necessary studies and assessments shall be completed prior to commencing any PB construction Works.

The construction sequence shall involve:

1) Pre-construction planning, environmental assessments, and public relation initiatives/consultations;
2) Project sign off by all stakeholders;
3) Excavation/identification of the reception and insertion chambers, as well as any access chambers required for service disconnection or utilities crossing;
4) Disconnection, and if necessary by-passing flow pumping, of all laterals from the pipe to be replaced;
5) Setting up controls and any auxiliary equipment;
6) Lowering PB equipment (winch and cables, hydraulic pulling unit and cable, or rigid pulling rods) into the exit chamber;
7) Setting up any electronic recording equipment required (if applicable);
8) Setting up drill string and attaching bursting head at exit chamber;
9) Pulling bursting head and replacement pipe through to exit chamber;

10) Pipe Testing & Inspection;

11) Reconnecting of all laterals;

12) Removing Bursting equipment;

13) Restoring site to pre-construction condition or better;

14) Project completion.

7.0 REFERENCES

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