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Research needs for on-line pipeline replacement techniques

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Abstract

This paper presents suggested research needs associated with on-line pipeline replacement techniques, such as pipe bursting and pipe splitting. These research needs were compiled prior to, and then debated at, a workshop involving both academia and industry. The aim of the workshop was to assess whether the suggested needs were accurately stated, whether there were additions to make, and most importantly to attach a priority to the research needs. This was achieved by a process of debates and subsequent voting. The areas considered to be most important for research are highlighted in paper. It is concluded that although there has been extensive research into some of the more common types of on-line replacement techniques, for example pipe bursting, there is still a need for further research. The priority research identified from the workshop are in the areas of decision making tools, improved information on safe distances to adjacent utilities and techniques for minimising open excavation when disconnecting and reconnecting laterals.

Keywords: Trenchless technology; On-line replacement techniques; Research needs

1. Introduction

On-line pipeline replacement techniques have been developed to remove an existing utility, such as gravity sewers, pressurised water and gas pipes and cables, and simultaneously replace it. The relative advantages of replacement techniques over conventional trenching methods are claimed to be faster installation, minimal disturbance to the environment, traffic, living and work areas, utilities, pavements, landscaping and existing structures, and cost savings. On-line pipeline replacement techniques are normally used in the following situations:

- The existing pipe is so badly deteriorated that rehabilitation by other methods is not feasible.
- The disruption caused by trenching is a concern.
- Long straight lengths of pipe with minimal lateral connections.

The research needs for on-line replacement methods have been grouped into the following categories for this paper:

- generic issues;
- pipe bursting;
- pipe splitting;
- pipes eating and replacement;
- pipe reaming with a directional drilling machine;
- pipe ejection/extraction (including lead pipe extraction and replacement); and
- other techniques
  - control line and grade system (CLG system) and
  - implosion (pipe crushing).

Each of these techniques is briefly described in the paper and relevant literature identified.

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A workshop entitled 'On-line Pipeline Replacement Techniques' was held on 4th November 2004 at the University of Birmingham, with invited participants from industry and academia. 23 people attended the workshop comprising six from academia/research organisations, nine from consultants, five from manufacturers/contractors and three from client/owner organisations.

The suggested research needs prepared prior to the workshop were discussed by the delegates in groups. Delegates were requested to priorities the research issues, i.e. to establish their relative importance, with *eight* 'General' votes: *five* for Generic Issues, Pipe Bursting and Pipe Splitting, and *three* for Pipe Eating and Replacement, Pipe Reaming with a Directional Drilling Machine, Pipe Ejection and Extraction and Other Techniques. Delegates were then also allowed *two* additional votes ('Priority' votes) which they could assign to any of the research needs across all the areas of pipe replacement, thus prioritising the important overall research needs. The outcomes of this voting exercise are provided in the paper. The tables have two columns one containing the 'General' votes and one for the 'Priority' votes. It should be noted that some delegates did not use all their votes and hence there are some differences in the totals.

2. Generic issues

The generic issues associated with on-line pipeline replacement techniques are presented in this section, beginning with the advantages and disadvantages of these techniques as highlighted in the literature and then outlining the research needs in this area.

2.1. Advantages

- Reduces disruption to traffic and businesses compared to open excavation (Hill and Esposito, 2002).
- Cleaning of the existing pipe is not necessary (APEG, 2003).
- Provides full structural rehabilitation of the existing pipeline (APEG, 2003).
- Pipe capacity can be maintained or increased (CSIRO, 2004).
- These techniques are most successful when there are long runs with few connections (APEG, 2003).

2.2. Disadvantages

- All appurtenances must be excavated before these techniques are used and reconnected to the new pipeline afterwards, although only local excavations are required (APEG, 2003).
- Distance to adjacent services must be checked to avoid damage that may occur due to ground displacements (Transco, 1997).

Important literature on on-line pipeline replacement techniques includes APEG (2003), ASTT (2004), Atkinson (2000), CSIRO (2004), Kramer et al. (1992), Rogers (1995a,b), Simicevic and Sterling (2001), Sims (2001) and Stevens (2004).

2.3. Suggested research needs

Table 1 provides a list of the research needs as discussed and debated prior to, and during, the workshop session. The table also provides the results of the voting that took place during the workshop. It can be seen that the three primary research needs are: the need for a best practice guide or knowledge based system that would help to inform clients and increase confidence in these techniques; to develop methods that reduce or remove the need for open excavations for disconnecting and reconnecting laterals; and to improve the understanding

Table 1
Suggested generic research needs together with the workshop voting

Research need	Number of votes	
	General	Priority
• Understanding the information on which the decision making process is made (e.g. which technique to use) would help to inform clients and increase confidence in usage. This could result in a best practice guide (or Knowledge Based System (KBS) tool)	15	11
• Reducing the need for open excavation to disconnecting or reconnecting laterals, i.e. improved methods of reconnecting laterals	15	10
• Further research into damage prevention of nearby utilities and surface road pavement structure and comparison with trenching (particularly upsizing and shallow service replacement)	12	9
• Environmental and economic benefits, relative to other on-line replacement techniques (whole life costs)	7	1
• Forward planning for future pipeline replacement	6	3
• Long-term effects of damage to PE and other plastic pipes, especially when in contact with rigid pipe shards, and whether there are advantages in using different types, or grades, of plastic for different replacement operations	3	
• Types of head (comparison) – decision matrix	1	
• Durability of the new pipe due to installation conditions, altered surroundings, joints		
• Long-term performance of the installation and adjacent pipes (collection of case histories)		
• Soil conditions (soft/stiff)		