PIPE BURSTING ALLOWS INSTALLING NEW HIGHER-POWER CABLES WITH MINIMAL EXCAVATION

Tom Zhao, EPRI
Brian Hunter, TT Technologies
Adam Brecklin, ATC
Jay Williams, PDC

ICC Subcommittee C - Cable Systems

April 9, 2019

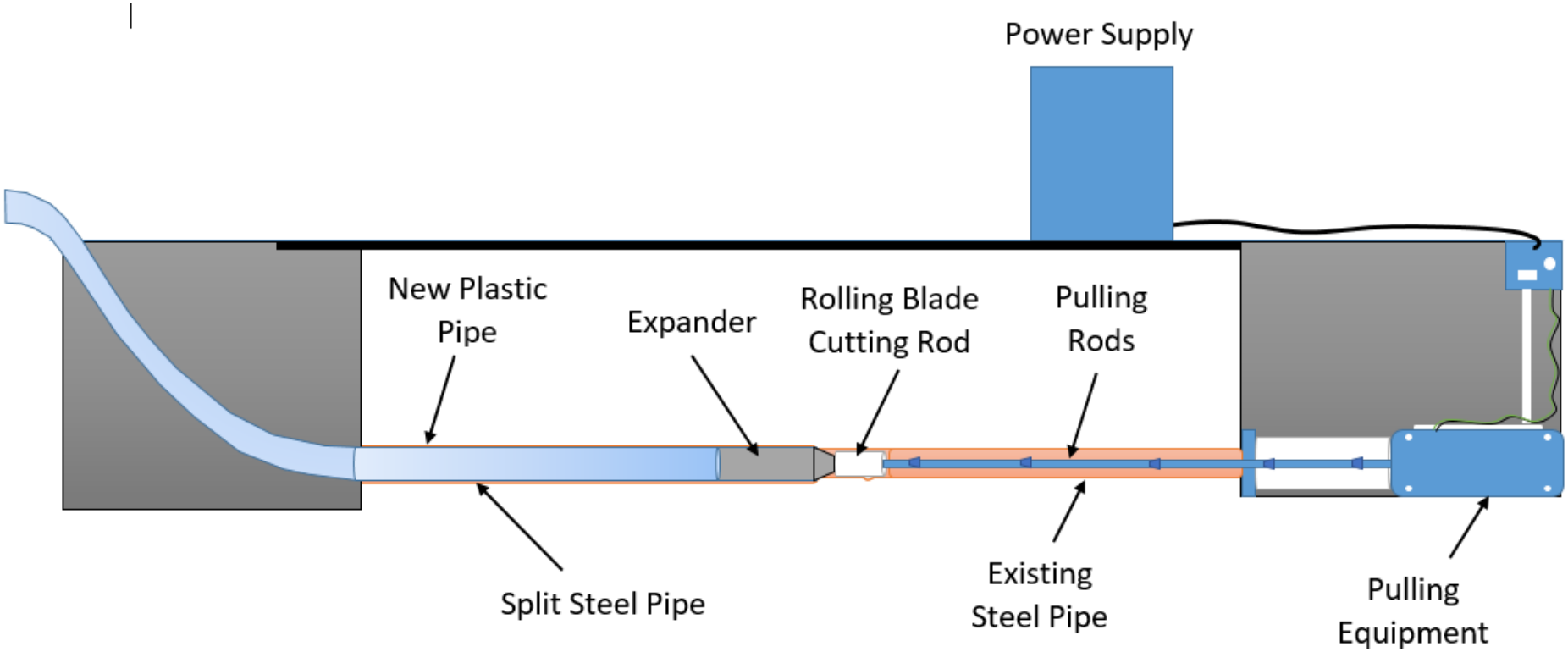
Pipe-bursting Project

- Major contributors to the pipe-bursting evaluation:
  - Tom Zhao, EPRI, Project Manager
  - Jay Williams, PDC, Project Engineer
  - Brian Hunter, TT-Technologies, provided pipe bursting equipment, performed tests on pipe sections w/ repair barrels.
  - Ray Markunas, PSE&G, provided 8” & 10” pipe-type cable pipe sections; Tom Villani and Jade Wong, ConEd, provided repair barrels; both for laboratory testing at TT-Technologies
  - Ron Knapwurst and Adam Brecklin, ATC, hosted field demonstration at ATC site
  - Tom Marti, Underground Solutions, provided fused PVC pipe
  - Intercon Construction, performed field work for demonstration at ATC

Why are electric utilities interested in pipe bursting? - Background

- More than 4000 miles of transmission pipe-type cables in service for 40-80 years.
- Although these lines provide excellent service throughout the years, pipe corrosion and fluid leaks exist. Some steel pipes may not be maintainable or repairable, causing potential environmental issues.
- Demands to increase power transfer of the existing cable line alignments are increasing or desirable.

Why are electric utilities interested in pipe bursting? - Technology



- Remove existing paper-insulated cables and fluid
- Split/burst the pipe
- Expand the pipe diameter
- Install a larger-diameter plastic or steel pipe
- Install new cables in the larger pipe

Benefits:

- By using the same cable alignments, far less permitting time requirements and lower project costs than installing a new trench/circuit
- Reduced chance of fluid leaks in cable pipe
- Increased power transfer capacity by using cables of greater conductor diameters
- Potential of using extruded-dielectric cables with optimized design
- Minimal excavation needed – just pits every 1000-2000 feet for bursting equipment although intermediate pits may be needed depending upon bends

History of Pipe Bursting

- 1977 – United Kingdom – King Report outlined the need to replace thousands of miles of defective gas main. Pipe bursting process was patented by British Gas. 1988 in US
- 1980s – Equipment developed for pipe bursting – originally with the pneumatic mole
- 1991 – Pneumatic Pipe bursting started in the United States – primarily for water and sewer
- Late 1990s – Static Pipe bursting became popular – Non-fracturable pipe could be split
- 2017 – Power Industry embraces the Static Pipe bursting process for replacing steel pipe

Definition of Pipe Bursting / Pipe Splitting

- Pipe Bursting / Pipe Splitting is the process of replacing underground host pipe material by fragmenting or splitting the existing host pipe and installing a new pipe of equal or larger diameter, all in the same trench line.
- It is used as an open-cut alternative

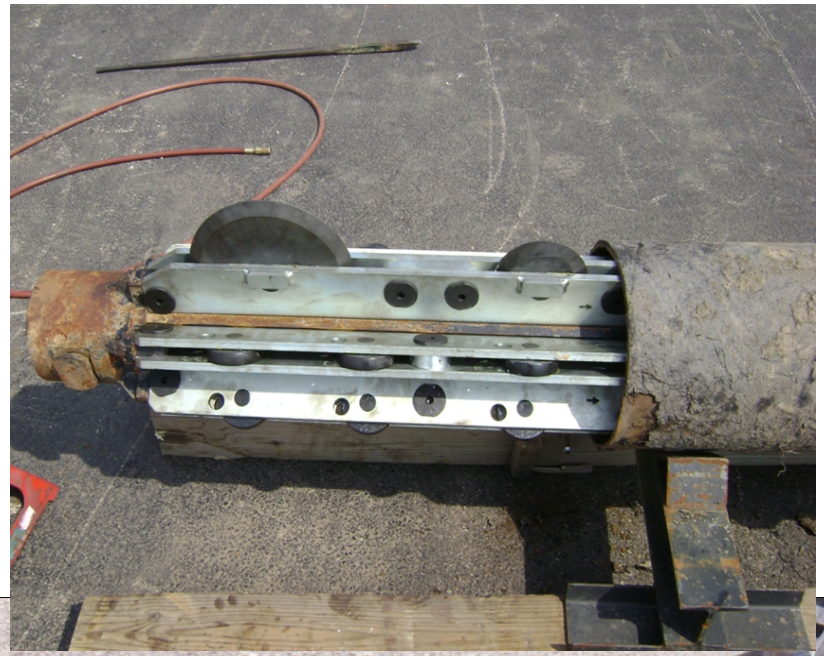
Static Pipe Bursting

Launching and Receiving Operations

Bursting rods

- The bursting rods are 32 inches long and connect to each other with a ball-and-socket type connection. The rods are pushed the full length of the existing steel pipe, connected to the pulling head, and pulled back to the hydraulic puller.

Specialized Tooling



Assembly pulled through pipe

Three splitting wheels, a centering device, and an expander are shown prior to entry into cable pipe (on right, not shown)

Pulling assembly in pit

Note racks of bursting rods

The pipe is REALLY expanded

This photo shows an initial laboratory demonstration conducted on pipe, chill ring, and leak repair “barrels” provided by interested utilities.

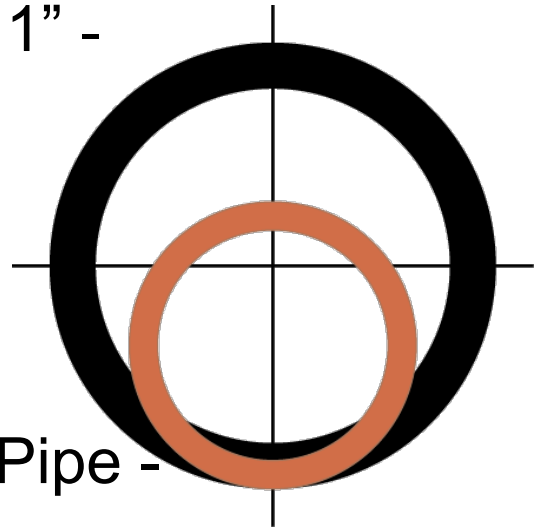
Beginning of re-piping process

Pipe insertion resembles an HDD

- The full section length of replacement pipe should be made-up prior to beginning insertion.
- A narrow trench is adequate.
- Trench length is determined by the allowable bending radius of the replacement pipe.

Burst Depth of Cover

8” Pipe Expander
Approx. 11” -



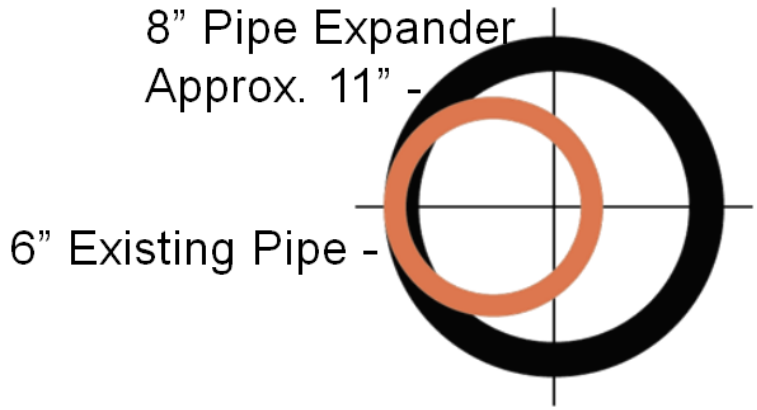
6” Existing Pipe -

Rule of Thumb:
10 x upsize difference in diameters

- 6” to 8” requires an 11” O.D. expander
- The differential is 5” (11” expander – 6” pipe)
- 5” x 10 = 50” or 4’-2” min. depth to prevent “heaving”

Recommended Separation from Other Buried Utilities

Recommended Separation from Surrounding Parallel Utilities



Rule of Thumb:
5 x upsize difference in diameters

- 6” to 8” requires an 11” O.D. expander
- The differential is 5” (11” expander – 6” ID pipe)
- 5” x 5 = 25” or 2’1” min. separation to prevent damaging surrounding utilities
- Minimum 16” separation

The Challenge:

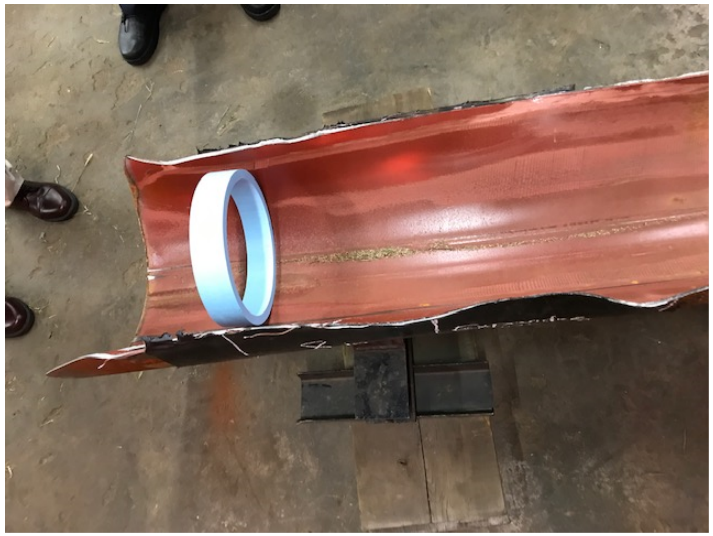
- Replace 6”, 8”, or 10” steel pipe with a new larger plastic pipe (1-2 upsizes)
- Typical installation of steel pipe was installed in the 1950s – 1970s in 45’ sections – welded at the chill rings – possible repair sleeves
- Steel pipe is assumed to conform to ASTM A-523 and 0.25” wall thickness
- Minimum depth to the top of the pipe is 36”
- Backfill is thermal sand
- Separation from other pipes/utilities is minimum 24”
- Average length of pipe is 2000’ from manhole to manhole

The Plan:

- We knew we could split the 0.25” steel – this had been done already in other markets (sewer, water, gas).
- We didn’t know about chill rings and repair sleeves.
- We weren’t sure about the distance that could be burst because of the type of backfill and the chill rings every 45’ and the possibility of repair sleeves.
- Set up a factory test – sample pieces of pipe – weld two pieces of pipe together along with repair sleeve.

The Laboratory Test:

- Used typical 8” and 10” steel pipe with chill rings and repair sleeves, provided by pipe-type cable users.
- Welded at factory and set up test.
- The tests are successful. The pipe and repair sleeve opened up as shown.



Demonstration Project, Pipe Splitting Spare Pipe

- Two spare 6-inch diameter cable pipes, installed in 1987
- Pipes located in abandoned manufacturing property in Madison, WI
- Depth of spare pipes range from 3-6 ft
- Relatively congestion-free installation
  - Distribution duct bank 6 ft away

Empty HPFF Pipes, 2 - 6-5/8" OD

Ideal Location for Pilot Demonstration

Splitting Plan

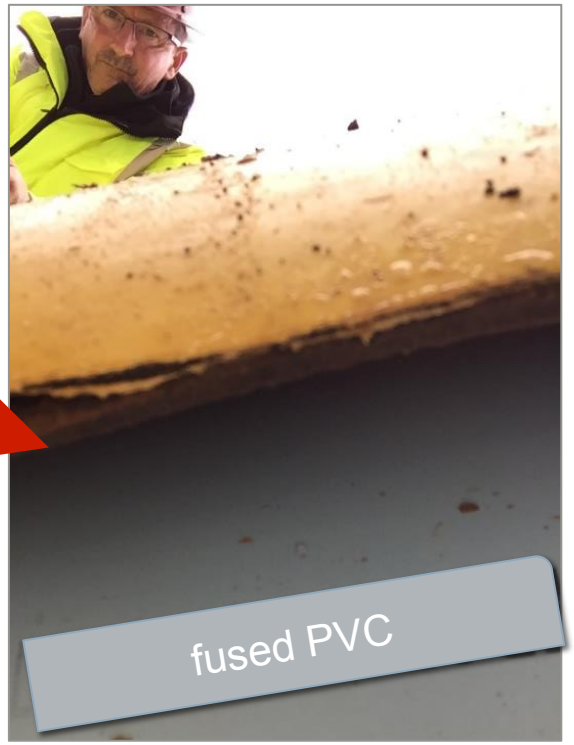
- Two pipe splits of 1000’
  - 1st run to go from 6” pipe to 8” fused PVC pipe (1 pipe size increase)
  - 2nd run to go from 6” pipe to 10” fused PVC pipe (2 pipe size increase)
- Project layout consisted of
  - Launch and pulling pits
  - Observation pits to witness the splitting action in the ground

Pulling Pit

Launch Pit

Cutting and Bursting Apparatus

Inspection Pit



Demonstration Project Conclusions

- Successful 1000-ft test runs for both a single upsizing (6” to 8”) and double upsizing (6” to 10”)
- Expander opened steel pipe, and fused PVC pipe arrived undamaged
- Observed 1/2” of ground heave on 6” to 10” run
- Considering pipe splitting as an option for a few select pipe-type cable replacement projects in the future

Cable System Applications

- As described in the previous slides, the pipe-bursting process and insertion of new, larger pipe have been successfully demonstrated for trial 1000-ft lengths of pipe-type cable pipes.
- Longer lengths considered feasible, perhaps even the 1500-2000-ft manhole-manhole lengths common on pipe-type cables in the 1950s-1970s
- If the entire length cannot be burst/replaced, an intermediate pit would be installed, the bursting equipment placed there, and the pipe split/replaced in both directions with a piece-out tying the two sections together. This may also be needed at sharp-radius bends.
- Note that the minimum bending radius of the bursting rods is greater than that of either fused PVC or steel replacement pipes.

Cable Installation

- Replacement with new cable would then be done in conventional fashion for pipe-type cables---i.e. individual reels, the three cables gathered together with a pulling head and pulled as one bundle. This helps provide the long manhole-to-manhole lengths on the original pipe-type cable system.
- Use of conventional XLPE cables can be considered, although optimized designs are being developed to provide easier installation and higher capacity in an fused PVC or steel pipe.
- The split steel pipe would reduce external magnetic field above ground and could serve as a ground continuity conductor. Or, a GCC could be installed along with the cables.

Cable Installation (Cont'd)

- Engineering design prior to start of installation would address items such as sheath bonding systems, whether existing manholes would be large enough for extruded-dielectric cable splices and supports/racking, whether splice casings would be provided as done for the pipe-type cable systems, how riser sections would be accommodated, etc.
- It is feasible to install steel replacement pipe in a larger size that would permit either Extruded Pipe-type cable or new pipe-type cable to be installed with LPP insulation and a large conductor giving a larger power-transfer capacity than the original. The LPP-insulated cable would make use of existing riser pipes, terminations, and pressurizing equipment.

Ampacity Studies

- Ampacity studies were performed for a variety of conditions.
- Since one of the purpose of using this pipe-bursting technique is to replace the existing pipe with an upsized pipe (e.g., 6” to 8”, and 8” to 10”, etc.), cable with a significant large conductor diameter could then be used, resulting in much higher ampacity using the same cable alignments.
- Further ampacity increases could be realized with reduced insulation wall and even larger conductors, insulated strands, high-efficiency cable designs, etc.

Abbreviated Summary of Steps in Pipe-bursting, Replacement Pipe, New Cable

- Identify circuit, verify plan and profile, perform detailed subsurface utility engineering, perform design calculations; verify suitability.
- Perform necessary excavations at entry and exit manholes and intermediate points such as sharp bends.
- Remove fluid and cable, clean pipe; extend manholes if needed; make necessary modifications at terminal ends.
- Burst pipe while simultaneously installing replacement pipe. Tie-in short sections if needed at sharp bends.
- Swab/mandrel replacement pipe to assure suitability
- Install, splice, terminate replacement cable.

Observations

- The replacement pipe should be pre-assembled prior to start of the pipe bursting operations----therefore the full 1000-2000 ft length or multiple “strings” should be welded prior to the start of the bursting/replacement operation just as would be done for an HDD project.
- The pipe-bursting and replacement approach can work with distribution cable ductbanks as well – but be careful of damage to adjacent ducts and utilities. Subsurface conditions are usually not as well known as for transmission cable circuits.

What is Next?

- The pipe-bursting and pipe replacement have been successfully demonstrated on 1000-ft essentially straight sections of steel cable pipe with chill rings.
- The procedure is considered applicable for lines that do not have concerns of damaging nearby utilities or bend radius less than about 160 ft – a value determined by the bending radius of the bursting rod string. We are working to reduce that number.
- Additional demonstrations should be performed to address issues for typical city-street installations having nearby utilities, sharp radius bends, etc. Excavation might be required for lines with bends of less than about 160 ft.
- Studies are needed to address these potential limitations.

Questions?

Questions are welcome on the research approach, pipe bursting concept, field demonstration, or potential cable applications