

Tunnel Communication

Presented by Joyce Lee

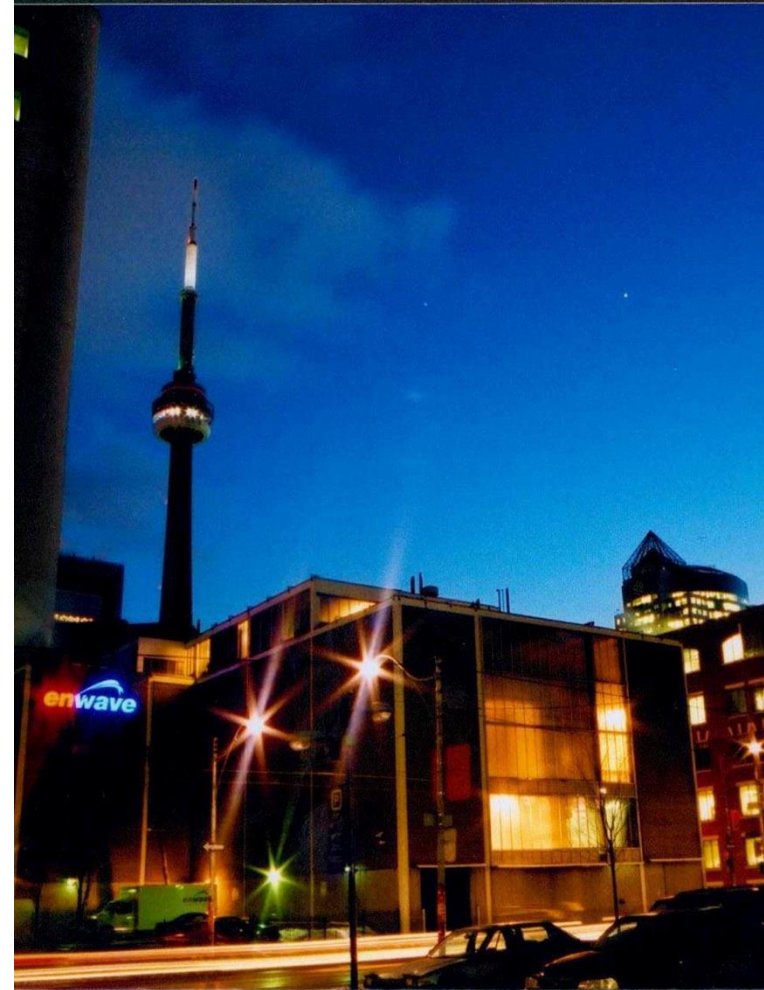
VP., Business Research & Analysis

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Presentation Outline

- Overview of Enwave Toronto
- Description of Enwave's Tunnel System
- Tunnel Communication Technical Details
 - System Description
 - Reason of Choice
 - Maintenance Requirements
 - Challenges/Pitfalls
- Tunnel Communication Protocol
- Tunnel Rescue Procedure



Enwave Overview



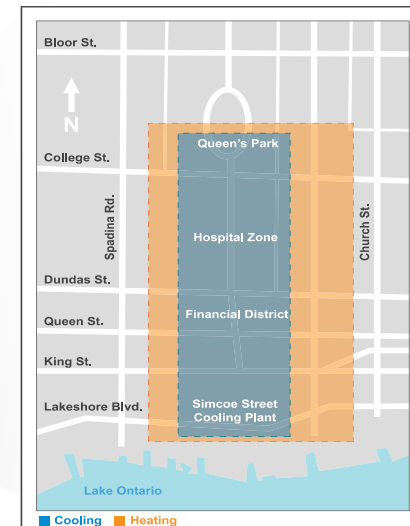
Corporate Overview

- One of the largest district energy companies in North America, providing innovative, sustainable energy services to a substantial portion of Toronto's downtown core
- Operates three divisions:
 - **District Heating:** network connects over 150 buildings to three modernized steam plants
 - **District Cooling:** network connects over 60 buildings to a world renowned cooling facility
 - **Energy Services:** supplies heating, cooling and energy management services to businesses and institutions
- Designation and rights of a utility under the *Public Utilities Act* (Ontario)

Enwave Operations



Toronto System



Facilities and Distribution Network



Queen's Park Steam Plant

- Re-commissioned 1995
- Peaking plant during heating season (210,000 PPH)



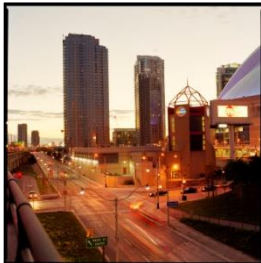
Walton Street Steam Plant

- Commissioned 1972
- Provides base load (875,000 PPH)



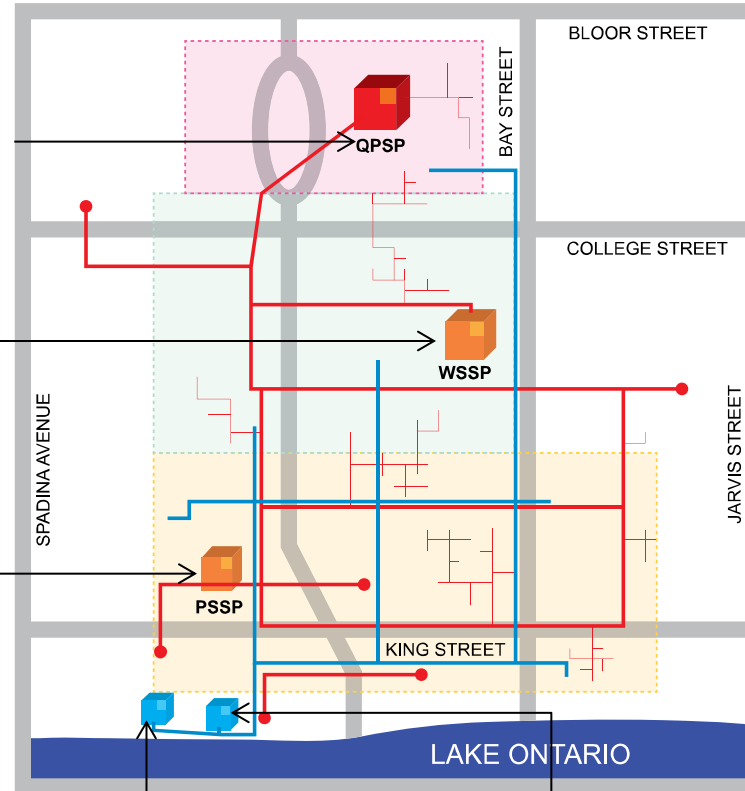
Pearl Street Steam Plant

- Commissioned 1964
- Peaking plant during heating season (800,000 PPH)



John Street Pumping Station

- Commissioned 2004
- Located at the John Street Pumping Station
- 18 x 2,400 Ton HX pairs



- QPSP** Queen's Park Steam Plant
- WSSP** Walton St. Steam Plant
- PSSP** Pearl St. Steam Plant
- Heat Distribution System
- Cooling Distribution System
- Queen's Park
- Hospital Zone
- Financial District



Simcoe Street Cooling Plant

- Commissioned 1997
- Located at MTCC South Building

Distribution Network

- 142 Steam Manholes (Multi/single level (15 ft – 100 ft)
- 34 CHW Manholes (Multi/single level (15 ft – 100 ft)
- 22 Tunnels (Multi/single level (15 ft – 100 ft)
- 40 km of steam distribution piping
- 10 km of chilled water tunnel

Typical Equipment in Manholes/Tunnels:

- Dual Trap sets
- Sump pit
- Sump pump & float
- Isolation Valves
- Expansion Joints
- Electrical/Breaker Panel
- Flash Tank
- Discharge to sewer piping
- Ducting
- Communication cable and repeaters
- Tunnel lighting

Enwave Standard Trap-line



Flash Tank



Isolation Valve



Sump Pit/Pump/Float



Electric panel





Enwave Customers

Steam Whistle Brewery



Toronto General Hospital



Queen's Park



Royal Bank Plaza



Princess Margaret Hospital



MTCC



ACC



TD Centre

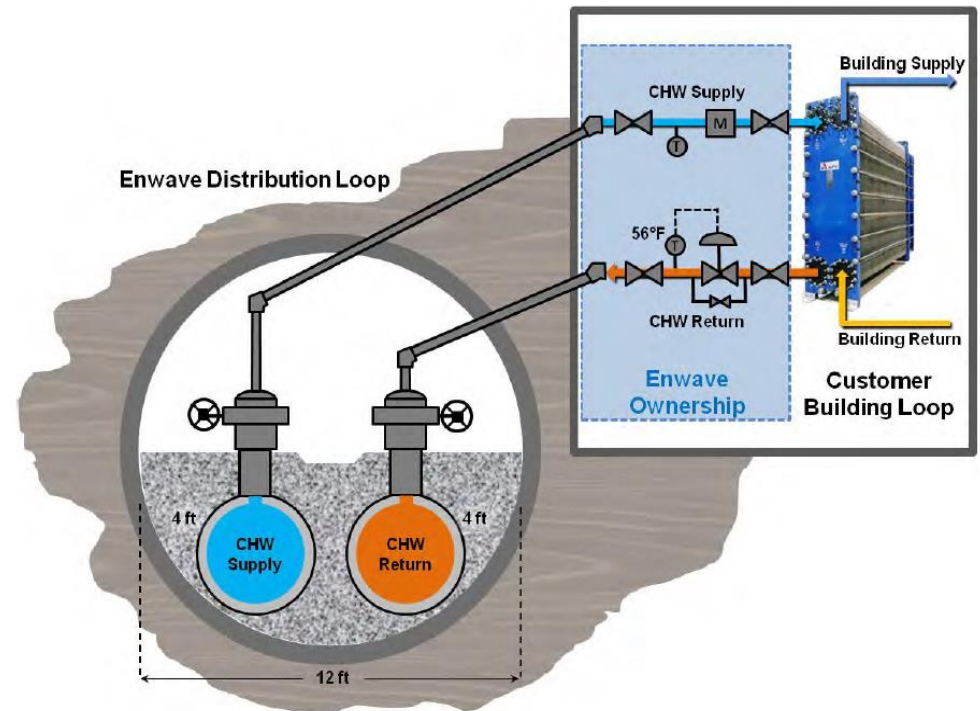


Description of Enwave's Tunnels



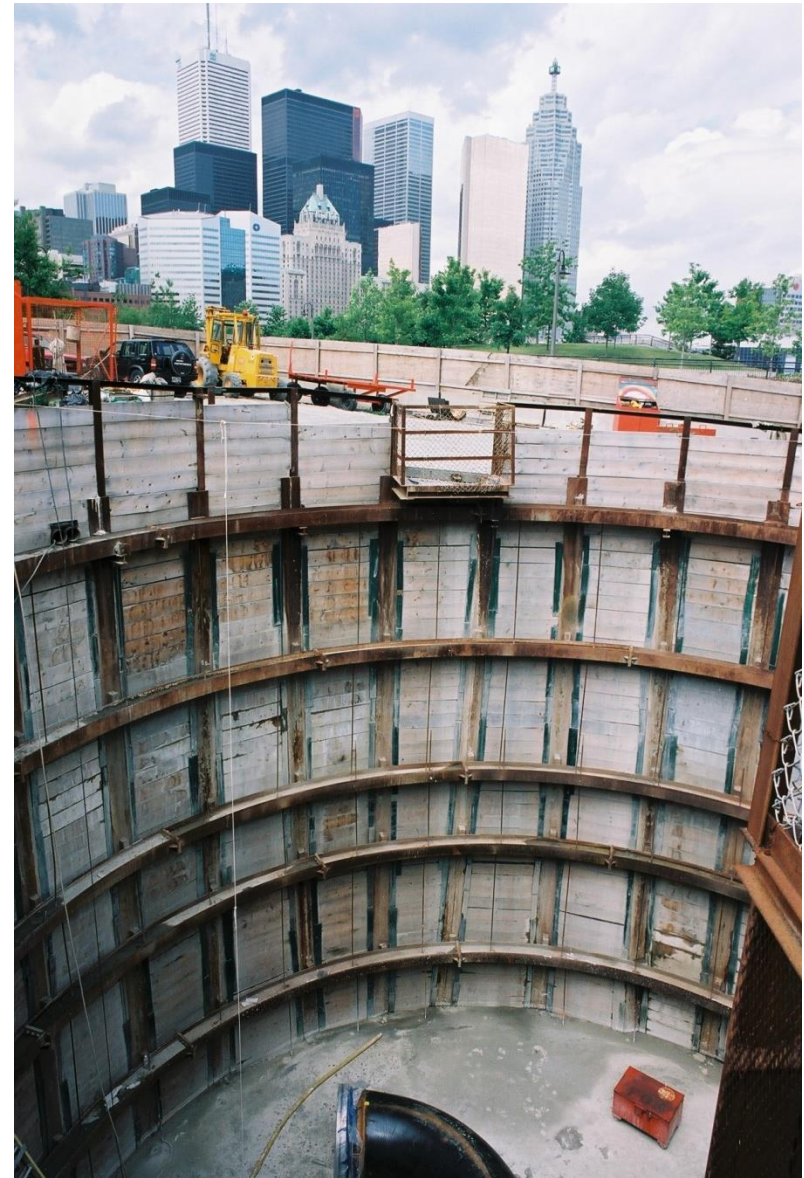
Chilled Water Tunnel

- 48" steel chilled water supply and return lines are lined with concrete and encased in concrete
- Isolation valves are provided for each building connection to the distribution system.
- Construction performed between 2004 and 2007.

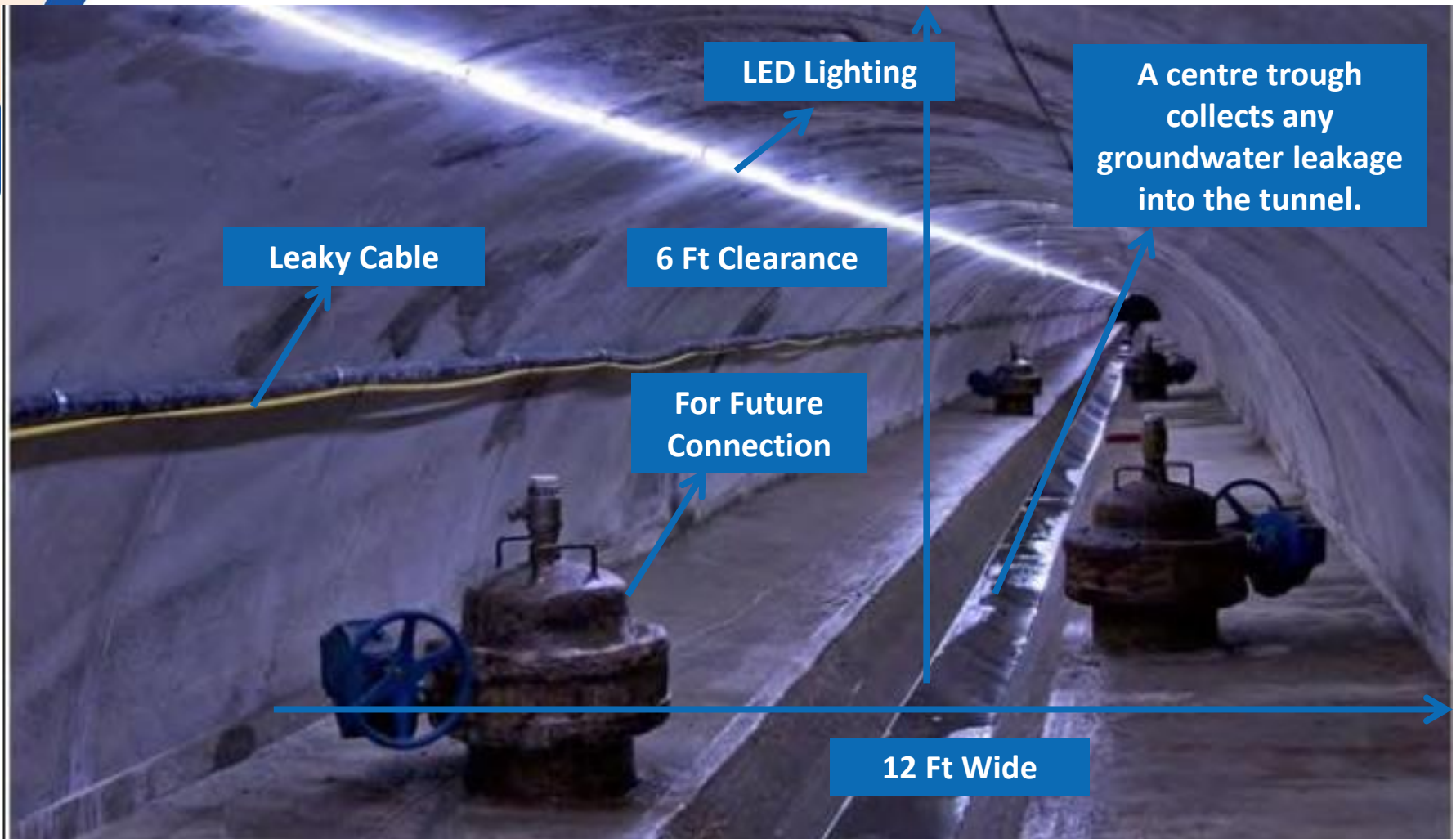


Chilled Water Tunnel

- To avoid the numerous interferences below the streets in downtown Toronto, the tunnels were constructed at much greater depths.
- Southern end is 85 ft deep; northern end 140 ft deep.
- Shafts were sunk at strategic locations in the city, and then tunnels were bored in the bedrock to connect the shafts.
- A concrete lining was installed in each tunnel section. Then the piping, valves, and other infrastructure were installed after.



Chilled Water Tunnel



Typical Chilled Water Distribution Tunnel



Typical Distribution Tunnel Junction Section

Chilled Water Tunnel



Typical Distribution Tunnel Section with Elevated Pipes

Challenges Working in Tunnel

- Environmental conditions:
 - Slippery due to groundwater seepage
 - Dark
 - Deep
 - Long tunnels
 - Lack of high voltage power supply
 - High temperature in certain sections
 - High humidity in certain sections
- Perceived as confined spaces
- Ventilation system for the tunnels required to be sized to provide two complete air changes in the tunnels every hour.
- Lighting, communications, temporary power, specialty tools, personal protection and rescue equipment required to withstand the above conditions.

Tunnel Communication System



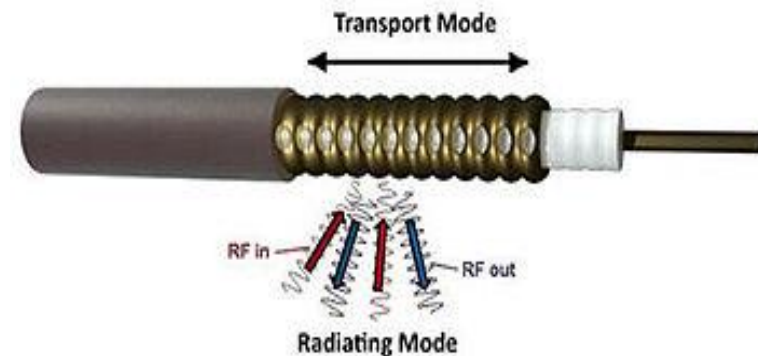
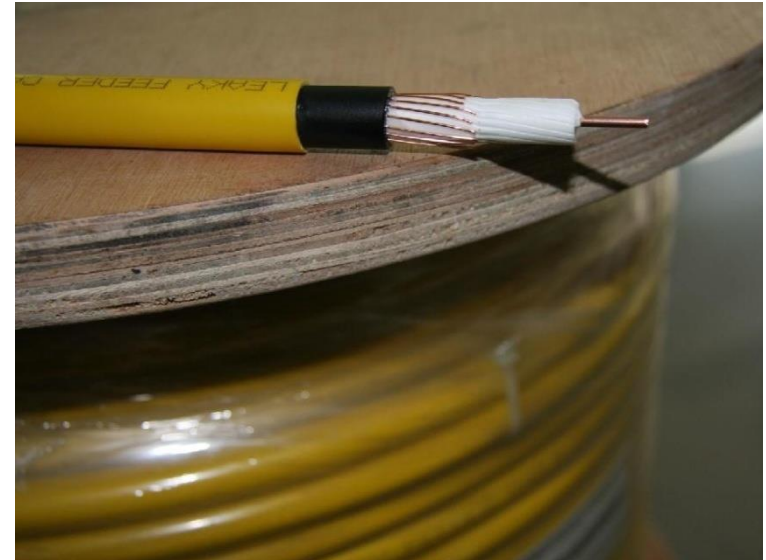
Tunnel Communication Technical Details

- System Description
- Reason of Choice
- Maintenance Requirements
- System Pitfalls



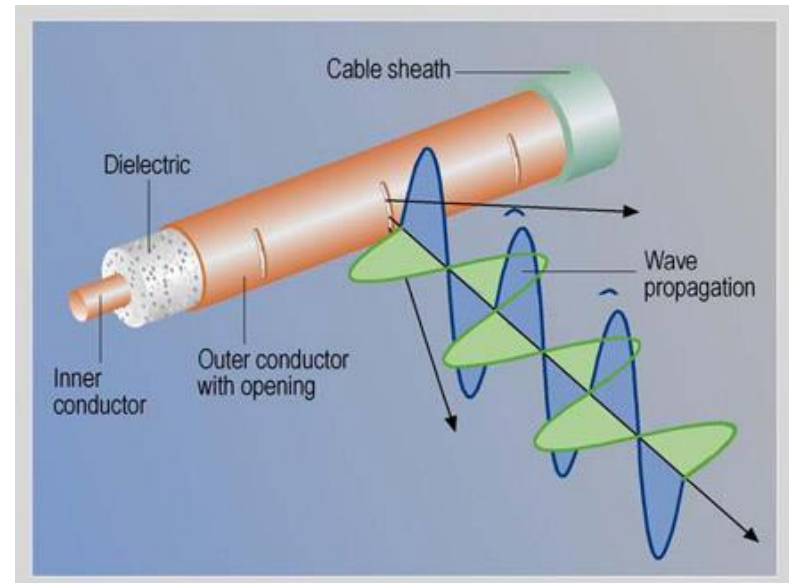
System Description

- Enwave installed the leaky feeder cables in all chilled water tunnels.
- The leaky underground coaxial cable system was used since 2009 to allow the workers in the tunnel to communicate with the safety attendee in the surface.
- The leaky cables enhances the radio frequency transmission by design.



System Description

- The leaky cable is a coaxial cable that has small sections of its copper shielding stripped away to allow the radio frequency signals to escape.
- Leaky feeders, act as an extended antenna to the surface. The cable is used in remote places where the depth of our tunnel is an issue for communication via regular radio wave band strength.
- Leaky cables are also able to pick up the transmissions of mobile or portable transmitters, thus permitting two-way radio communications with other units connected to the cable.



System Description

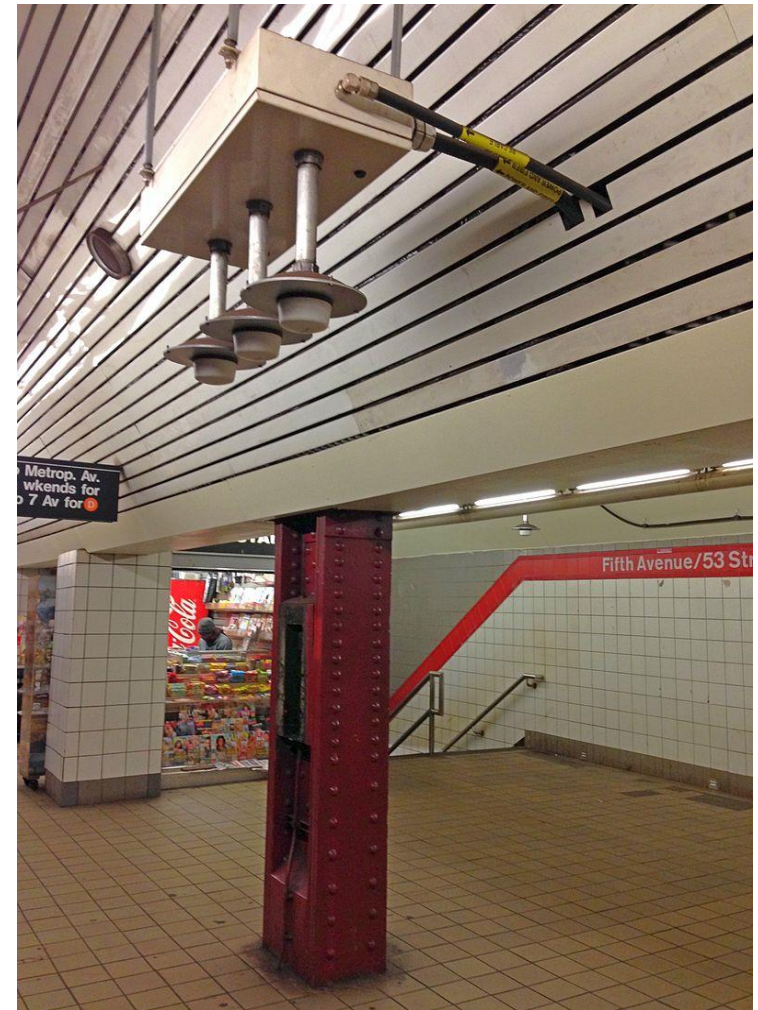
- Due to the depths of the Enwave tunnel system it would be near impossible for the workers to communicate to the attendee without amplifying the radio frequency (RF) signal.
- Repeaters are required every 350 to 500 meters depending on the power of the booster.



Radio Base Unit and Repeater

Reason of Choice

- Enwave chose leaky cable over the other options because it was the only available technology at the time for our application.
- Other option:
- Fiber DAS (Distributed Antenna System)
 - It carries more than just radio e.g. cellular as well as telematics information from the equipment to set alarms in case of failure or breakdown.
 - The New York subway system replaced the leaky feeder system for fibre DAS allowing them to have WIFI, Cellular, Radio and Telemetry for their trains.



The RF node with three antennas at the platform and another antenna near the stairs on the far side.
(Courtesy of Wikipedia)

Operating and Maintenance Requirements

- Require two radio frequency licenses for both underground and surface communications (typically VHF or UHF)
- Maintenance on the system will be dependent on the type of cable that is used and the environment that it is used in.
- The cable can last a very long time in the right condition. However if there are weak points like unprotected connectors, this can allow for moisture to enter the cable and corrode from the inside reducing the power of RF (Radio Frequency) to the point where communications can be lost.
- Enwave checks the Leaky Cable System which includes the hubs and radios semi-annually .
- Typical failures or breakdown on Enwave's communication system: Corrosion on the cable, failure in the inline boosters, collapsed cable, bad connectors

Pitfalls

- Boosters and connectors could fail if they are not properly shielded leading to corrosion.
- There is dead spot in our tunnel system - Bay and King
- Therefore, repeaters and booster units are required to be installed at various spots.
- The communication between the workers in the tunnel and the steam plants must go through the attendees on the surface.

Tunnel Communication Protocol

Tunnel Communication Protocol

- Contact the attendee by two-way radio. Continuous radio contact will be in effect about every 10 minutes.
- Specify the designated tunnel space when entering to perform the site inspection.
- Specify the estimated time duration in tunnel.
- Describe the work to be accomplished.
- Ensure rescue is in place, notify the Steam Plants.
- Notify attendee by two-way radio once work is completed and the area exited.



Tunnel Rescue Procedure

Tunnel Rescue Procedure

- **If a threat to safety or health is observed or perceived, the workers shall immediately exit the tunnel by the nearest means of egress.**
- The workers will immediately communicate to the attendee that they are exiting the tunnel.
- Workers are not to re-enter the tunnel until the hazard is identified and evaluated
- Secure jobsite.
- Contact the Chief Engineer or his designate.



Thank you for listening!

