

10-40 Code 4, Steam Leak-- Do You Know the Hazards?

by Battalion Chief Frank C. Montagna

You are working in downtown Manhattan and receive an alarm for a reported explosion in the street. While responding, you consider the possibilities. It could be an electrical manhole or a transformer vault. It could be the gas tank of a car or truck. It could be the result of a natural gas leak and, reluctantly, you admit that it could be terrorism.

The dispatcher reports that numerous calls have been received and, as you approach the scene, you hear a loud, roaring noise and see a white plume of smoke pushing out from behind a building. As you round the corner, you realize that what you are seeing is high-pressure steam boiling out of a gaping hole in the ground and rising in a white, turbulent plume. The noise is deafening and though you hear something come over the radio, you cannot make out what was said.

You are on the first-due truck at a steam main break. A section of the street has been blown away by the underground break and scalding steam is roaring out of the void. What do you do? What are the hazards? What help do you need? Are there victims in need of assistance? Can you help them?

These incidents occur infrequently and do not occur in all parts of the City. As a result, most Firefighters have never responded to such an incident and might not be sure of the correct answers to these questions. This article will explain the process of generating and delivering steam, how it is used, where it is found, the hazards associated with it and how to safely respond to a steam incident.

The Con Edison steam system

Con Edison maintains more than 100 miles of buried steam pipe and supplies high-pressure steam to nearly 2000 buildings. More than half of Con Ed's steam is produced by co-generation, an environmentally efficient process where steam is used to turn turbines that generate electricity. It then is delivered through the underground network to Manhattan, where it is used in buildings for heating and hot water. Steam also is used for sterilization in hospitals and for cooking in restaurants. Additionally, steam pipes are positioned under some sidewalks to melt snow and ice.

Con Edison steam is produced by giant boilers--typically fueled by natural gas or oil--in generating plants found in Manhattan, Brooklyn and Queens. The steam is produced at pressures reaching nearly 2000 psi at 900 degrees Fahrenheit and is

pipied, underground, from the generating plants to where it is used in Manhattan from below 96th Street to the Battery. The high-pressure steam found under the streets in Manhattan is typically at 170 psi and 350 degrees Fahrenheit. While this is lower than generation pressure and temperature, it still can be extremely dangerous if there is a major rupture. Steam pipes run under both the streets and sidewalks and manholes give utility workers access to the underground steam system.

Why pipes rupture

Seeing steam vapor rising in the street is not unusual in downtown Manhattan. Often, it is not a steam leak, but instead is the result of water from water lines, sewer drains and other sources contacting the hot steam pipes and boiling off. Occasionally, however, steam pipes do fail. For example, when an unusually large amount of cold water--say from a broken water main--contacts a hot, high-pressure steam pipe, physical stresses can be created that the pipe cannot handle and, as a result, it may burst. This failure releases the high-pressure steam underground.

Additionally, if the steam in a section of pipe cools, water condensate may form inside the pipe. Most of this water is properly removed and does not result in any problems. Sometimes, however, it will be pushed along the pipe at high speed by the steam until it encounters a bend in the pipe. The water slug will slam into the bend with great force and can cause the pipe to fail.

Con Edison steam workers refer to steam pipe failures as **high-energy line breaks (HELB)**. They can occur inside a power plant, out in the street or in a building supplied with steam. If not responded to correctly, a HELB can have deadly consequences.

HELB in a power plant

There are many levels of grated ramps and platforms in a generating plant. Escaping steam quickly rises through the gratings to the upper levels of the power plant, filling it with steam, obscuring vision and making movement around the plant hazardous. A high-pressure steam leak is invisible near the source of the leak. As it cools, the steam starts to condense and it is this condensate that Firefighters see and identify as steam. At the pressures and temperatures developed in a generating plant, a pinhole leak in a high-pressure steam pipe--though invisible near the source--is capable of cutting through a steel bolt like a hot knife through butter. (See photo #4.) On November 10, 1992, Captain Martin McTigue was badly burned and several other members of Rescue 4 were burned to a lesser degree by a steam leak at a Con Edison steam plant.

all photos by Battalion Chief Frank C. Montagna



Photo #1--High-energy line break (steam leak).



Photo #2--Steam manholes often are found in pairs, inserted into a concrete vault cover.



Photo #3--Vent stacks direct steam up and away from the roadway.



Photo #4--Bolt severed by high pressure.



Photo #5--Consult with the Con Edison White Hat before entering a steam-generating plant.



Photo #6--Steam room in a building supplied by Con Ed.

Other potentially deadly hazards found inside a power plant include high voltage (up to 345,000 volts), high-pressure natural gas lines, fuel oil and chemicals (acids and caustics). Additionally, flammable gases under pressure and compressed gas cylinders--including oxygen, acetylene and hydrogen--can be found at these locations. You also will encounter sumps filled with near-boiling water, heavy machinery and moving equipment.

HELB in the street

The pressure released in a HELB is high enough to cause an intact street to collapse or explode out as the high-pressure steam escapes from the ruptured pipe. The escaping high-pressure steam can hurl debris at 200 miles per hour, turning concrete, bricks, rock and manhole covers into deadly projectiles. It also can expose and damage underground high-voltage electric cables and gas mains.

High-pressure steam can obscure the vision of Firefighters and civilians, making driving hazardous for both. A collapsed street or a missing manhole cover may not be visible if it is within the steam plume and poses a danger to anyone walking in the area. Additionally, getting too close to the escaping steam can result in severe burns.

The deafening sound of escaping steam often renders radio and verbal communication ineffective in the vicinity of the break. Since many underground steam pipes are wrapped in insulation that contains asbestos, a burst pipe can result in an asbestos release over a large area. Asbestos can be contained in the vapor plume and is a health hazard to anyone who breathes it. It will contaminate bunker gear, equipment and vehicles, as well as buildings and any exposed civilians or Firefighters.

Steam leak inside building

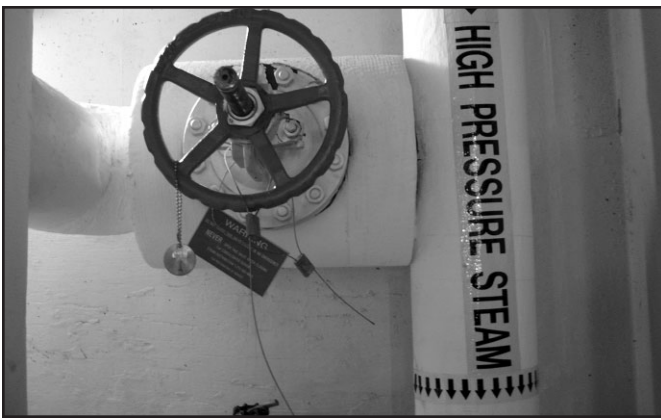
Steam incidents inside a building supplied by Con Edison steam range from minor to major. A minor incident, such as a leaking radiator, can be treated as any other steam emergency. A burst high-pressure pipe can be an entirely different matter. Inside supplied buildings, steam temperatures can be as high 350 degrees with pressures reaching 170 psi. A damaged steam riser quickly can fill a room with super-heated steam and in an enclosed area, oxygen may be displaced by the steam, creating an asphyxiation hazard.

Occupants of the building in the vicinity of a burst high-pressure steam pipe in an enclosed space might not have the opportunity to escape and rapidly could become fatalities. Additionally, the first-responding units may not be able to make entry into the affected room or area until the steam is shut off and the area vented.

General tactical considerations, HELB tactics

Generating plant leak--Never enter a Con Edison plant without an escort. Instead, respond to the designated muster site outside the plant, per AUC 338, Addendum 1.

- Look for and contact the Con Edison White Hat. He will provide information on the emergency, give you an escort if entry is necessary and alert you to the problems and hazards inside the plant, as well as explain Con Ed's efforts to mitigate the emergency.
- Request an accountability report from the White Hat regarding his personnel. He will know who was in the plant when the incident occurred and if they have been accounted for.
- The White Hat will remain in the lobby and assign an escort to accompany you into the plant. Move cautiously inside the plant and do not wander from your Con Edison escort. The noise of the escaping steam and the normal turmoil created by a HELB in the plant can result in disorientation to those not familiar with it, so stay close to your guide and confer with him regarding the hazards with which you are faced.
- Con Edison personnel will make needed repairs to mitigate the problem. Firefighters should limit themselves to search and rescue.
- *Steam leak in the street*--Never rush into a HELB steam scenario. This is a haz-mat incident and the hazards can change from moment to moment. So, how do you respond to these incidents?
- Approach outdoor incidents from upwind and stay clear of the vapor plume. Stage units and personnel in an area where they will not become contaminated by asbestos and where communication is possible.
- Position apparatus and set staging area upwind, outside of the vapor plume and far enough away to allow voice and radio communications.
- Look for and work with the Con Edison White Hat. This person is the Con Edison incident commander and will be your source of information at these incidents.
- Closely supervise personnel to avoid injury and asbestos contamination. The high temperature of the vapor plume is debilitating and can be deadly.
- Search for and remove victims if it is safe to do so.
- Limit the number of Firefighters exposed and ensure that all exposed personnel wear full bunker gear and SCBA when operating in and around the escaping steam.
- Isolate exposed Firefighters, civilians and equipment in order to limit the spread of asbestos contamination.
- Prevent civilians from exiting buildings into contaminated areas.
- If it is necessary to evacuate, consider evacuating from the rear or side of buildings to avoid contamination.
- Shut building ventilation systems and close windows to prevent the spread of steam and asbestos to the inside of nearby buildings.
- Prepare for decontamination of civilians, Firefighters' bunker gear, tools and equipment and vehicles. This is a non-emergency decon, but isolation of exposed civilians and personnel will prevent cross-contamination.
- Decontaminated apparatus, tools and bunker gear may not be returned for several days.
- Anyone and anything exposed--including buildings--will have to



Photos #7 and #8--Inside service valve with warning signs.

be decontaminated if asbestos is present in the plume. *HELB in a steam-supplied building*--Supplied buildings will have a steam control room. Inside will be a confusing series of valves and piping.

- Never randomly shut valves. Some valves are critical for condensate removal. Shutting the wrong valve could damage the system, creating other hazardous conditions.
- The inside service valve will be labeled and sealed. It is permissible to shut this valve, if necessary. It would be preferred, however, if Firefighters wait for Con Ed steam personnel to shut the valve. In any case, always notify Con Ed personnel of any valves shut and *never* open a valve once shut.

It is not just Con Edison steam

Firefighters can find privately owned “district steam systems” at locations throughout the City. Universities, hospitals and other large developments--such as Starrett City and the Bay View Projects in Brooklyn, as well as New York University in Manhattan--have their own central steam boiler plants and distribute the steam to the buildings in their respective complexes. Although these “district steam systems” are not part of the Con Ed system, the hazards remain the same. At these locations, Firefighters should operate as they would at an incident involving Con Edison steam, but seek out and employ the expertise of the local plant manager.

General safety precautions and considerations

- Transmit the appropriate radio code (10-40-4) with an explanation of conditions.
- Because of the potential for asbestos release, all high-pressure steam incidents are likely to be haz-mat incidents. Transmit the appropriate 10-80 code.
- Request response as needed from Con Edison, NYPD for crowd control, EMS as needed for victims and other City agency personnel.
- Do not approach a high-energy line break.
- Consider a HELB to be a haz-mat incident until the debris is tested and proved to be free of asbestos.
- Prior to its regulation, asbestos was the insulation of choice for steam pipes. While some of it has been removed, much of it still exists on steam pipes today. If a steam pipe bursts in the street, a building or a power plant, there is a very real possibility that the pipe insulation contains asbestos.
- When operating in the vicinity of a HELB, always wear SCBA until air monitoring is completed.

A HELB in the street might adversely impact the buried elec-

tric and gas infrastructure, creating a gas leak or electrical hazard.

- If you suspect involvement of one of these other utilities, request the response of the affected utility in addition to requesting Con Edison steam’s response.
- Do not shut a high-pressure steam valve other than the “inside service valve.” If possible, wait for Con Ed steam personnel to arrive and let them shut valves as required.
- Do not open any high-pressure steam valves that you have shut.
- Notify Con Ed steam personnel of all valves that you have shut.
- Remember, high-pressure steam is invisible until it cools and condenses. A hook, broom or stick held in front of you as you move through a steam environment in a generating plant may be hit by the invisible high-pressure steam leak, warning you of its location.
- Except to save life, keep well back from a HELB in the street. Scalding slugs of water and debris can be projected well beyond the vapor cloud and getting too close to the break may result in serious burns.
- It may take some time to shut valves to isolate the leaking section of steam piping.

Isolating a burst steam pipe in the street can take Con Ed as long as three hours, depending on the number of valves that must be shut to isolate the leaking section of pipe. It can take up to one hour to isolate a HELB in a building and in the generating plant.

- Exercise caution when operating a hose stream in buildings supplied with high-pressure steam. Directing a hose stream onto a high-pressure steam riser exposed by overhaul or some other structural damage can result in a ruptured pipe and steam release.

Con Edison currently conducts steam training for the FDNY in a number of venues. New Probies, Lieutenants, Captains and Chiefs receive a class on steam and the other Con Edison utilities. Additionally, drills are conducted with units in areas that respond to steam incidents. The training, as well as this and other *WNYF* articles, are part of the *Partnership in Safety* FDNY has forged together with Consolidated Edison. This partnership has resulted in greater safety for Firefighters, Con Edison workers and the people they both serve.

About the Author...

Battalion Chief Frank C. Montagna is a 37-year veteran of the FDNY, the past 21 years of which have been as a Chief Officer. He is assigned to Battalion 58. Currently, he is working in the Bureau of Training, where he is responsible for curriculum development. He holds a degree in Fire Science from John Jay College, where he has taught fire science courses. He is a member of the editorial advisory board of Fire Engineering and has published articles in that publication and contributes frequently to WNYF. He is the author of Responding to “Routine” Emergencies.



Members are urged to review the following:

- All Units Circular (AUC) 338, Addendum 1.
- “Lexington Avenue Steam Pipe Explosion,” by Deputy Chief Robert J. Boyce, Jr., on page 2 of this issue of *WNYF*.