STATE OF NEW YORK
DEPARTMENT OF PUBLIC SERVICE

Report on
Steam Pipeline Rupture
41st Street & Lexington Avenue
Consolidated Edison Company of New York. Inc.
July 18, 2007
(CASE 07-S-0984)

Safety Section
Office of Electric, Gas & Water
February 2008

Executive Summary

At approximately 5:56 PM. on Wednesday, July 18, 2007, a 20-inch diameter steam pipeline owned and operated by Consolidated Edison Company of New York, Inc.[1] (Con Edison or the company) ruptured in the intersection of 41st Street and Lexington Avenue in Manhattan. Escaping steam broke through the pavement, creating a large crater measuring approximately 32 ft. x 32 ft. x 16 ft. deep in the intersection. There was one fatality reported as a person suffered a heart attack while fleeing the scene just after the rupture. Two persons were seriously injured, suffering extensive burns when the tow truck they were riding in fell into the cavity created by the escaping steam. Many others sustained less severe injuries. The rupture also impacted telecommunications utilities in the area as well as natural gas and electric transmission and distribution facilities owned and operated by Con Edison.

Con Edison personnel who initially responded to the incident had to close a total of 12 valves in order to isolate the ruptured section of pipeline and stop the flow of steam. This was accomplished by approximately 7:40 PM. Eighteen steam customers temporarily lost service as a result of the rupture and subsequent isolation of the steam main.

There was an immediate loss of several electric feeders affecting local networks. There were no customer interruptions, but a press release was issued requesting that customers reduce load. Several temporary cables were installed and the networks were returned to full service by the night of July 20.

[1] Con Edison is a steam corporation subject to New York Public Service Commission jurisdiction under the New York Public Service Law and applicable provisions of the New York Codes, Rules, and Regulations (NYCRR).

A 12 inch diameter cast iron gas distribution main was partially exposed in the crater, but surveys found the main intact and not leaking. As a precaution, Con Edison cut and capped the gas main to isolate the section on Lexington Avenue between 40th and 42nd Streets. No gas customers lost service.

Verizon reported that it had sustained damage to several high-capacity fiber cables that served customers in office buildings in the surrounding area and that also provided vital telecommunications links between Verizon switching offices. Verizon also sustained minor damage to two copper cables serving individual customers in the area. No other telecommunications carriers were affected by the incident. Despite the severe damage to telecommunications facilities at the incident site, the impact on customers was mitigated by the fact that most services were rerouted and restored prior to the return of customers to affected buildings.

The 20-inch steam main that ruptured was comprised of steel pipe normally operating at a pressure of 150 to 170 psig, and was installed in 1924. The pipe was wrapped with asbestos insulation. Assuming that asbestos contamination was a possibility, emergency response officials established a “hot zone” in the area bounded by 40th and 42nd Streets and Park Avenue to 3rd Avenue. Sampling for possible asbestos contamination began about three hours after the rupture. Air samples taken by both Con Edison and the New York City Department of Environmental Protection (DEP) were within acceptable limits. However, some samples taken from debris confirmed asbestos contamination in the surrounding area. No personnel were allowed into the hot zone without respirators and protective clothing. Clean up of asbestos contamination in the zone continued over the course of the two weeks following the incident. As this progressed, the size of the “hot zone”

gradually decreased until it encompassed the area immediately surrounding the crater. Some nearby buildings also sustained broken windows resulting in contaminated debris getting inside, and the need for window replacements and interior cleaning.

Staff from the Department of Public Service (DPS or Staff), Office of Consumer Services assessed Con Edison's response to customer needs and its efforts to maintain communication with customers, municipal and elected officials, emergency response organizations and the news media in the aftermath of the steam incident. Staff concluded that Con Edison implemented an effective communication program and adhered to its emergency plan procedures for addressing emergency events. Staff from the DPS Office of Electric, Gas and Water's Safety Section conducted an investigation of the incident to identify contributing factors and make recommendations for improvements in Con Edison's steam system operations and maintenance programs and procedures.

To ensure proper handling of the evidence which was to be analyzed to determine the cause of the pipe rupture, Con Edison retained an independent consultant, Evidence Secure, Inc., specializing in documentation and preservation of physical evidence from property and casualty loss locations. Staff and other interested parties also monitored the exposure, removal, packaging, and transport of facilities critical to the investigation. Con Edison engaged two independent consultants; a metallurgical consultant, Lucius Pitkin, Inc. (LPI), to evaluate pipe and material samples secured from the rupture site, and ABS Consulting (ABS) to conduct technical analysis to determine the cause of the rupture considering steam system operating conditions on the day of the incident and prior history. The DPS retained a metallurgical consultant, Kiefner and Associates, Inc. (KAI), to review the testing protocols,

monitor the testing done by LPI and advise Staff regarding the appropriateness of the testing and analyses.

The metallurgical testing performed on samples of the ruptured pipe determined that the pipe was fit for the intended service, exhibiting adequate strength, ductility and toughness consistent with pipe manufactured in the 1920's. There is no indication that the pipe was deteriorated or weakened by corrosion. KAI and Staff are satisfied that the material preparation and testing were done according to accepted industry standards and the established protocols, and agree with the findings reported by LPI.

ABS determined that the cause of the pipe rupture was an excessive internal pressure, the result of a condensation-induced water hammer. Staff concurs with this determination. Some condensate is normally present in the steam pipeline system as the steam condenses into water due to heat loss. The condensate is removed by steam traps, which discharge into the sewer system. On the morning of July 18, 2007, heavy rain occurred in Manhattan. This, in addition to a normally high water table relative to the depth of the steam pipeline, allowed water to accumulate within a manhole in the intersection of 41st Street and Lexington Avenue containing a flange[2] joint in the 20-inch steam pipeline, and within the concrete and clay tile housing that encased the steam main through the intersection. Water contacting the steam pipeline facilities caused rapid and excessive condensation of steam inside the pipe, eventually filling the pipe section across the intersection with condensate. This is one of the primary causal factors that contributed to the pipe rupture. Upon investigation after the

[2] A flange connects two pieces of pipe to one another. The ends are bolted together, and a gasket is installed between the two pieces to prevent leakage. See Figure 7 for a photo.

incident, the steam traps were found to be nearly completely clogged with debris, severely reducing their ability to eliminate the condensate from the steam main. This was the second primary causal factor that contributed to the rupture.

The pipe section remained full of water until late that afternoon when routine steam system flow adjustments in response to customer demands created a pressure differential across the intersection that allowed steam to enter the pipe section, initiating the condensation induced water-hammer. A water-hammer occurs when a steam bubble becomes entrapped in the relatively cooler condensate. The steam bubble rapidly condenses to water, with the surrounding condensate rushing to fill the void, slamming into itself and generating a very high-pressure pulse that transmits through the condensate and was sufficient to rupture the pipe in this case. Based on calculations, the magnitude of the pressure pulse is estimated to have been at least 1,060 psig. Staff and KAI agree this was the likely cause of the rupture.

Staff's investigation and analysis of Con Edison's operating and maintenance practices and procedures germane to this incident identified deficiencies that contributed to the occurrence.

- Con Edison did not have a sufficient plan or procedure for a direct inspection of manholes subject to flooding. The manhole containing a flange connection between sections of pipe at the intersection of 41st Street and Lexington Avenue had an extensive history of flooding subsequent to significant precipitation events. On many occasions over the four years prior to the incident, Con Edison had to pump water from the manhole to alleviate the condition conducive to excess condensate generation in the main. Despite this, Con Edison had not identified this manhole

location as flood-prone, and had no procedure in place to physically inspect this and locations with similar characteristics following significant precipitation to determine if potentially unsafe conditions existed. The company instead relied on a practice of patrolling the steam system after significant precipitation events to visually identify if active vapor conditions exist, indicating water contacting steam facilities, or possibly a leak, and requiring further investigation. Staff's investigation confirmed that on the morning of July 18, 2007, a visible steam vapor condition did exist at 41st Street and Lexington Avenue, but had disappeared before the company's patrol surveyed that location.

- Con Edison's procedures for evaluation of identified pipe damage were deficient. There were two dents on the bottom of the pipe on the west side of the flange within the manhole at 41st Street and Lexington Avenue. A welded leak repair was made on a crack in one of the dents more than two years prior to the incident. The pipe rupture did not initiate at this prior repair and it did not contribute to the failure. However, Con Edison records indicate that the pipe needed to be replaced, but no investigation or analysis was conducted to determine the cause of the dents. It is likely that the dents resulted from a prior less-severe water hammer event at the location, which caused the pipe to jump or lift off its support and slam back down. Also, no action was taken to replace the damaged pipe section prior to the rupture.

- Con Edison's control of the process for sealing flange leaks and replacing defective pipe was lax. On several occasions over the two years prior to the incident, Con Edison injected sealant into the flange connection within the manhole at 41st Street and Lexington Avenue to stop leakage. The debris that clogged the steam traps was analyzed and found to contain the leak sealant material that had been injected into the flange. The company's contract with the vendor who performed the leak sealant injection stated that the quantity of material injected must be minimized based on a calculation of the volume needed to stop the leak. Con Edison could not produce any documentation to demonstrate that such calculations were performed. The company relied on the vendor technician who performed the leak sealing procedure as to the acceptability of repeated attempts to seal the flange leak. Additionally, the leak sealing process was sometimes done with the steam main in operation and sometimes not. On eight of the ten occasions when the leaking flange was sealed since July 2005, the section of steam main was shut down specifically to facilitate the leak sealing process. There is concern that these conditions can allow the sealant to enter the steam pipe. Occasions when the steam main was shut down also offered opportunities to make a permanent repair or eliminate the flange. According to Con Edison management, there were plans to do so on at least two occasions, but the work was delayed in favor of other work, and was never carried out.

- Con Edison's steam trap inspection procedure did not include a requirement to periodically verify that the traps

were free of any debris. The procedure only verified that the trap was operating and removing condensate. Because the traps were significantly oversized for normal operation, they could be partially blocked by debris and still pass inspection based on audible indication that the trap is opening and closing and observation of condensate being removed. The procedure also did not include a requirement to analyze or test traps that failed inspection to determine the cause.

- Con Edison's procedures did not adequately address the requirements of 16 NYCRR 420.4(b)(5) for continuing surveillance of the steam system. The company did not integrate existing known data and information regarding the flange manhole at 41st Street and Lexington Avenue including the history of flooding and pumping after precipitation events, the persistent leakage of the flange resulting in repeated attempts over a two year period to stop the leak by sealant injections, the repair of the leaking crack within the dent, and the documentation indicating that the pipe should be replaced. Careful consideration of these items should have prompted the company to expeditiously pursue replacement of the pipe section within the manhole.

As a result of Staff’s investigation, and its analysis of Con Edison’s publicized Recommendations and Action Plan dated December 17, 2007, a number of recommendations are identified for improvement.

1) Con Edison must establish a specific procedure for direct physical inspection of steam facility manholes that are historically prone to flooding due to significant

precipitation events or other causes of water infiltration. The procedure must include detailed criteria warranting the inclusion and updating of specific manhole locations, and specific actions to be taken by company personnel in response to observed conditions. The documentation process must include the inspection results and the follow-up actions.

2) Con Edison must establish a procedure for identifying and continually evaluating manhole locations, including information from field crews, to determine locations that require automatic pumping capability.

3) Con Edison must evaluate its steam system to identify locations that, based on elevation profile and potential for water infiltration or flooding, are similar to the piping arrangement that existed on 41st Street across Lexington Avenue prior to the incident. These locations must be subject to detailed engineering evaluation to determine all reasonable actions that are necessary to alleviate potentially unsafe conditions.

4) Con Edison must establish a detailed trap inspection procedure sufficient to periodically ensure that the steam traps are clear of any debris and can freely operate at its design capacity. At a minimum, it will require the replacement of all traps on an annual basis and internal inspection of all traps removed from service. Traps that fail inspection must be immediately replaced and promptly investigated to determine the cause of failure.

5) Con Edison must establish training and operating procedures to ensure that instances of steam system damage or degradation detected by company personnel are documented and referred to Steam Engineering for appropriate detailed

evaluation and analysis. The company must prioritize conditions based on the likelihood and consequences of a system failure, and recommended actions to correct unsafe conditions must be timely completed.

6) Con Edison must revise its manhole inspection procedure to explicitly state that the condition of the steam facilities within the manhole be checked during the inspections, and to include a timeframe for correcting deficiencies as required by 16 NYCRR 420.4(b)(4).

7) Con Edison must establish procedures for effective control of contract vendors performing any operations, maintenance, or repair work on its steam system. The procedures must ensure that contract stipulations are strictly adhered to based on oversight by appropriate, knowledgeable company personnel with extensive experience in the steam system operations, maintenance, and repair procedures and processes.

8) Con Edison must categorize repairs to the steam system as temporary or permanent, based on detailed engineering evaluation of the repair method. Repairs categorized as temporary must be eliminated in favor of a permanent repair within a specific timeframe supported by the evaluation, but not to exceed six months. Con Edison also must revise Procedure S-11971 - Welded Repairs of Steam Distribution Piping, to provide a specific time frame for repairs, including such repairs in manholes. Repair intervals for all components must be addressed for compliance with 16 NYCRR 420.4(b)(4).

9) Con Edison must establish a procedure to review its SOMIS[3] and other pertinent records to determine the status of any outstanding recommendations or notations for repair, replacement, analysis, etc. upon which it has not acted, prioritize completion, and take appropriate action.

10) Con Edison must establish procedures to control tracking of planned projects in its SOMIS to ensure that all work is completed. The procedures should prohibit initiating and assigning unrelated work to existing project numbers and avoid closing out projects in SOMIS when the originally intended work has yet to be completed.

11) Con Edison must discontinue the use of leak sealant injections as a method to repair leaks unless it can demonstrate that effective controls are in place to verify the proper quantity of material injected, limit excessive applications, and ensure that the steam system components will not be adversely affected.

12) Con Edison must conduct feasibility analyses for remote monitoring systems to detect real-time water infiltration into subsurface structures containing steam pipeline facilities. Con Edison must also conduct feasibility analysis on systems to detect condensate levels within steam piping at specific locations identified based on history of excessive condensate formation requiring actions to alleviate potentially unsafe conditions. Bi-monthly progress reports shall be submitted to the Office of Electric, Gas and Water.

13) Con Edison must conduct feasibility analysis of high capacity steam traps and trap assembly designs with the aim of improving debris removal. Bi-monthly progress reports

[3] Steam Operation and Maintenance Information System; Con Edison's electronic record keeping system.

shall be submitted to the Office of Electric, Gas and Water.

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I. Description of Steam System

The Consolidated Edison Company of New York, Inc. (Con Edison or the company) steam system extends from the southern tip of Manhattan north to 96th Street on the West Side, and to 89th Street on the East Side. The major uses of steam include space heating, air conditioning and domestic hot water. Currently, the system provides steam to 1,785 accounts. The system is comprised of approximately 105 miles of pipe with diameters ranging from two inches through thirty-six inches. The system incorporates various piping vintages (see Table below) and designs, some from as early as the 1920's when flanged-end connections were utilized to enable field connections during original construction. The network also incorporates thousands of subsurface manhole vaults which house such facilities as isolation valves, pipe supports, anchors, expansion joints, steam traps and drainage mechanisms.

Age (Years)	Miles of Steam Main	Miles of Steam Services	Total
0 – 10	5.4	2.7	8.1
11 – 20	2.8	2.4	3.2
21 – 30	7.6	1.9	9.5
31 – 40	21.5	3.9	25.4
41 – 45	4.2	1.7	5.9
> 45	45.2	5.5	50.5
Total	86.7	18.1	104.8

The distribution steam mains operate at pressures between approximately 150 – 190 pounds per square inch gauge (psig), with a maximum temperature of 413°F. The transmission mains

operate at pressures between 150 – 400 psig, with a maximum temperature of 475°F. The piping is insulated to minimize heat loss, and is generally encased within a concrete, steel pipe or clay housing and incorporates an approximate two-inch air gap between insulated pipe and housing.

Con Edison owns six steam generating stations that supply the system, and also has a long-term contract for steam supply with the Brooklyn Navy Yard Cogeneration Partners, an independent power producer.

II. Location Specifics

The steam distribution facilities at the intersection of 41st Street and Lexington Avenue, as they existed on July 18, 2007, are shown in Figures 1 and 2. A 20-inch main ran east-west across 41st Street, in the northern half of the street. Near the northeast corner of the intersection it connected with another 20-inch main at a T-connection, which then ran north along Lexington Avenue, just west of the eastern curb. Just east of the T-connection, the 20-inch main reduced down to 16 inches. An eight-inch main connected to the top of the 16-inch main east of the reduction in diameter, then turned in a series of bends and followed the sidewalk south along Lexington Avenue to serve two customers.

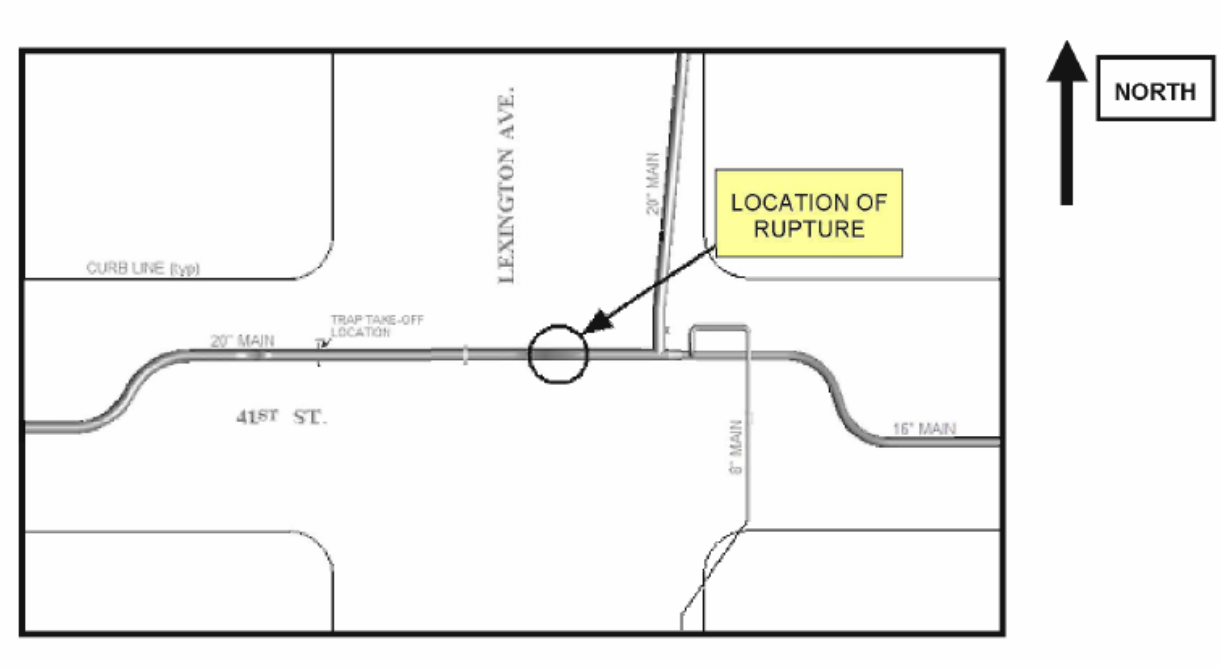

Figure 1 - Plan View of Steam Main Configuration

Source: ABS Report 1763931-R-001

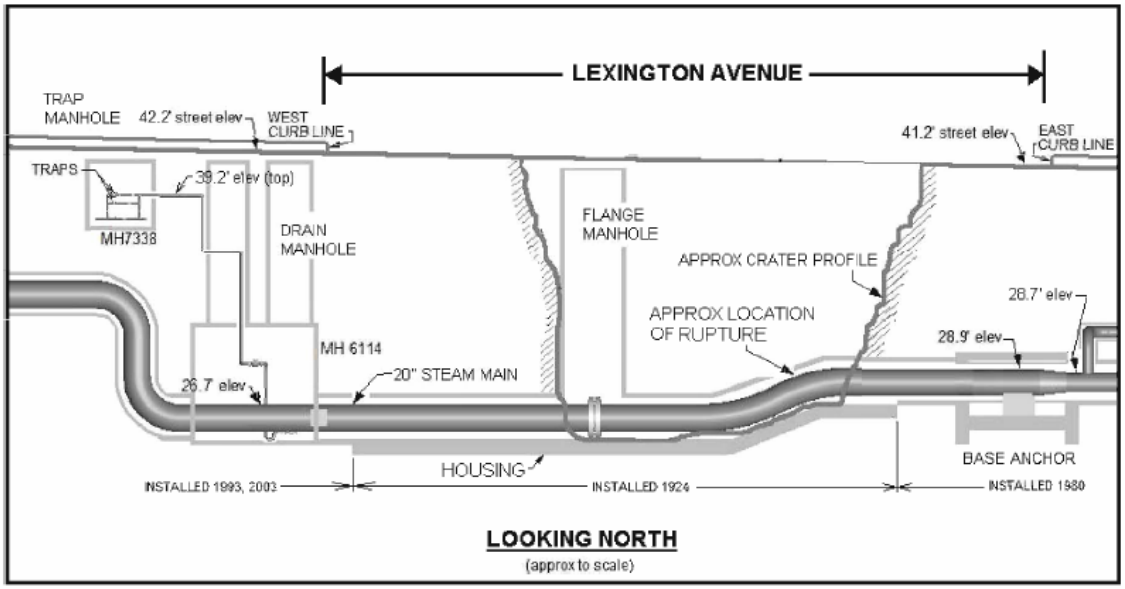

Figure 2 - Elevation View of Steam Main Beneath Lexington Avenue

Source: ABS Report 1763931-R-001

The 20-inch east-west main had two major elevation changes in the intersection. Just before entering the intersection on the west side, it changed elevation by means of two ninety-degree elbows from approximately five feet to 15 feet below street level. Just east of the elbows is the calculated local low point, located in a manhole structure referred to as a "drain manhole." The elevations of the steam mains are designed to direct operational condensate toward known low points, where steam trap assemblies are connected in order to remove it. The steam trap piping is connected to the bottom of the main in the drain manhole by means of what is referred to as a "fish-mouth connection." Some condensation within the steam mains is expected as part of normal operations. The system is designed so that condensate drains out of the main at the fish-mouth connection and flows under pressure through a series of piping to the steam trap assembly, located in a separate, but adjacent manhole structure.

East of the trap assembly, near the center of the intersection, is a flanged piping connection. There are approximately 3000 flanged piping connections on the Con Edison steam system, dating to the original construction of the system. This flanged connection was located in a dedicated single-headed[4] manhole structure (referred to as "flange manhole" in this report). This is the only flange on the system located in a manhole. All others are buried. Con Edison could not explain why this was the only flange located in a manhole. However, this manhole structure was smaller (approximately 5 feet by 5 feet) than most manhole structures on the system.

As the 20-inch main continued east of the flange manhole it became shallower by means of what is referred to as a "file 3

[4] Meaning one manhole cover.

bend"[5], rising to approximately twelve and a half feet deep. Just east of the file 3 bend, the 20-inch main met the T-connection for the eight-inch main serving the two customers to the south on Lexington Avenue.

The section of main from the west side of the intersection, including the flange connection and the file 3 bend, was all installed in 1924. Sections of piping west of the flange, including piping around the trap and drain manholes, had been updated in 1993 and 2003. The T-connection east of the file 3 bend, to the 20-inch north-south main, had been redesigned in 1980 to incorporate welded connections, rather than flanged connections. In June 2007, in order to repair a leak where the eight-inch main connected to the side of the 20-inch main, that connection point was moved to the top of the 16-inch main. These modifications resulted in approximately 43 feet of the original 1924 installation remaining running east and west in the middle of the intersection.

III. Description of Events

Background on Water-Hammer

Water-hammer is a phenomenon which occurs when a steam bubble is entrapped within a mass of condensate, i.e. steam that has cooled to below the saturation temperature to form water. The temperature difference between the steam bubble and the surrounding water causes rapid condensation and collapse of the steam bubble, which creates a void where the bubble previously existed. The surrounding water rushes in to fill the void, impacts itself and, due to its incompressibility, creates a large pressure pulse. The pressure pulse is transmitted through

[5] The rupture occurred on the top part of the file 3 bend.

the condensate and impacts the pressurized piping system containing it.

For an underground steam piping system, the conditions conducive to a hazardous water-hammer can form if steam facilities become submerged. In such a situation, encroaching rainfall or groundwater can cause the steam inside the pipe to cool sufficiently to generate excessive condensate, i.e. liquid rather than vapor. In addition, the heat of the steam system can be transferred to the surrounding water, causing it to boil and produce a vapor condition at street level.

Steam System Environment on July 18, 2007

On the morning of Wednesday July 18, 2007, heavy rains moved through the New York City area, with over one and a half inches of rain falling in Manhattan between 6:00 AM and 11:00 AM (source: National Weather Service historical data).

Con Edison's Steam Distribution Operations and Maintenance Instructions (Steam Distribution Procedure S-11952) require that listed "Flood Prone Locations" be patrolled during significant rain conditions.[6] However, recent actual practice has been to send several supervisory and management persons to patrol the entire steam system. When possible flooding is identified, typically by a visible vapor condition emanating from a manhole, a crew is dispatched to investigate the condition and remediate any hazard by pumping water out of the manhole, venting the vapor further above ground level with a stack, installing a rain gutter or barricades, or closing valves to isolate the affected section of main. On the morning of July 18 steam system

[6] The intersection of Lexington Avenue and 41st Street incident intersection was not one of the listed flood-prone locations, which are mainly in tidal areas.

operations management determined that the rainfall was significant and initiated a patrol. The steam system was divided into 14 zones and patrolled by six steam supervisors that day. Twenty-five locations were identified as potentially flooded due to visible vapor above street level and crews were dispatched to all of these locations. In all these cases crews were able to remediate the situation without the need to shut down any part of the steam system. When the incident intersection was patrolled at approximately 11:30 AM, no vapor condition was observed and therefore no crews were dispatched to this location.

Also on July 18, a major source of steam supply for lower Manhattan, the Brooklyn Navy Yard steam production facility, was taken off line after operational alarms tripped the station out of service at around 5:15 AM. To redirect steam supply from the uptown plants towards lower Manhattan, a control valve (CV3) located near First Avenue and 9th Street, was opened from five to 56 percent in three stages over the course of about an hour and a half. Such control valve adjustments are part of normal steam system operations, as on any given day steam is redirected on the grid multiple times to respond to system supply and demand. These actions created changes in the direction of steam flow and differential pressures in some locations. The Brooklyn Navy Yard plant was brought back online at around 8:15 AM. However, CV3 remained at the 56 percent open position until later that afternoon.

On weekdays, Steam Dispatching typically begins to reduce production between the hours of 4:00 PM and 5:00 PM in anticipation of daily usage drop-off. Records show that on July 18 production was ordered to be reduced at five of the steam production plants between 4:00 PM and 5:30 PM. In addition, Steam Dispatching began to gradually close CV3, this time in

four stages, over the course of ninety minutes. Just minutes before the incident, at 5:52 PM, CV3 was reduced to seven percent open. The pressure in the pipeline in the vicinity of the rupture at the time of the incident was 145 psig.

Incident Occurrence

At approximately 5:56 PM, a section of steam main in the intersection of 41st Street and Lexington Avenue catastrophically ruptured. The rupture created a crater in the intersection at least 30 feet in diameter and 16 feet deep. A tow truck traveling south on Lexington Avenue fell into the crater. Flying debris and the plume of steam from the ruptured main caused damage to building fronts and nearby vehicles. Many windows in nearby office buildings were broken. The steam roared loudly. Dozens of people were injured, including the tow truck driver and a passenger who both sustained serious burns. One person reportedly suffered a fatal heart attack while attempting to flee the scene. The surrounding buildings, primarily office buildings, were evacuated.

A Con Edison Steam crew working at 59th Street and Lexington Avenue noticed the steam plume and immediately notified the steam dispatcher. Con Edison Steam Dispatching also noted a system pressure drop near the incident location. Electric control personnel received alarms that several primary feeders had tripped off-line.

Steam crews were dispatched to the incident site at 5:59 PM, with all other available steam crews directed to respond to the location. A steam emergency was declared. Con Edison notified government agencies, including the New York City Police (NYPD), New York City Fire (FDNY), the New York City Office of

Emergency Management (OEM), and the New York City Department of Environmental Protection (DEP). DPS Safety Staff was notified at home by telephone at approximately 6:00 PM. Staff arrived at the scene at approximately 6:30 PM.

Stopping the flow of steam to the rupture area became the immediate priority. Ultimate isolation of the steam main required the closing of 12 valves, the last of which was closed at 7:38 PM. Con Edison steam crews then returned to all 12 valves, tightened them, and verified their closed status. The main was confirmed shut down at 8:03 PM.

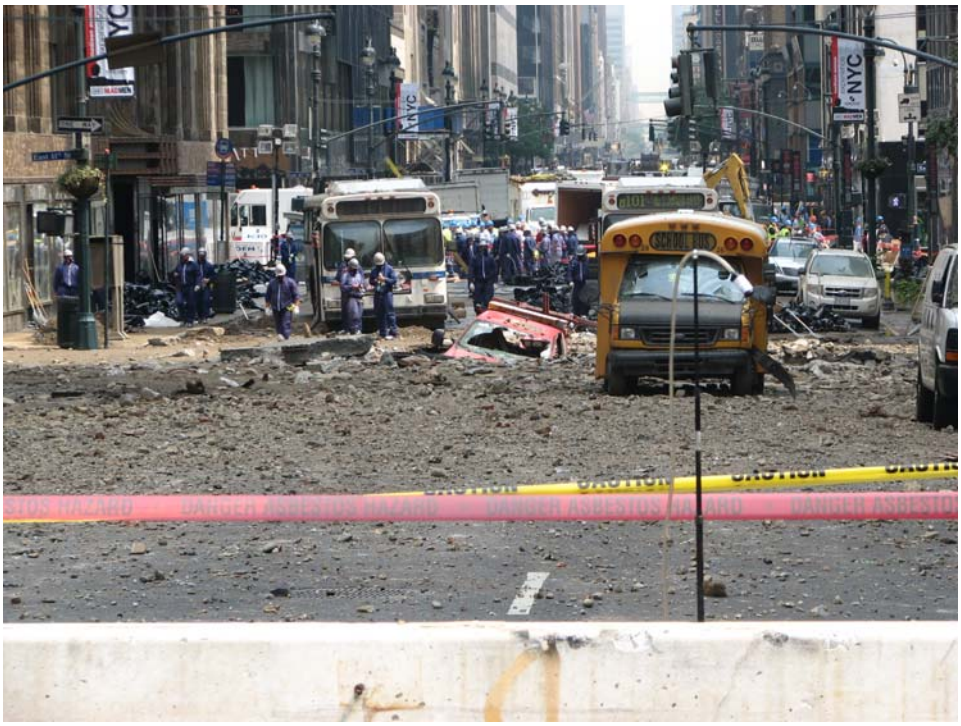

Figure 3 – Photo of Incident Site on July 18 Looking North

Figure 4 – Photo of Tow Truck in Crater

Asbestos Hot Zone and Clean-up

Most steam mains installed on the Con Edison system before 1972 are insulated with asbestos. In past years, Con Edison has had a program to abate all readily accessible steam mains, primarily those located within subsurface structures. However, mains that would require excavation to expose have been left with asbestos insulation until they are accessed for some other reason. The steam pipe within the flange manhole had been abated, but the buried 1924-vintage pipe within the intersection had not. Therefore, asbestos contamination of the air and surrounding buildings, sidewalks, streets, vehicles, and materials in the incident crater became an immediate concern.

When DPS Staff arrived at the location, at approximately 6:30 PM, responding agencies, including DEP, OEM, NYPD, FDNY, and Con Edison were in the process of establishing a “hot zone” around the incident crater. The hot zone was created large

enough so that it would contain all areas thought to be potentially contaminated with asbestos. DEP and Con Edison both began taking air and bulk (solids, such as sediment) samples within the hot zone to test for the presence of asbestos. The hot zone included Lexington Avenue between 40th Street and 42nd Street, 41st Street between Park Avenue and Third Avenue, and all of the buildings facing those streets. No one was allowed to enter the hot zone unless they were fitted with the proper respirator and protective clothing. The entrances were monitored. In the meantime, two bulk samples taken by DEP showed an elevated level of asbestos in the immediate area of the crater. At that time, responsible officials agreed that the hot zone would be maintained until an entire abatement could be completed.

The asbestos abatement work made evidence recovery from the incident crater area a very time consuming process. Large crews of qualified asbestos abatement contractors were brought to the location during the evening of the incident, and Con Edison worked with DEP to develop and coordinate a cleanup plan for the area, initially focusing on responding fire equipment and nearby building facades, then expanding to gradually decrease the size of the hot zone and open as many streets to vehicular and pedestrian traffic as quickly as possible.

Staff was present daily to witness the asbestos removal process. Certain Staff members were qualified to enter the work area with a respirator and protective clothing and were able to directly observe the site clean-up and evidence removal.

The hot zone shrank as clean up progressed. The abatement (not including the interiors of some buildings) was completed early in the morning of August 2.

Impact on Gas Facilities

Con Edison gas crews also immediately responded to the incident. Con Edison Gas Operations personnel were concerned about the impact on several gas distribution mains in the area. A 12-inch low-pressure cast iron gas main extends north-south along the west side of Lexington Avenue. A 6-inch steel main tied into the 12-inch main and extends west along 41st Street. Also, an 8-inch wrought iron main extends north on the east side of Lexington Avenue until reaching the south-east corner of 41st Street and Lexington Avenue, where it reduces to 6-inches and turns east along the south side of 41st Street.

Due to the emergency response and clean-up activities, Con Edison gas crews could not immediately gain access to the rupture site to investigate the condition of the mains. Gas system pressures in the area appeared to remain stable. Crews were able to gain access to several buildings in the immediate area and found no indications of gas entering the buildings which would have suggested system leakage. After steam flow to the rupture was stopped, gas crews were able to survey the area and found no indication of gas leaks. However, because the crater appeared unstable, Con Edison management decided to isolate the gas mains in the vicinity.

Because there are limited valves on Con Edison's low pressure gas distribution systems, the company began investigating locations where the gas mains could be physically isolated from the distribution grid with minimal impact on customer supply. Con Edison gas crews chose locations where excavations could be made and the mains fitted with stoppers[7] to enable a quick shut down in the event of an emergency. Five

[7] The mains were tapped and inflatable bags were inserted to block the flow of gas.

such excavations were dug. Two were located on Lexington Avenue, near 40th and 42nd Streets, to isolate the 12-inch cast iron main which was partially exposed in the crater and considered most at-risk. A third excavation was dug west of the crater over the six-inch main, completing isolation of this gas main from the system without impacting any customer supply. Two additional excavations were needed to isolate the mains east of the crater. Over the next two days, Con Edison crews worked to physically disconnect the impacted section of 12-inch main. Reconstruction of utilities in the area, including the gas facilities, was completed in late September 2007.

Impact on Electric Facilities

Staff monitored the impact of the incident on electric facilities. The incident affected several electric networks in the vicinity of the incident. Nine feeders tripped out of service at the time of the incident in the Grand Central, Beekman, and Greeley Square networks. There were no customer interruptions from the trip out, but a public appeal was made for customers to reduce load. Twelve shunts[8] were installed and these networks were fully returned to service by the night of July 20. The extent of the damage to the 13 kV feeders in the hole was unknown leading into the weekend of July 21.

During the early stages of the steam incident, the electric system recovery efforts were hampered by asbestos contamination near the site of the crater. Staff was on site the afternoon of Saturday July 21 inspecting the installed temporary shunts and the associated shunt boxes. Staff made daily visits to the

[8] A temporary hookup to maintain electric service while repairs are made.

incident site and monitored the electric operation activities throughout the investigation.

By the end of July, trench work was completed to allow crews to remove all of the primary cables, which were sent to a secure Con Edison storage facility in Astoria for asbestos abatement.

By the end of September, the last of the feeders shunted after the incident were de-energized. All barriers, wood boxes and barricades were removed from those areas and the pavement work was completed. The twelve damaged feeders were restored and the remaining affected streets were re-opened.

Impact on Telecommunication Facilities

DPS Office of Telecommunications Staff monitored the impact of the incident on communications facilities. Verizon reported that it had sustained damage to several high-capacity fiber cables that served customers in office buildings in the surrounding area and that also provided vital telecommunications links between Verizon switching offices. Verizon also sustained minor damage to two copper cables serving individual customers in the area. Staff inquiries to other telecommunications companies in the area following the incident indicated that no other carriers were affected.

Despite the severe damage to telecommunications facilities at the incident site, the impact on customers was mitigated by the fact that most services were rerouted and restored prior to the return of customers to affected buildings. Where applicable, redundancies built into the network allowed for affected Verizon interoffice services to be quickly rerouted, in many cases automatically. The most severely impacted services were high-speed data services to businesses carried on the nine

damaged fiber cables, serving approximately 10 affected buildings. Because of the hazardous conditions present, it took several days for Verizon to access required locations to fully assess damage and to commence full-scale restoration efforts. However, once Verizon technicians were able to access customer buildings and associated manholes in the affected area they quickly addressed customer outage conditions. Throughout the restoration effort there were fewer than 100 Verizon customer generated trouble conditions reported. Verizon reports that all data services and most individual voice service outages were restored by Tuesday, July 24. The restoration of services was accomplished through permanent by-pass of damaged cables (both fiber and copper) at the impact location. Some sporadic outages affecting individual customers on copper facilities lingered as the overall infrastructure restoration was completed. After completing the bulk of its restoration within a week of the incident, Verizon remained on site until early September 2007 to address remaining individual outage conditions, protect and replace damaged telecommunications facilities at the site and assist in the overall infrastructure restoration.

Customer Service Operations

DPS Office of Consumer Services Staff monitored Con Edison’s response to human needs issues. Staff analyzed Con Edison’s efforts to ensure effective communication and information exchange with its customers, public officials, the media, emergency response organizations and other relevant entities. Con Edison actively maintained consistent and continued communications with relevant entities while adhering to its emergency plan procedures for handling outage events. Throughout the event, Con Edison worked collaboratively with

public officials, emergency response agencies, news media representatives and the affected businesses in the incident area. The company met customer information needs by maintaining on-site customer service centers, answering inquiries through its Call Center and providing up-to-date and timely information on its web site. The web site provided information concerning cleanup and restoration efforts, claims reimbursement procedures, proper handling of potentially contaminated clothing and belongings, and pertinent contact information for New York City agencies. The company was responsive to customer needs and concerns and maintained communication efforts throughout the incident. Staff is satisfied with Con Edison's overall performance in this area, including its efforts in areas such as the offer of portable temporary steam supplies to affected customers and the development of a claims reimbursement program. Attachment F provides a detailed description of Con Edison's efforts to address human needs.

IV. Material/Evidence Recovery

Outside Consultants

Several outside consultants were hired to assist with the investigation of the incident and determination of the root cause:

Evidence Secure, Inc. (ESI) was retained by Con Edison to manage identification and tracking of pieces of evidence from the incident site.

Lucius Pitkin, Inc. (LPI) was retained by Con Edison to conduct metallurgical evaluation and mechanical testing of the affected facilities.

ABS Consulting (ABS) was retained by Con Edison to conduct technical analyses to determine the cause of the rupture

considering steam system operating conditions on the day of the incident and prior history.

Kiefner & Associates, Inc. (KAI) was retained by the DPS to review engineering and metallurgical testing protocols and material handling procedures, monitor testing to ensure it is carried out according to the protocols and accepted industry techniques, and advise Staff in its investigation as to the possible failure mechanism of the pipe.

Security of Evidence

As the hot zone decreased to the area immediately surrounding the crater, identifying underground facilities and materials within the crater for the purpose of determining the root cause of the rupture became a priority. ESI was responsible for identifying each piece of material as it was removed from the crater. Anything removed was physically tagged with an identifying number and photographed. The entire evidence recovery process was videotaped with a digital recorder. Staff was provided with copies of the evidence retrieval videos. Each item was catalogued along with the approximate location at which it was found.

Evidence Recovery

Because of the size and depth of the crater, debris removal, asbestos abatement, and the evidence collection and removal process, reaching the steam main took several days. Since the pipe was not visible from street level initially, Con Edison utilized a video inspection vendor to internally inspect the section of 20-inch steam main within the intersection in order to determine what section of the pipe had apparently

failed. On July 24 a mobile robotic video camera was inserted into the pipe on 41st Street west of the intersection.

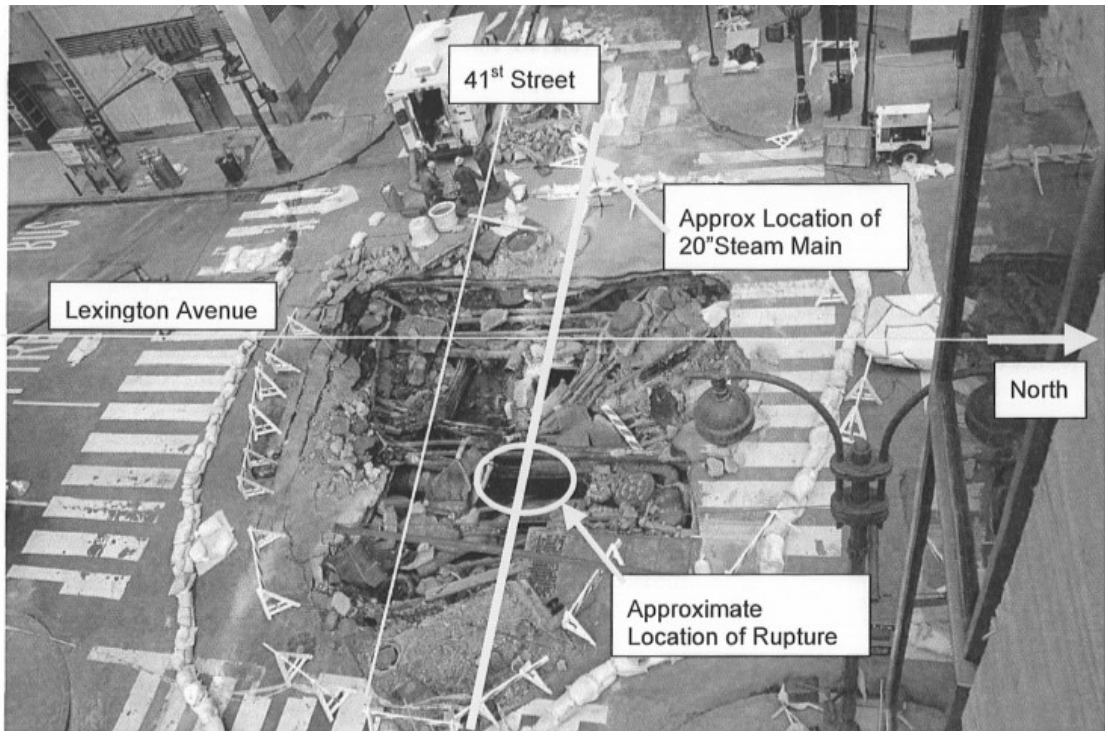

Figure 5 – Image of Crater during Debris Removal
Source: ABS Report 1763931-R-001

The camera traveled east, encountering a full open ended pipe approximately 20 feet beyond the flange manhole. The pipe end was fully submerged in water but clearly visible, with several large pieces of concrete resting within the pipe near the opening, providing the first positive identification that a pipe failure had occurred. On July 26, the camera was inserted into the 16-inch main east of the intersection on 41st Street. From there it traveled west until encountering the full open-ended pipe in the file 3 bend. Again the opening was submerged, but it was clearly visible that the pipe had failed catastrophically, with several jagged torn edges of pipe visible.

The steam main was first exposed in the crater on July 30. At this time Staff was able to view the ruptured portion of the main. By August 2, the area around the steam main had been sufficiently abated and the excavation shored so that Staff could gain close access to the main. As shown in the Figure 6 below, taken on August 2, the rupture opened in a flap approximately 47 inches long, unpeeling the top half of the pipe.

Figure 6 – Photo of Ruptured Main Exposed at Site

The flanged pipe connection in the manhole to the west of the rupture was found to be intact (see Figure 7 below). It was evident that the flange connection had been previously repaired by a technique that required the installation of an encapsulating clamp, enabling injection of sealant into the joint.

Figure 7 – Photo of Flange with Leak Sealant Injection Clamp

Approximately twelve inches west of the flange, Staff noted two dents at the bottom of the pipe, spaced so as to suggest they were due to some sort of force against pipe supports, although no pipe supports were found in the manhole. There was visual evidence that one of the dents had been repaired with a puddle weld, i.e. weld filler material deposited to fill in the dent.

Figure 8 – Photo of Puddle Weld

Representatives from LPI were on site to view and document the pipe rupture and the surrounding pipe. A plan was developed to remove the ruptured main in two pieces, created by making three field cuts. This resulted in one piece including the rupture, and the other including the flanged connection. Staff was present to witness the cutting and removal of the steam main (see Figure 9 below), and accompanied it during transport to a secure Con Edison storage facility in Astoria, Queens.

Figure 9 – Photo of Rupture Section Removed from Site

All materials removed from the incident crater were abated for asbestos and stored at the Astoria site. Included were piping from the steam main, water mains, electrical conduit, concrete and brick pieces from manhole structures, and abandoned facilities, including gas main and telecommunications conduit. At the guarded storage facility, Con Edison installed video monitoring equipment. During the investigation, access to the facility to view and photograph items was provided to all interested parties, including Staff.

Figure 10 - Photo of Ruptured Steam Main at Astoria Site

V. Testing and Analysis of Evidence

After initial observations were made of the rupture section, including measurements and close-up photography, a protocol for further testing was also developed by LPI, and reviewed by Staff, KAI, and other interested parties and consultants.

Pipe Rupture / Lap Weld Seam

To determine the strength properties of the pipe, various tests were performed using materials cut from the steam main near the rupture location. Staff observed the performance of tensile tests, Charpy V-notch tests, and bend tests. The tests confirmed that the pipe material had adequate strength, ductility and fracture toughness consistent with 1920’s vintage pipe and was fit for the intended application.

As previously discussed, the rupture occurred on a section of steel steam main approximately 15 feet below the street surface at the top of a file 3 bend. It appeared to follow a manufactured lap-weld seam at the three o’clock position (facing

east) on the pipe for a length of approximately 47 inches, before tearing circumferentially at both the east and west ends, opening to the nine o'clock position. The lap-weld seam manufacturing process essentially consists of a flat steel plate with beveled edges being rolled through a die into a tubular form with the edges overlapping. The edges are heated to a forging temperature and then squeezed together between external rollers and an internal mandrel. No filler material is used in this process.

The pipe fracture surface exhibited a rough and slanted texture consistent with ductile overload, shear fracture, and the pipe exhibited bulging and significant plastic deformation prior to fracture, indicating that the pipe sustained stress levels in excess of the yield strength[9] prior to rupture. The pipe surface appeared to be in very good condition, with superficial surface rust but no signs of corrosion pitting. Various methods were used to identify potential contaminants or harmful substances at the fracture surface. Primarily, the testing by LPI found only surface rust, at levels expected as a result of the pipe sitting in water post-incident.

At the Astoria facility, LPI performed ultrasonic thickness testing across the entire rupture piece, in a four-inch by four-inch grid. Subsequently at LPI's facilities more detailed thickness measurements were performed on certain locations near the fracture surface using a ½-inch by ½-inch grid. In general, a reduction of wall thickness was noted in the area immediately adjoining the fracture surface, particularly near the seam weld. The reduction in thickness near the failure edge, along with no other signs of pipe material loss, also suggests plastic deformation near the failure surface. KAI reported that even if

[9] The lowest stress that causes permanent deformation.

the thinned wall was present prior to the failures it would not have challenged the strength of the material. KAI's opinion was that the loss of metal thickness that was limited to the flap side of the seam occurred after the failure, due to erosion. Steam discharged at high pressure for up to 2 hours into a confined space with significant quantities of debris over the pipe. The erosion is thought to have been caused by particles of debris swirling or circulating in the discharging steam.

Beyond but near the rupture location, intact cross sections of the lap weld were cut out of the pipe. Microscopic examination confirmed that the pipe was manufactured using a lap weld seam, and that the seam was largely sound. Examination of the fracture surface found indications consistent with plastic deformation prior to rupture, without any evidence of fatigue or progressive cracking.

Several inclusion stringers[10] were found present along the seam weld (see Figure 11 below). LPI reports that considering the fabrication techniques used in the 1920's, these are clearly from the original fabrication and are considered normal and acceptable for the application, having only a marginal effect on the seam weld strength. Such voids would have been undetected during the pre-installation inspection process as they would not have been visible from the outside of the pipe. KAI agrees with this assessment.

On the pipe, beyond the end of the rupture, an area where the seam appeared to have been pulled partially open over a length of approximately two inches was found. Examination confirmed that the seam was partially opened at the pipe surface. KAI noted that chemical analysis of materials from deep inside the opening indicated that it had been exposed to

[10] Areas of incomplete fusion of the seam creating a void.

the environment for some time. This suggests that the seam may have partially opened due to an earlier overpressure condition, such as a previous, yet less severe, water-hammer event(s). However, given the buried location of the seam, the partial opening would not have been discovered by Con Edison during normal operations.

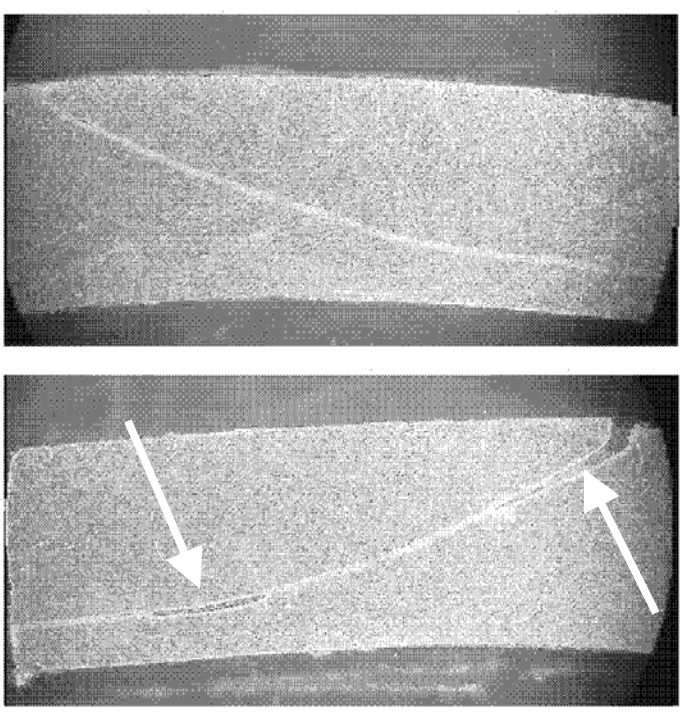

Figure 11 - Macrospecimens Showing Inclusions in Lap Weld
Source - LPI Report

Dents Found Near Flange

As noted previously, examination of the pipe from the flange manhole found two dents in the pipe spaced so as to suggest they were due to some sort of force against pipe supports. Attachment A depicts the typical support design. There were no supports or wear plate found at this location. It was apparent that in one of the dents, a crack had been repaired by a puddle weld. KAI’s examination found that both dents

protruded on the inside surface, exhibited small circumferential cracks at the center of the protrusions, and clearly preceded the weld repair. Further analysis by ABS and KAI determined that these dents would not have been formed by the dead weight of the pipe, even filled with condensate. ABS concluded that a prior water-hammer event of insufficient magnitude to burst the pipe likely occurred at the site prior to the weld repair.[11] Such an event could have caused the pipe to jump or lift off its support and slam back down on the supports. This theory is also supported by KAI's analysis.

Steam Traps

A steam trap assembly was located in a manhole on 41st Street just west of Lexington Avenue. The assembly consists of three parallel runs of piping in a manifold. Also located on the front end of the manifold in many cases is a blow down valve, manually used to clear the trap assembly of excessive water and debris during certain operations. The bottom run of piping has a bypass valve for the assembly. On the top and middle run of pipe are two identical steam traps, preceded in-line with isolation valves. The traps are essentially thermodynamic valves, which open when condensate collects to a certain level behind the valve. In typical operations, the traps will pulse open every few minutes. The three pipe runs collect at the end of the manifold and then drain directly into the sewer system (see Figures 12 and 13 below).

[11] Staff's record review found that this repair was performed in March 2005. The record also noted "Should consider breaking out MH (manhole) & relay pipe in near future."

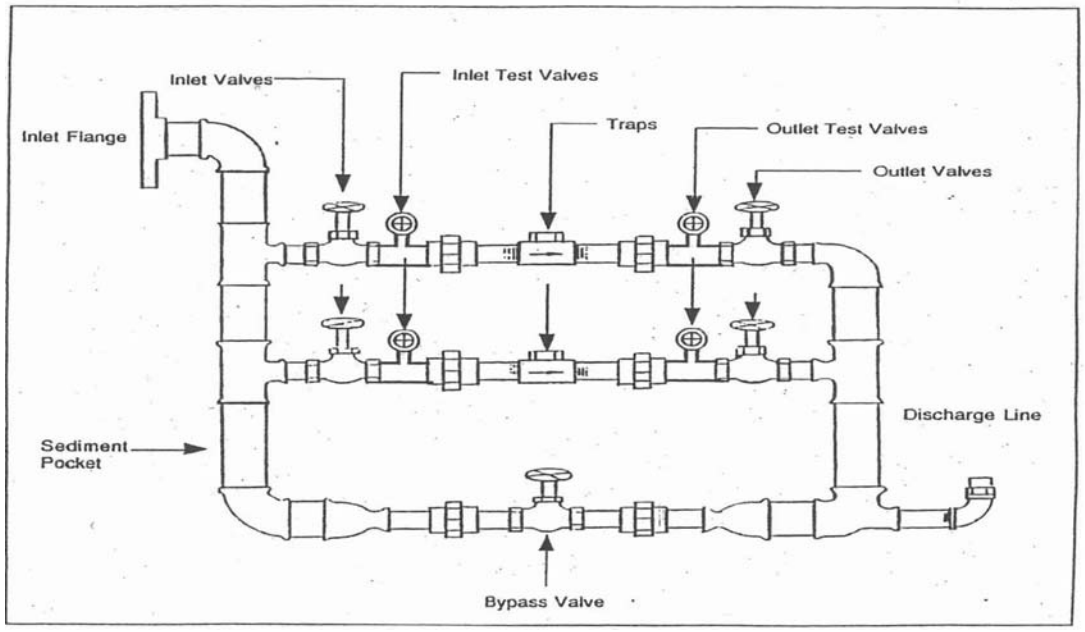

Figure 12 – Diagram of a Trap Assembly

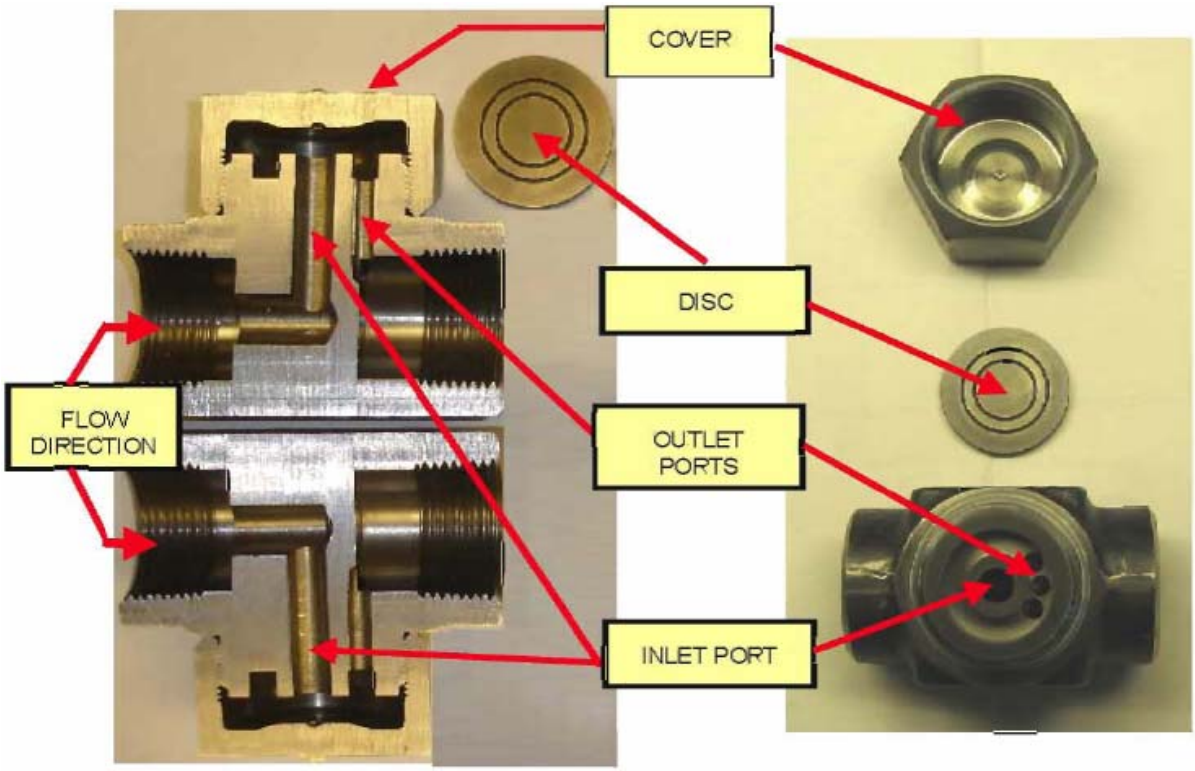

Figure 13 – Steam Trap Cut-Away
Source: ABS Report 1763931-R-001

Because steam flow is necessary to test the traps and it had been redirected in the area of the intersection following the incident, the traps could not be tested in place. It was decided that the traps would be removed and bench tested at Con Edison's facility on 16th Street in Manhattan. On July 25, 2007, Staff was present as Con Edison entered the trap and drain manholes west of the incident intersection and physically removed the steam trap assembly, as well as a section of steam main including the fish-mouth connection. The entire trap assembly and related piping was removed in three sections. Staff accompanied Con Edison personnel as they moved the trap piping to their 16th Street facility. Also present were representatives from LPI and ESI.

The entire trap assembly was connected to a steam supply to simulate the conditions existing at the trap under normal operating conditions in the field, to determine if the traps would operate as intended under normal circumstances. Typically, every few minutes the traps should pulse open to release condensate buildup, indicated audibly by a clicking noise, and visibly with a burst of steam and water exiting the trap piping.

The test pressure was approximately 160 psig. During the test the trap assembly did not appear to be operating properly. Rather than pulse, a constant but small amount of condensate and steam seemed to be flowing out of the traps. Attempts to isolate each of the two traps to encourage operation failed. It seemed possible that the bypass valve on the assembly could be leaking, allowing condensate to pass, rather than build up to the level required to open the traps.

Figure 14 – Photo of Steam Trap Assembly - First Bench Test

On July 26, 2007, a second test of the trap assembly was performed, again witnessed and photographed by Staff and LPI. This time, the bottom leg of the trap assembly was removed, and replaced with a plug, essentially removing the bypass valve thought to be leaking. However, results of this testing remained the same. It appeared the traps were stuck open slightly, as a small amount of steam and condensate was constantly flowing from the trap assembly. The traps never pulsed.

A third test was performed on July 30. This time, a brand new trap assembly was installed at the test location, so that its performance could be compared to the incident trap. Staff observed that the testing room steam was producing enough condensate to initiate the new traps to operate as expected. However, when the trap assembly from 41st Street and Lexington Avenue was again installed, the traps did not pulse. A small

amount of steam and condensate trickled from the assembly. Thus it was concluded that the traps were not operating correctly.

After these bench tests, the traps were turned over to LPI for further testing. Under Staff observation, the two traps were removed from the assembly and radiographed, which indicated that the mechanical disk inside the traps was not seated as expected. All of the steam piping was inspected and found to be visibly free of debris. After the traps were disconnected from the assembly piping, their inlet and outlet ports were inspected from the outside, and no debris was visible. The caps of both traps were removed. The disks of both traps were found askew, pushed up in both cases by masses of debris protruding from the internal inlet ports. The debris in both traps appeared visually similar, consisting of wet, clumped masses, which were brown and orange in color (see Figures 15 and 16 below). The cap was replaced on the bottom trap, so that the trap could be maintained as found, should future testing be required.

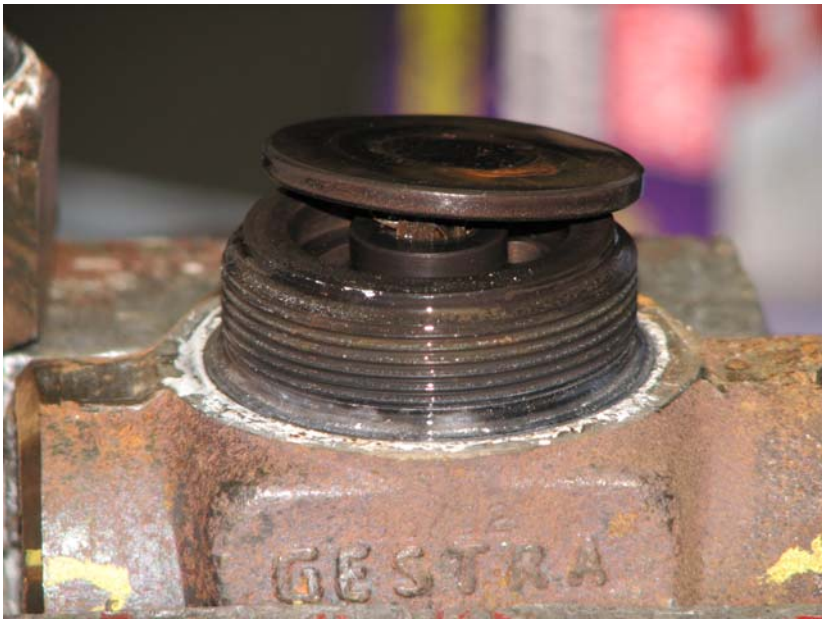

Figure 15 – Photo of Steam Trap (top) With Cap Removed

Figure 16 – Photo of Close up of Debris in Inlet Port
Source: ABS Report 1763931-R-001

The debris from the top trap was carefully removed and collected in layers. The materials were sent out to the University of San Diego (USD)[12] for detailed composition analysis. The materials were found to be chemically similar to samples of leak sealing epoxy taken from the nearby flanged main connection.

ABS performed an analysis of the sinking and dragging forces that would cause epoxy particles to travel from the fish-mouth opening in the main to the steam trap assembly. The analysis determined that during times of heavy condensate formation, which occurs when the outside of the pipe is flooded, both traps would be constantly open and could lift larger particles that would be more likely to plug the trap inlet orifice than a single trap with intermittent flow under normal operating conditions. ABS's analysis also stated that since a water-hammer event is a very short-duration, high-intensity

[12] LPI had an existing contract with USD to perform highly detailed chemical analysis of materials.

pressure pulse, it would not move debris up the drain line. However, ABS suggests that since the drain line would have been water-solid at the time of the water-hammer, the pressure pulse would have traveled up the line and compacted debris material that had collected at the inlet port of the steam traps.

Fish-Mouth Connection

When the fish-mouth connection piping was removed in the field, a large amount of sediment was found caked in the connection. The connection piping was taken apart in pieces, so that samples of the sediment within the fish-mouth connection could be retrieved in layers. The concern was that there was a potential that stratified layers of distinctive sediment would have built in the fish-mouth connection over time, and would have impeded the ability of condensate in the system to flow to the traps and be discharged. These samples were also sent to the USD for testing, which determined they were the result of post-incident debris accumulation, including asbestos from the pipe insulation material, but contained no epoxy sealant materials.

Figure 17 – Photo of Debris in Fish-mouth Connection

Metallurgical Cause of Pipe Rupture

Based upon the physical evidence and historical records reviewed by Staff, as well as the operating conditions on July 18, 2007, and the analysis conducted by ABS, it has been determined that the likely cause of the pipe rupture was a water-hammer event. The failure mode of the steam piping, as determined by LPI and ABS with concurrence from KAI, was consistent with such an event. ABS, LPI and KAI each calculated an estimate of the internal pressure at which pipe would burst, which resulted in a range of approximately seven to ten times the normal operating pressure of approximately 150 psig.[13] KAI further reported that failures of the lap joint in lap-welded pipe tend to occur spontaneously at historically high pressure levels, rather than by incremental crack growth mechanisms. This then suggests that the water-hammer event that caused the pipe to fail was of greater magnitude than prior water-hammer events.

Pressure readings on the steam distribution system, in the vicinity of the rupture, at the time of the incident were 145 psig. Con Edison does not have the capability to generate or distribute steam at pressures above 400 psig. Therefore, the pressure necessary to rupture the pipe did not occur from Con Edison's generation or distribution of steam. In contrast, a water-hammer event has the ability to generate pressure pulses in excess of 1,000 psig.

KAI reported that the examination and testing were adequate to establish that the failure occurred as a rupture originating at a manufacturing flaw (the inclusion stringers) in the lap welded pipe seam, and to eliminate several potential causes of

[13] ABS calculated that for steam bubble sizes of 5% to 25% of the 20-inch diameter pipe, the resulting pressures will be approximately 1,000 to 2,800 psi.

failure, including metal loss due to corrosion, fatigue crack growth, and environmental cracking. KAI also reported that although the pipe contained imperfections in the seam originating with its manufacture, there is no evidence that the pipe was unfit for its intended service. The internal pressure that resulted in the failure was an abnormal level that was many times greater than what the pipe operates at and probably exceeded any prior proof tests[14] of the integrity of the pipe.

VI. ABS Analysis of Conditions Resulting in Water-Hammer

ABS analyzed the operating conditions of the steam system on the date of the incident. Its report states that 912 feet of piping drained to the fish-mouth connection mentioned above, where a 2-inch diameter pipe carried condensate to the steam trap assembly. Approximately 47 feet of horizontal piping crossed beneath the intersection at the low elevation (top of pipe at elevation 26.7 feet) – refer to Figure 2). The two steam traps were designed to remove approximately 3,700 pounds of condensate per hour (lbs/hr) combined. Normal condensate generation for the pipe draining to that location was approximately 400 lbs/hr. However, the inlet ports of the traps were clogged with debris.

ABS calculated that if 100% of the steel pipe's circumference was directly exposed to surrounding flood water, approximately 323 lb/ft/hour (pounds per foot of pipe per hour) of condensate would be generated for the 47 feet of 20-inch pipe, or 15,000 lbs/hr. This rate will diminish, depending on

[14] The steam line was installed prior to the adoption of any standards for design and construction. However, KAI reports that the practices of pipe manufacturing mills in the 1920's would likely have led to an integrity test of between 450 to 650 psig for a pipe of this grade and size.

the external floodwater depth, the condition of the exterior pipe insulation, and as the pipe interior fills with condensate. The condensate level did not reach an elevation where the customers to the south on Lexington Avenue were affected, and therefore the flooding was to at least an elevation of 26 feet 10 inches but not higher than 28 feet 10 inches.

ABS calculated that several hours would be required for the condensate to cool sufficiently to create the conditions necessary for condensation induced water-hammer, within the assumed timeframe of when external water contacted the steam pipe[15] to the rupture at 5:56 PM.

Analysis of the data from pressure sensing telemetry indicates that the pressure differential across the intersection was approximately plus or minus 1 psi from approximately 10:00 AM to 5:30 PM. With the late afternoon operation of valve CV3 described previously, the pressure differential across the intersection rose, with the higher pressure on the west side, allowing steam to come into contact with the condensate, where a steam bubble became entrapped and created the water-hammer phenomenon described earlier (see Figures 18 and 19).

[15] Based on visible vapor conditions recorded by a nearby security camera. See Vapor/Rain Patrol section below.

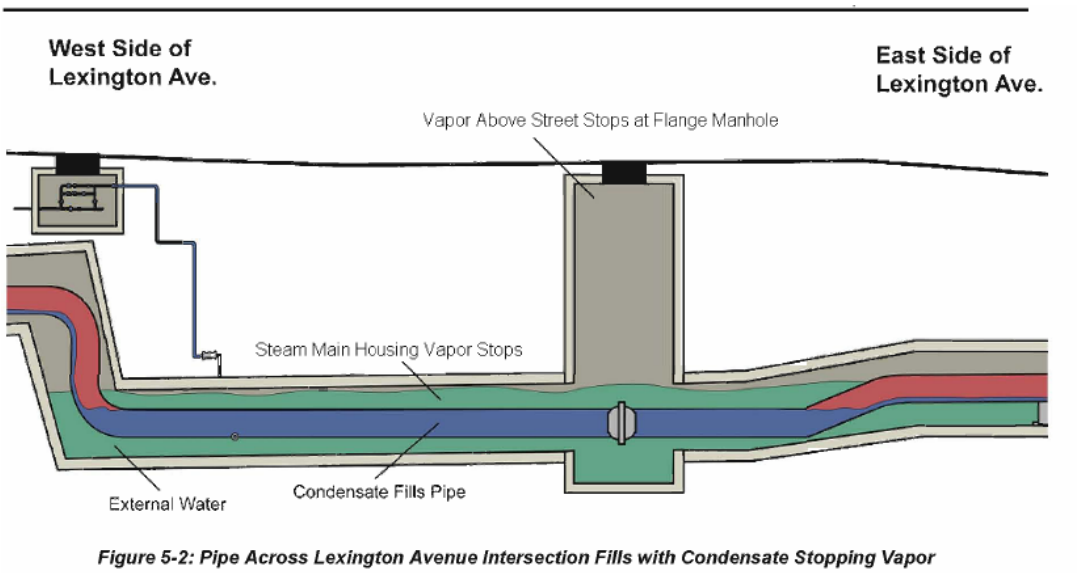

Figure 18 – Pipe Filled with Condensate Stopping Steam Flow

Source: ABS Report 1763931-R-001

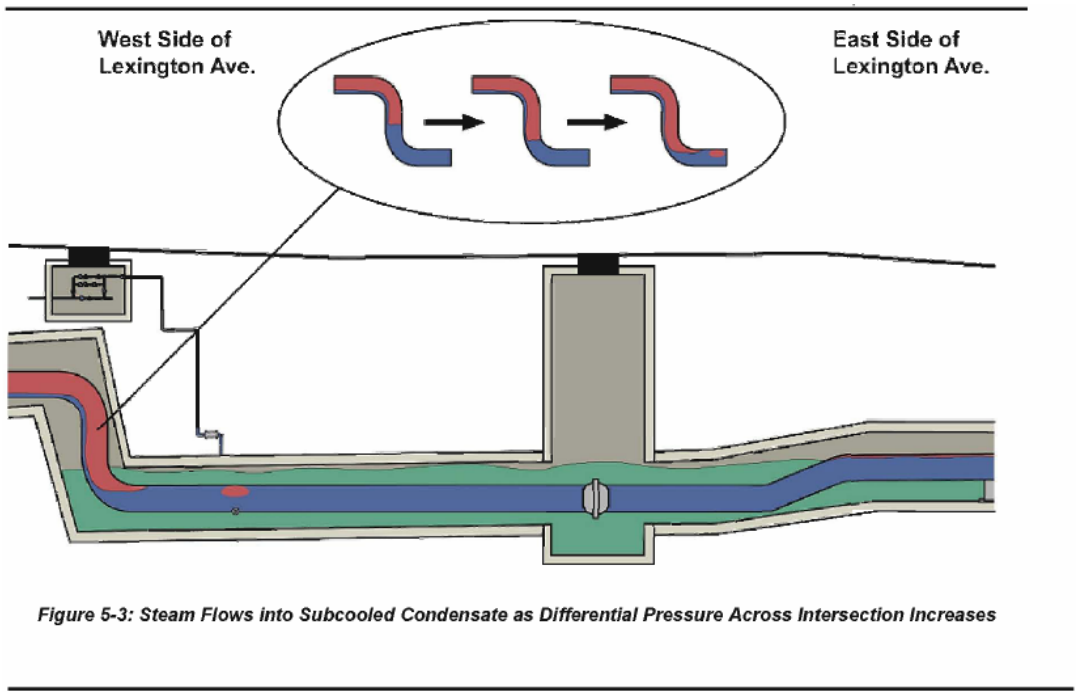

Figure 19 – Steam Flows into Subcooled Condensate

Source: ABS Report 1763931-R-001

VII. Steam System Operations and Maintenance

Staff performed further investigation and analysis to determine what causal factors existed conducive to creating the conditions that would lead to a water-hammer event, including review of Con Edison's Operation and Maintenance Procedures, Steam Operations & Maintenance Information System (SOMIS) records, and vendor invoices.

The minimum standards for operating and maintaining the Con Edison steam distribution system are set forth in the Commission's regulations 16 NYCRR Part 420 – Distribution of Steam. Of particular relevance are sections 420.4 and 420.10 set forth below.

> 420.4 Operating and maintenance plan.
>
> (a) Each steam corporation subject to this Part shall establish and file with the Albany office of the Gas Division of the New York State Department of Public Service a detailed written operating and maintenance plan for complying with all the provisions of this Part.
>
> (b) The operating and maintenance plan shall include, as a minimum, the following:
>
> (1) detailed instructions for employees covering operating and maintenance procedures during normal operations and repairs;
>
> (4) procedures to correct, within specified timeframes, deficiencies found during inspections, evaluations, tests, etc. required by this Part;
>
> (5) procedures for continuing surveillance of steam facilities to determine and take appropriate action concerning failures, leakage history, and other unusual operating and maintenance conditions;
>
> (d) Each steam corporation shall satisfactorily conform with the operating and maintenance plan submitted to the Gas Division of the New York State Department of Public Service.

420.10 Records.

(a) Each steam corporation shall maintain records documenting all inspections, maintenance, tests, etc., required by this Part.

Con Edison's plan containing procedures for compliance with the inspection provisions of Part 420 and filed with the Department is Steam Distribution Procedure S-11952 – Operations and Maintenance Instructions. Sections pertinent to this incident are discussed below.

Steam Traps

420.8 Periodic inspections.

(a) Steam traps and trap piping assemblies shall be inspected for general condition and proper operation at least six times each calendar year at intervals not exceeding ten weeks

The trap set combination that drains the section of steam piping involved in the incident was designated as trap TLXA41S, and was located west of the intersection in Con Edison Manhole 7338. A review of inspections records covering March 1, 2006 to July 18, 2007 showed that it was inspected 12 times, in accordance with Con Edison procedures and Part 420. An inspection on December 5, 2006 noted that both traps were malfunctioning (blowing in the open position) and were replaced.[16] The last inspection before the incident date was conducted on June 8, 2007 with no abnormal conditions found.

[16] The malfunctioning traps were discarded with no test performed on them.

Manhole Inspections

420.8 Periodic inspections.

(e) Manholes containing steam facilities shall be inspected for general conditions and adequacy of insulation at least once each calendar year at intervals not exceeding 15 months and shall be inspected for structural integrity at least once each ten calendar years

A drain manhole (6114) just west of the incident intersection, and a steam trap manhole (7338) just west of manhole 6114, were both found to have been inspected in accordance with Con Edison procedures and on schedule.

The flange manhole was not numbered or listed on Con Edison's manhole population records. However, records indicate that Con Edison personnel had entered it multiple times within the prior 15 months and were aware of the general conditions. One other manhole of the same type was identified that was also not included in Con Edison's program of periodic manhole inspections, although it was not involved in this incident. This is technically a violation of §420.8(e), but had no bearing on this incident. Staff informed Con Edison that all manholes in the system are required to be inspected in accordance with §420.8.

Vapor/Rain Patrols

As discussed previously, S-11952 included a procedure for vapor patrols during periods of heavy rain. Part 420 does not contain a specific requirement for these patrols, but it can be considered an aspect of "continuing surveillance to determine and take appropriate action concerning …unusual operating and maintenance conditions" (§420.4(b)(5)). The procedure contains a list of "Flood Prone Locations" that would be patrolled.

However, within the two years prior to the incident Con Edison had adopted a more conservative practice of vapor patrolling the entire steam distribution system, although the written procedure was never updated. When a hazardous vapor condition is encountered, a crew is dispatched to take appropriate corrective action to alleviate the condition, such as pumping out the manhole, venting the vapor further above ground level with a stack, installing a rain gutter or barricades, and isolating mains should pumping not maintain the water level below the steam main.

An interview of Con Edison management personnel present on the day of the incident, determined that Con Edison initiated a vapor patrol sometime between 8:30 AM and 9:00 AM due to the amount of rainfall predicted, using six experienced people to carry out this task. No vapor condition was observed at 41st Street and Lexington Avenue when it was patrolled at approximately 11:30 AM. Subsequent to the incident, Staff suggested that a review of video recorded by a security camera aimed at the intersection from a nearby building be pursued to determine if a vapor condition had existed earlier that morning. The security tapes revealed the existence and then disappearance of a vapor condition at 8:53 AM and 10:05 AM, respectively (see Figure 20 below[17]).

[17] The timing/date stamp on the security camera was 54 minutes slow, determined based on observation of the event time on the camera versus known time.

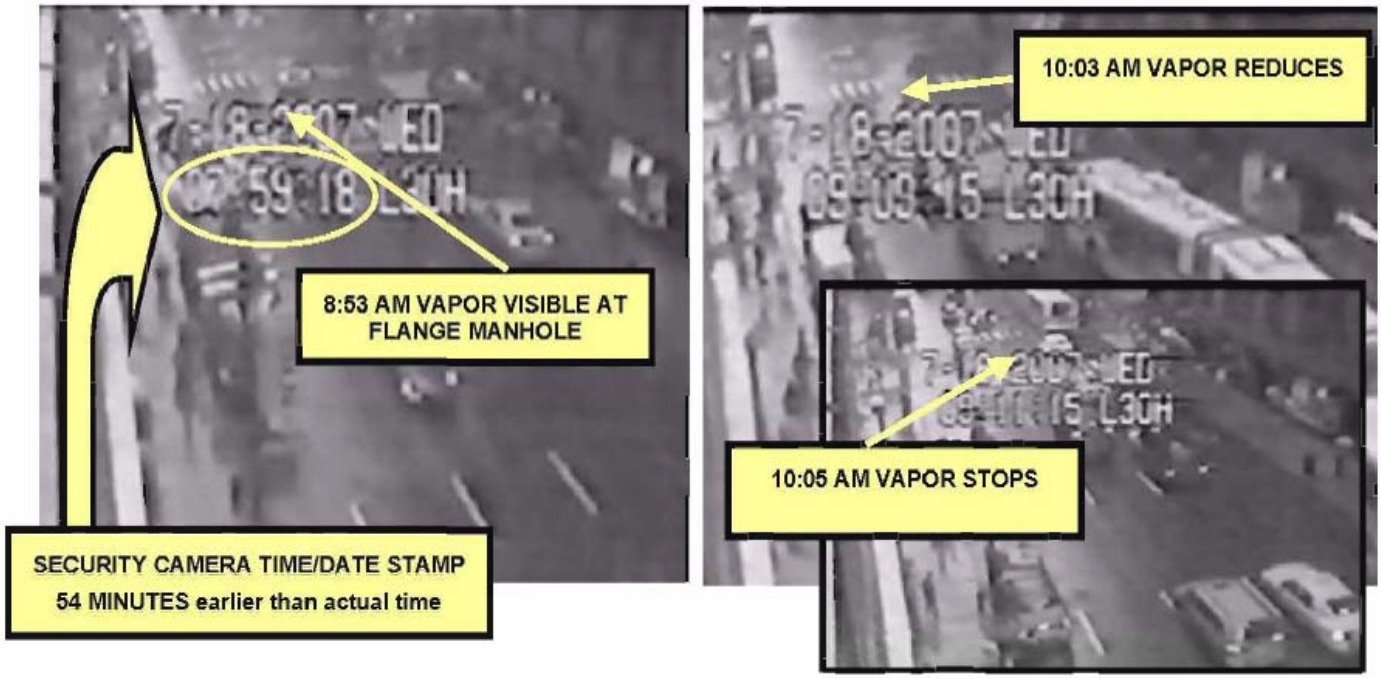

Figure 20 - Start and End of Observable Vapor Condition
Source: ABS Report 1763931-R-001

VIII. Maintenance History at 41st Street and Lexington Avenue

Staff conducted a limited review of New York City DEP records associated with maintenance and repair of NYC water and sewer facilities in an attempt to determine additional sources of water that could have contributed to the incident. The review found records of routine water main breaks, sewer problems, fire-hydrant breaks, broken manhole covers, etc., but nothing that could be definitively linked to the incident.

ABS performed extensive analysis of the infrastructure in the region of the incident. It examined surrounding piping, sewers, and storm drains and indicated a potential for these facilities to contribute to the external water infiltration in the manhole. However, even if these facilities could have contributed to the incident, Con Edison is ultimately

responsible for the safe operation of its steam distribution system.

Staff reviewed various Con Edison records associated with the intersection of 41st Street and Lexington Avenue, including Steam Investigation Tickets (see Attachment B for example), SOMIS records, Steam Leak Status Reports, Planning Meeting Notes, and a chronology of repair activity in the intersection provided by Con Edison to compile the information shown in Attachment C.

The records show that since August 2003, Con Edison responded to the intersection approximately 35 times to address vapor complaints ranging from slight to heavy, to place a vent stack, and/or to pump the flange manhole due to flooding. On some occasions Con Edison conducted dewatering absent any rainfall or on days when minimal amounts of precipitation were noted. Flooding within the manhole also occurred subsequent to consecutive days of slight precipitation, presumably as a result of ground saturation and the proximity of the steam main to the natural water table within the intersection (approximately 2 feet below the bottom of the pipe). In addition, Staff noted remarks on several Steam Investigation Tickets stating that the manhole has had a history of flooding during heavy rains.

Leak Sealing of the 20-inch Flange

The records also noted multiple attempts to seal the leaking flange. A review of invoice records noted that Con Edison had contracted with Team Industrial Services (Team) to perform leak sealing on the 20-inch flange located within the manhole (process routinely referred to as a “LeakTech”). A review of SOMIS records reveals that several attempts were made

since 2002 to repair gasket leaks by injecting sealing products into the flange. On July 16-17, 2005, Team installed a clamp on the flange to facilitate sealant injections. From that date through March 2007 there were ten occasions where sealing products were injected into the flange (see Attachment D – Leak Sealing History at Site (2005 – 2007)).

Various industry research and inquiries by Staff indicate that leak sealing is generally performed with the steam main energized so as to optimize uniform flow of sealants, epoxy cure rates and real-time feedback as to whether the procedure is successfully arresting the leak. In addition, a highly promoted benefit of the process is that it can be used without interrupting customers and/or production. Attachments C and D show that the steam main was shut down during eight of the ten attempts to seal the flange leak. The steam main was shut down due to excessive heat and the hazardous working conditions related to the active leakage in the small manhole. In addition, records show that five of the ten attempts failed to seal the leak. The Comments column of Attachment D refers to a situation known as “mainlining” on three separate occasions with the main shutoff, with the record on January 6, 2006 indicating “heavy mainlining.” Mainlining is the free flow of sealant beyond the flange gasket into the steam main, evident when no resistance is encountered at the injection gun. Attachment D depicts the number of sealing attempts, including quantity of sealant material utilized as well as the on-line status of the steam main at the time of injection. The last attempt at sealing the flange prior to the incident occurred on March 14, 2007 at which time 4 quarts of #1 Liquid, 3 tubes of 2X sealant and 1 Valve Pack AX tube were utilized to seal the flange during

a main shutdown.[18] The largest quantity of sealant utilized in one day on this flange since installation of the clamp was recorded on September 11, 2006 – 3 quarts of #1 Liquid and 10 tubes of 2X sealant on one shift with the main on, then 4 quarts of #1 Liquid and another 10 tubes of 2X sealant on the next shift with the main off.[19]

Attempts to Replace the Steam Main in Flange Manhole

Attachment C shows that recommendations to replace the piping in the flange manhole were made and considered several times.

- March 30, 2005 – in association with the dent/weld repair the Steam Investigation Ticket contained a notation "should consider breaking out MH *(manhole)* & relay pipe in near future."

- August 18, 2005 – measurements taken to replace the flange with a welded piece.

- September 1, 2005 - inspection is performed to check for welder accessibility. Although the space is adequate, an excavation is needed to allow removal of the clamped flange. A sewer limits manhole clearance.

- September 3, 2005 - MSO *(main shut off)* is taken to remove the flange. However, the job is postponed due to unsafe atmospheric conditions.[20]

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[18] This equates to approximately 275 cubic inches of material for this attempt.
[19] This equates to approximately 624 cubic inches for this attempt.
[20] Although the September 1, 2005 entry notes excavation is required to remove the clamped flange, Con Edison proceeded on September 3 anticipating that the flange clamp could be cut up or the top of the manhole broken up to allow removal of the flange clamp. However, the work was stopped when it became apparent that atmospheric conditions in the manhole were unsafe for cutting and welding work.

- September 4, 2005 - Unable to do relay. … The MH needs to be broken out to relay for permanent repairs.

- January 4 & 26, 2006 - Planning meeting discussions on replacement/permanent repair.

- June 8, 2006 - Planning meeting discussion - removal of flange, interference layout for excavation work, and opening permit.

- June 14, 2006 - Engineering forwards sewer plates, water plates, WPA[21] plates, electric plates and gas plates to steam construction. It is determined that a layout[22] is not required.

- June 17, 2006 - MSO. Could not repump flange due to turn on. Measurements taken for an enclosure for the flange during MSO, but the flange is not leak sealed due to lack of time on MSO.

- June 20, 2006 - Planning meeting discussion - vendor may need to fabricate a custom-made clamp.

- June 24, 2006 - Flange is leak sealed during MSO. A slight leak remains at 12 o'clock position on the flange. (Photo shown in Attachment E taken with notation “previous weld repair. Pipe is dented & pitted in several places. Should change pipe!”)

- September 10, 2006 - Also found heat from east MH wall. Possible buried leak. Vapor from electric MH east.

- October 23, 2006 - Permit M01-2006296-081 issued for SOMIS 20062606. Purpose: Repair Steam Leak. Specific Location: 5’ EEC Lexington Ave – 12 NSC 41 ST. Valid: 10/28/06 – 11/12/06.

- December 10 and 11, 2006 – LeakTech could not seal leak on flange at 6 o'clock position due to heat in manhole.

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[21] Works Progress Administration – a federal program which included an initiative to map infrastructure.
[22] To determine if other utilities would interfere with any planned work.

- December 28, 2006 - Permit M01-2007018-046 issued for SOMIS 20063530. Purpose: Construct or Alter Manhole &/or Casting – Rebuild Manhole With Leak. Specific Location: 10’ SWC 41 ST- 22’ WEC Lexington Ave. Valid: 01/18/07 – 03/16/07.

- March 23, 2007 - Permits issued for SOMIS 20063530. M01-2007082-024 – Purpose: Repair Steam leak. Specific Location: 65’ NNC E 41 ST – 3’ WEC Lexington Ave. Valid: 03/31/07 – 04/29/07. M01-2007082-025 – Purpose: Repair Steam Leak. Specific Location: 10’ SWC E 41 ST – 22’ WEC Lexington Ave. Valid: 04/02/07 – 04/29/07.

- April 27, 2007 - Permit M01-2007117-113 (reissue of M01-2007082-025) for SOMIS 20063530. Purpose: Repair Steam Leak. Specific Location: 10’ SNC E 41 ST – 22’ WEC Lexington Ave. Valid: 04/29/07 – 06/03/07.

- April 27, 2007 - At the above location received request to pump area - Heavy vapor in area due to rain. Pumped out 1 headed MH in intersection. Installed (2) - 37" stacks on plated excavation. Secured area with horses, cones, and tape. Contractor needed to open plates. Excavation should be checked at a later time - Pedestrian traffic in area

- June 19, 2007 - Permit M01-2007170-032 issued for SOMIS 20063530. Purpose: Repair Steam Leak. Specific Location: 10’ SNC E 41 ST – 22 WEC Lexington Ave. Valid: 06/23/07 – 07/22/07.

- June 25, 2007 - Buried leak is repaired and the 8-inch branch connection near east crosswalk is re-laid and street restored.

- June 28, 2007 - Job 20063530 closed out in SOMIS Thurs 6/28/07.

Based on review of these records, it appears that in September 2005 some efforts were made to replace the piping within the manhole without having to break the manhole open, which would be more expensive, time-consuming, and require permits from the City of New York to open the street. These attempts were unsuccessful due to unsafe atmospheric conditions

for pipe cutting and welding,[23] and lack of space to remove the clamped flange. Apparently, Con Edison was not fully prepared to accomplish the work at these times.

In October 2006 Con Edison received permits that would allow them to open the street and break out the manhole. However, at about the same time it became apparent that there was a buried leak to the east of the manhole, based on heat in the manhole and pinpointing of vapor conditions in the intersection. Con Edison's attention was diverted to addressing that issue, leading to the reconfiguration of the 8-inch branch connection serving customers to the south on Lexington Avenue, which was completed in June 2007.[24]

IX. Discussion and Analysis

Based on the evidence discussed above, it is apparent there were a series of events leading to the incident, which includes several missed opportunities that may have helped avoid the incident altogether. There were several causal factors, some overlapping and inter-connected, and these will be analyzed in this section. Importantly, these factors are related to the operation and maintenance of the steam system, rather than the age or condition of the steam facilities.

Since the incident, Con Edison has made several modifications to its policies and procedures as more fully described in its Action Plan. Where appropriate, Staff makes

[23] These activities consume oxygen, creating an asphyxiation hazard for personnel in the manhole.

[24] Every year the City of New York imposes an embargo on street opening work from approximately Thanksgiving to New Years Day, which limits the work that could be done in that time period and extends the completion time for a project.

additional recommendations to further minimize the potential for a recurrence.

Steam Traps

As described within, a significant causal factor of the rupture was the clogged steam traps. Con Edison procedure S-11952 requires a visual inspection to assess the general condition of the trap manhole, trap combination, and all piping, and an operational test to determine if there is a proper intermittent discharge of condensation and flash steam to the atmosphere. It also required that during the normal inspections in January and February of each year, the sediment pocket be cleared by opening the bypass valve approximately one turn or until non-obstructed steam flow is heard. Con Edison was meeting the inspection frequency requirements of the regulations, and conducting the inspections in accordance with its procedure. Since the incident, Con Edison has revised its procedure to require clearing the sediment pocket on each inspection rather than once a year.

Con Edison is also evaluating the feasibility of using high capacity traps and various combinations of trap arrangements. It reports that a high capacity trap may not be the optimal solution, because under a sustained “stuck open” condition excessive steam may be released as vapor to the street creating an unsafe condition. However, it reports it is working with various manufacturers to evaluate the positive and negative aspects of this approach, and will implement a program to install them at locations prone to higher condensate loads if it is determined these traps will safely improve the ability to remove condensate. Con Edison is also reviewing and testing trap piping assembly designs to determine if changes could

minimize the possibility of debris entering the traps and to optimize the ability of removing debris if it enters the assembly.

Con Edison's current inspection procedure involves a simple pass-fail test of whether the steam trap is opening and closing and is discharging condensate. It is possible that a trap could be partially clogged with debris yet still pass this test. Also, traps that failed inspection are routinely discarded without any further testing after removal. Staff recommends that Con Edison implement a detailed trap inspection procedure sufficient to periodically ensure that the trap is clear of any debris and can freely operate at its design capacity. At a minimum, it will require the replacement of all traps on an annual basis and internal inspection of all traps removed from service.

Following the incident Con Edison replaced all of the steam traps on its system with a model having a larger inlet port area, which reduces the possibility of debris accumulation. The removed traps were checked for debris, and if found it was analyzed to determine if it contained polymeric material consistent with the epoxy sealant used for flange leak repairs. The results are listed below

Traps in system - 1653
Traps replaced - 1653
Traps opened and inspected - 1558
Traps unaccounted for - 95[25]
Traps without debris - 1369
Traps with debris -189
Traps analyzed – 183
Traps pending analysis - 6
Traps with polymeric material found - 4

[25] Despite the intent to retain all of the traps removed, Con Edison's lack of accurate record keeping and controls resulted in 95 traps being unaccounted for.

Original location of four traps (aside from 41st and Lexington) with polymeric material:

1) Warren east of West Broadway
2) Carmine east of Varick
3) 7th Ave south of Charles Street
4) 6th Avenue south of 55th Street

Con Edison reviewed its records to determine if there is any correlation with recent leak sealing activity in the nearest drainage area to these locations. It found such a correlation for the first listed location. The lack of correlation with the other locations suggests that the leak sealing material can be carried some distance downstream by the steam flow. Thus, concerns about leak sealing material affecting traps beyond the immediate area where the process is utilized must be addressed in revised procedures to justify continued use of epoxy injections to repair leaks.

Manhole Inspections

Regarding manhole inspections, Con Edison's procedure S-11952 states:

> In addition to determining if any leaks exist, mechanics thoroughly examine the integrity of the manhole structure, anchors, insulation and existence of extenders.

It is unclear if the reference to "leaks" is intended to mean the manhole structure, the steam facilities within the structure, or both. The procedure also does not include a timeframe for correcting deficiencies as required by §420.4(b)(4). Staff recommends that the procedure be revised to explicitly state that the condition of the steam facilities within the manhole be checked during the inspections and include specific timeframes for repair.

Vapor/Rain Patrol

It is apparent that relying on visual observance of steam vapor conditions for locating problem areas is inadequate. Vapor conditions can readily cease at any given point in time depending upon the cooling rate of water impinging on the outside of a steam main, which is affected by the rate of condensate build up within the steam main. By the time Con Edison had arrived at 11:30 AM on July 18, 2007, the vapor had subsided because the pipe had become filled with condensate. If Con Edison had more than six people performing the vapor patrols in its designated 14 patrol areas, there would have been a greater chance a Con Edison employee would have arrived before the vapor condition had disappeared. Con Edison's records indicate a known history of flooding at this intersection, even on occasions of less significant rains, and yet that information was not used to anticipate potential flooding conditions. If the Con Edison personnel conducting the rain patrol had pulled the cover for the flange manhole at 41st Street and Lexington Avenue, they would have found it flooded and initiated corrective action according to its procedure, thereby avoiding the incident.

Staff's review of the records of this July 18, 2007 patrol found that Con Edison was able to provide documentation of the personnel assigned and their respective patrol areas. However, it was not able to provide documentation recording the results of the patrolling or whether all patrols were completed.

Con Edison was able to provide records of locations where crews were assigned and mitigated the effects of the rainfall, but these assignments did not have any originating information to tie them back to the patrolling function.

Since the incident, Con Edison has enhanced its practices to include dispatching additional crews to locations that have experienced prior occasions of water accumulation during heavy rains (priority vapor locations), opening manhole covers to inspect the structures for water, and taking appropriate action such as pumping, inspecting adjacent manholes for water infiltration, opening blow-off valves to remove condensate from the steam pipe, and/or main shutoff. Con Edison submitted procedure S-11974 – Rain Response Procedure, which addresses guidance for defining priority vapor locations, requires the highest ranking management person on duty to determine whether a vapor patrol should be initiated, and includes directives for field crews to evaluate priority vapor locations and report their findings to the Troubleshooter Dispatcher and/or designated support staff. Staff recommends that it be revised to more fully describe the documentation process, including results and follow-up activities.

In addition, Con Edison should develop a methodology for identifying, recording, updating and maintaining a list of priority vapor locations. The incident intersection was not on the list of flood-prone locations in S-11952. However, there were extensive records indicating a history of flooding and pumping at that location. Con Edison should conduct a comprehensive review to determine if there are additional locations that should be listed.

Analysis of Dents

Staff's investigation found:

- A Con Edison's Steam Investigation Ticket record dated March 30, 2005 containing a notation: "… welder temp repaired hole in pipe … Also, bottom of pipe is dented

where saddle & roller was located. … Should consider breaking out MH & relay pipe in near future."

- A photo (see Attachment E) associated with flange leak sealing activity on June 24, 2006 with a notation: "previous weld repair. Pipe is dented & pitted in several places. Should change pipe!"

No engineering analysis was ever performed to determine the cause of this unusual condition. Post-incident analysis determined that the dents were likely caused by a prior water-hammer event(s). Had such analysis been performed earlier, the possibility of prior water-hammer event(s) at the location might have been identified, leading to the realization of the susceptibility to such events and further leading to actions to mitigate the hazard. In addition, Con Edison apparently did not have a process to ensure that some type of permanent action is taken to remedy temporary repairs.

Prior to the incident, Con Edison had a very general written failure analysis procedure, consisting of the following:

S-11915 Emergency Response Procedures

Section 9.0 Follow-Up Investigation
The Section Manager of Steam Engineering ensures that required failure analyses are performed on any fittings involved in the hazardous steam condition.

Following the incident Con Edison submitted Steam Distribution Procedure S-11956 – Conducting Failure Analyses of Steam Distribution Equipment, which provides more detail and guidance to ensure that piping and/or facilities that have failed or are

found in poor or abnormal condition receive adequate analysis and corrective action.

Con Edison also submitted Steam Distribution Procedure S-11971 – Welded Repairs of Steam Distribution Piping, which contains the following:

> Temporary Repairs: repairs which will be made permanent at the next availability. Temporary repairs in an excavation will not be backfilled until the repairs have been made permanent, unless specifically approved by the General Manager of Steam Distribution.

The procedure lacks adequate detail and specificity as to when a temporary repair is made permanent. It also does not specifically address such repairs in a manhole. And, it is limited to welded repairs on distribution piping. Repair intervals for other components, for example manholes as discussed above, need to be addressed in order to comply with §420.4(b)(4). Staff recommends that Con Edison revise this procedure to specifically delineate temporary versus permanent repairs, based on detailed engineering evaluation of the repair method. Repairs categorized as temporary must be eliminated in favor of a permanent repair within a specific timeframe supported by the evaluation, but not to exceed six months.

In addition to the actions Con Edison has already undertaken, Staff recommends that it develop and implement training for all steam personnel in identifying evidence of abnormal system operations and conditions, including physical damage such as dents, gouges, pipe deformation and inadequate support mechanisms. Instances must be referred to Steam Engineering for detailed evaluation and analysis, and prioritized for timely remediation as necessary.

Staff further recommends that Con Edison review its SOMIS and other pertinent records to determine the status of any outstanding recommendations or notations for repair,

replacement, analysis, etc. upon which it has not acted, and to prioritize completion.

Leak Sealing of 20-inch Flange

Con Edison used a contractor multiple times to repair a leaking flange on the steam pipe within the manhole at 41st Street and Lexington Avenue, using a method of injecting an epoxy sealant into the flange. The term contract with this vendor contained the following:

> Special Engineering Requirements
>
> 4 The quantity of compound injected shall be minimized, based on calculation of the volume needed to seal the leak.

Con Edison was not able to produce copies of any such calculations and apparently did not enforce or monitor compliance with this provision of the purchase order.

Staff did some further research into this method of leak repair and found the following from a Nuclear Regulatory Commission Inspection Manual[26]:

> Injection of sealant should be limited to two attempts. If after two sealant injections the leak continues, the method should be abandoned. This course of action will minimize the potential for causing undue fatigue loading on the bolts resulting from the high injection pressures normally employed. Additionally, it limits the amount of material that could be injected into an operating system. This recommendation to limit injections to two does not include later injections when a leak seal has been successful and a resealing is needed during or after start-up from a subsequent outage. This statement does not imply that resealing should be repeated indefinitely. The staff notes that the sealants often cannot withstand the differential expansions that occur during a unit outage or a restart cycle and thus are not considered permanent replacements

[26] Part 9900 - Technical Guidance – On-Line Sealing Guidelines for ASME Code Class 1 and 2 Components. Issue Date 07/15/97.

> for packing or gaskets. A permanent repair would normally be expected at the next refueling outage.

In addition, Con Edison shared with Staff the following excerpt from an Electric Power Research Institute (EPRI) technical report,[27] which it consulted when developing the post-incident procedure revisions discussed below:

> 5.5 LIMITING REINJECTIONS
>
> The leak sealing process stops leaks, but it does not correct design or other inherent problems causing the leak. Typical problems include piping system movement and bending brought about by temperature changes in the process, and joints which were forced into alignment during construction. These two problems are easily resolved, but will almost always occur again.
>
> To continually assess these problems, it is necessary to reevaluate any sealed joint after successive reinjections. An initial reinjection of a sealed component may be necessary because injection process problems were not obvious during the first application. Subsequent reinjections should be examined for causes outside the sealant process.
>
> A rule practiced by the Central Electricity Generating Board of Great Britain for flanged systems is to reexamine the joint if more than four reinjections are required. Plant rules and the nature of the process may warrant earlier evaluation. If the reevaluation determines that the joint is of solid integrity and the fasteners are in good shape, it is possible to continue reinjections. In any event, an evaluation should be conducted if reinjection requirements continue.

Bearing in mind that the above references are from the nuclear industry rather than steam distribution systems, Staff asked Con Edison management whether it ever questioned the vendor about the multiple repair attempts. It replied that it relied on the expertise of the vendor, which advised that it

[27] On-Line Leak Sealing: A Guide for Nuclear Power Plant Maintenance Personnel. July 1989

could do the repair, and that reinjections may be required if the piping undergoes cycling (in and out of service). Con Edison stated that this advice came from a technician-level person, not engineering or management. Con Edison also maintains that the concerns relative to multiple epoxy injections have more to do with damaging the flange than with epoxy material entering the piping system downstream.

Since the incident, Con Edison has implemented a new procedure (S-11973) requiring that prior to using this process, the history of a leak location will be reviewed and additional levels of management approval will be required. Vendors are required to provide calculations of sealing material quantity, by volume, for review and acceptance. Any individual component shall not be leak sealed more than three times. When the process is complete, the steam main will be flushed out for an extended period before reenergizing nearby steam traps. After reenergizing, those traps will be inspected once per shift until they are removed from service.

If Con Edison had given greater consideration to the amount of sealant injected and the number of attempted repairs, it might have evaluated other means of eliminating the leaks. Many of these attempts were made with the steam main shut off, defeating the supposed benefits of using leak sealant; not interrupting customers, and providing real-time indications that the leak is actually being sealed. If the main is to be shut off, that presents an opportunity to eliminate, replace or rebuild the flange. If the logistical problems discussed above made those options impractical without breaking open the manhole, the company could have accelerated its efforts to obtain the necessary permits and do the work needed to replace it.

Con Edison provided additional information regarding its leak sealing experience for the two and a half years prior to July 2007, as follows:

- 76.4% sealed first application
- 16.2% sealed second application
- 7.4% sealed third or more applications

Replacement of the Flanged Pipe

Replacement of the piping in the flange manhole was first recommended in March 2005. There was some effort to do so in September 2005, and again in October 2006. In the interim some discussions and planning activities were occurring regarding the work. Meanwhile, flange leak repairs using the epoxy sealant injections continued.

When the work began again in October 2006, the focus shifted to resolving a different issue in the same intersection. Once that work was finished, the job was documented in SOMIS as complete. The original intended work remained uncompleted, and it was apparently not brought up again in planning meetings. Con Edison must institute controls to ensure that in similar situations, the original work does not get “lost in the shuffle.” Con Edison must establish controls for tracking projects in its SOMIS to ensure that all work is completed and prevent unrelated work being assigned to existing project numbers.

Whether the primary motivation for replacing the pipe was removing the dents on the bottom of the pipe, or eliminating the flange and its associated leak repair efforts, both issues would have been addressed. If the flanged pipe had been replaced with straight piping, the flange would have been removed, eliminating

further attempts to repair it by epoxy sealant, thereby avoiding the material clogging the steam traps and affecting the ability to drain condensate from the steam main, and further avoiding the build up of condensate which lead to the water-hammer event.

Continuing Surveillance and Safe Operation

Con Edison's procedures did not adequately address the requirements of 16 NYCRR 420.4(b)(5) for continuing surveillance of the steam system. The company did not integrate existing known data and information regarding the flange manhole at 41st Street and Lexington Avenue including the history of flooding and pumping after precipitation events, the persistent leakage of the flange resulting in repeated attempts over a two year period to stop the leak by sealant injections, the repair of the leaking crack within the dent, and the documentation indicating that the pipe should be replaced. Careful consideration of these items should have prompted the company to expeditiously pursue replacement of the pipe section within the manhole.

Remote Monitoring: Steam Trap, Condensate & Water Conditions

Since the incident, Con Edison has committed to evaluating the feasibility of establishing systems to remotely monitor the condition of steam traps, condensate levels within steam piping, and water levels in steam system underground structures. If this could be achieved it would improve the detection and response time to adverse conditions. Con Edison reports that it is working with various manufacturers, but there are a number of constraints to overcome, such as the harsh environment of elevated temperatures, steam vapor, and possible underwater

operability. Reliable data transmission and power supply is also a consideration, and Con Edison reports that it is evaluating the use of wireless technology and powering schemes, and is working with vendors to evaluate equipment that will be able to withstand the harsh environments.

X. Recommendations

1) Con Edison must establish a specific procedure for direct physical inspection of steam facility manholes that are historically prone to flooding due to significant precipitation events or other causes of water infiltration. The procedure must include detailed criteria warranting the inclusion and updating of specific manhole locations, and specific actions to be taken by company personnel in response to observed conditions. The documentation process must include the inspection results and the follow-up actions.

2) Con Edison must establish a procedure for identifying and continually evaluating manhole locations, including information from field crews, to determine locations that require automatic pumping capability.

3) Con Edison must evaluate its steam system to identify locations that, based on elevation profile and potential for water infiltration or flooding, are similar to the piping arrangement that existed on 41st Street across Lexington Avenue prior to the incident. These locations must be subject to detailed engineering evaluation to determine all reasonable actions that are necessary to alleviate potentially unsafe conditions.

4) Con Edison must establish a detailed trap inspection procedure sufficient to periodically ensure that the steam

traps are clear of any debris and can freely operate at its design capacity. At a minimum, it will require the replacement of all traps on an annual basis and internal inspection of all traps removed from service. Traps that fail inspection must be immediately replaced and promptly investigated to determine the cause of failure.

5) Con Edison must establish training and operating procedures to ensure that instances of steam system damage or degradation detected by company personnel are documented and referred to Steam Engineering for appropriate detailed evaluation and analysis. The company must prioritize conditions based on the likelihood and consequences of a system failure, and recommended actions to correct unsafe conditions must be timely completed.

6) Con Edison must revise its manhole inspection procedure to explicitly state that the condition of the steam facilities within the manhole be checked during the inspections, and to include a timeframe for correcting deficiencies as required by 16 NYCRR 420.4(b)(4).

7) Con Edison must establish procedures for effective control of contract vendors performing any operations, maintenance, or repair work on its steam system. The procedures must ensure that contract stipulations are strictly adhered to based on oversight by appropriate, knowledgeable company personnel with extensive experience in the steam system operations, maintenance, and repair procedures and processes.

8) Con Edison must categorize repairs to the steam system as temporary or permanent, based on detailed engineering evaluation of the repair method. Repairs categorized as temporary must be eliminated in favor of a permanent repair

within a specific timeframe supported by the evaluation, but not to exceed six months. Con Edison also must revise Procedure S-11971 - Welded Repairs of Steam Distribution Piping, to provide a specific time frame for repairs, including such repairs in manholes. Repair intervals for all components must be addressed for compliance with 16 NYCRR 420.4(b)(4).

9) Con Edison must establish a procedure to review its SOMIS and other pertinent records to determine the status of any outstanding recommendations or notations for repair, replacement, analysis, etc. upon which it has not acted, prioritize completion, and take appropriate action.

10) Con Edison must establish procedures to control tracking of planned projects in its SOMIS to ensure that all work is completed. The procedures should prohibit initiating and assigning unrelated work to existing project numbers and avoid closing out projects in SOMIS when the originally intended work has yet to be completed.

11) Con Edison must discontinue the use of leak sealant injections as a method to repair leaks unless it can demonstrate that effective controls are in place to verify the proper quantity of material injected, limit excessive applications, and ensure that the steam system components will not be adversely affected.

12) Con Edison must conduct feasibility analyses for remote monitoring systems to detect real-time water infiltration into subsurface structures containing steam pipeline facilities. Con Edison must also conduct feasibility analysis on systems to detect condensate levels within steam piping at specific locations identified based on history of excessive condensate formation requiring actions to alleviate potentially unsafe conditions. Bi-

monthly progress reports shall be submitted to the Office of Electric, Gas and Water.

13) Con Edison must conduct feasibility analysis of high capacity steam traps and trap assembly designs with the aim of improving debris removal. Bi-monthly progress reports shall be submitted to the Office of Electric, Gas and Water.

Attachment A

Pipe Support Design

EO-7412-C

REVISIONS

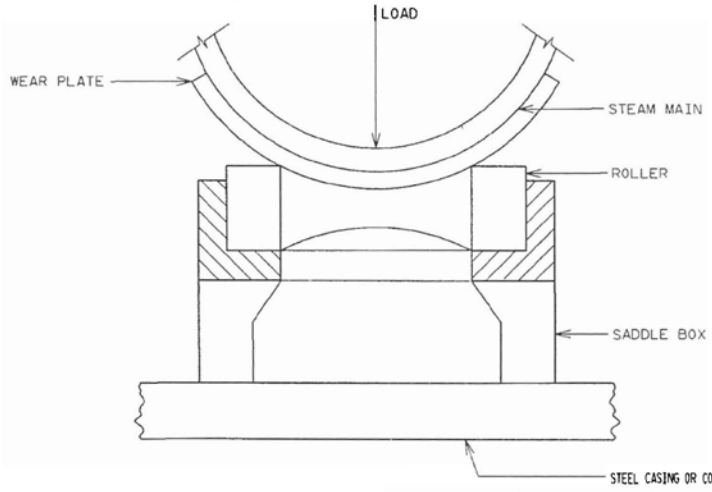
	13

ADDED THIS DWG AS SHEET 2 OF 2 R.P.R. 6/15/05

ALLOWABLE PIPING LOADS FOR CAST IRON SADDLE BOX FOR 200 PSIG OR 400 PSIG STEAM MAINS

THESE LOADS ACT DOWN ONLY (AS SHOWN BELOW) AND CAN BE FROM ANY COMBINATION OF LOADS (DEADWEIGHT, PRESSURE THRUST, THERMAL EXPANSION) CONSULT WITH STEAM ENGINEERING IF CALCULATED LOADS ARE GREATER THAN SHOWN BELOW.

MAIN SIZE (inches)	ALLOWABLE LOAD (lbs.)
6	1,760
8	1,850
10	2,690
12	4,120
16	4,390
20	4,610
24	4,060
30	4,440



CAST IRON SADDLE BOX AND ROLLER FOR 6" TO 30" STEAM MAIN (SHEET 2 OF 2)

CONSOLIDATED EDISON COMPANY OF N.Y., INC.
STEAM DISTRIBUTION ENGINEERING

DATE 06-15-05
LAST REV. 05-12-06
DWG. NO. EO-7412-C REV. 14

Attachment B

Steam Investigation Ticket (page 1 of 2)

1 X (3)

Steam Investigation Ticket

Address/Location Lexington Ave + 41st Date 4-13-04
Cross Street Intersection
Specific Measurements
Parking Restrictions NA Gas Test % 2-8

LAYOUT# 20040572 AWU# 9538952 ACCT# F3815 JOB STATUS

Leak in Street N FWL N Noisy MH Cover N Shifted Road Plate N Other
(Acct # F3815) Acct # F3953) (Acct # 8)

LINE UP 4-14 4-14

ORIGIN OF COMPLAINT
Public
Company Forces ✓
Telephone Co.
Other

PRIORITY
1
(2)
3

VAPOR CONDITION
Slight
Medium ✓
Heavy

Installed 37" stack Yes Damages Claimed by Complainant N

Problem: Leak in MH N Buried Leak N Water in MH N Water/Sewer Leak yes MH Jackets Y/(N)

Fitting Type / Size

Leak Thru Valve Y/(N) BOV Y/(N) 1" BO Assembly Required Y/(N) 1" BO Assembly Installed Y/(N)

Expansion Joint N Corr Leak N # of Corr N Size N " F/F Meas. N " Gasket Leak Y/(N)

Traps 200/400 Blowing N Size ½" ¾" 1" Walseal Leak N TBP Blowing N

Leak on CC / Discharge N Replace Trap Combo N Weld Leak N

M.S.O. Required For Repairs Y/(N) Suspect PACM Y/(N) Cast Iron Y/(N)

MH Repair N DigJob N Pinpoint N MH Cleaning Required N Casting/Slab NA

Welder Required Y/(N) Enough Room to Make Repairs Y/N

Condition Causing Problem to: Pedestrian ✓ Building Traffic ✓ Other

DISPATCH TIME/DATE 1620 / 4-13-04 INSPECTED BY Easterling / Brunner
ARRIVAL TIME/DATE 1630 / 4-13-04 SUPV. SIGNATURE [signature]
Job Description &Action Needed: Respond to complaint of vapor in Street
Upon arrival found NYPD securing MH cover. After removing cover found water touching main. Pumped out MH and installed 37" Stack + grading. MH has history of flooding during times of heavy rain. While pumping out MH. DEP arrived and inspected catch basin and sewer. Possible cracks in catch basin. Stack can be removed once rain stops

COMPLETED: Date: By:

Job Code: S Follow Up Needed By: Steam ✓ Electric Gas DEP ✓ Other

Attachment B

Steam Investigation Ticket (page 2 of 2)

Inspection & Repair Record

8-5 TRAP INSPECTION

DATE 4-13-04 INITIAL GE

SIZE	INSP.	REPAIR CODE
1.00	G	

INSP. CODES	REPAIR CODES
G= GOOD	U=UPPER TRAP BLOWING
R= REPAIRED	L=LOWER TRAP BLOWING
W= NOT REPAIRED	X=UPPER TRAP PLUGGED
C= NEW COMBO	Y=LOWER TRAP PLUGGED
T=TRAFFIC/PARKING	B=TPB LEAK THROUGH
V=VEHICLE ON COVER	Z=TBP PLUGGED
O=OTHER	N=NIPPLE LEAK H=UNION LEAK
	K=FLNGE LEAK S=WALSEAL
	C=CLEANED MH
	P=PUMPED MH
	I=COMBO INSTALLED

MH INSPECTION - TYPE _____

DATE _____ INITIAL _____

WATER IN MH? Y / N - AMOUNT _____"

% INSUL	ROOF	WALL	ANCHOR
0	G	G	G
25	F	F	F
50	P	P	P
75	EXT Y N		T-BEAM
100	LEAK Y N		NA

REMARKS _____

SLIP JOINT INSPECTION

DATE _____ INITIAL _____

SIZE ____" LEAK Y / N GREASE Y / N

NOTE TRAVERSE #1 & # 2 AS N-S or E-W

TRAVERSE MEAS. #1 _____"____

TRAVERSE MEAS. #2 _____"____

PACKED LEAK? Y / N STOPPED? Y / N

LEAK NEAR PLUNGERS_____

ALIGNMENT Y / N - TEMPERATURE ____

REMARKS _____

Valve Inspection

Valve directions include N - S - E - W and X if none is available

Significant corrosion requires an MSO ASAP. Submit MSO Ready Sheet

Valve manufacturers are Chapman, Conval, Darling, KeroPlate, KeroCap, KeroClamp, New Co, Walworth, Williams & Zidell

Valve types include MV, BO, BP, DS, TV & SV.

Leaks and other defects require a WA

Insulation is to be removed from ALL BOV's

Insulation is to be removed from ALL BOVs

DO NOT REMOVE jacket or insulation on a Kerotest Valve if leaking

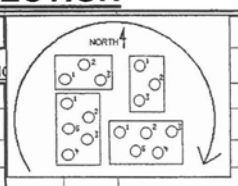
Insulation types include; "J" = Jacket, "I" = Insulation, "Y = Yes, "N" = No, "?" = information can not be determined

MH#	LOCATION	DIRECTION	MANUFACTURER	TYPE	INSUL.	CORROSION (circle one)
						N/A SLIGHT SIGNIFICANT
						N/A SLIGHT SIGNIFICANT
						N/A SLIGHT SIGNIFICANT
						N/A SLIGHT SIGNIFICANT
						N/A SLIGHT SIGNIFICANT
						N/A SLIGHT SIGNIFICANT
						N/A SLIGHT SIGNIFICANT

MANHOLE COVER / SLAB INSPECTION

MH #1 Measurements _____

LOCATION:		COVER #	SOLID	COATED	CONDITION	44" RING
☐	SIDEWALK	1	☐	☐	G / F / P	☐
☐	CROSS WALK	2	☐	☐	G / F / P	☐
☐	CURB LANE	3	☐	☐	G / F / P	☐
☐	STREET	4	☐	☐	G / F / P	☐
☐	SCHOOL/PLAYGROUND	5	☐	☐	G / F / P	☐



COMMENTS:

Covers are to be counted clockwise starting from the North or West end of the manhole slab. See diagram.

Attachment C

Chronology of Manhole Pumping, Flange Injections, & Repair Efforts

DATE	PRECIP inches	MANHOLE PUMPED	LEAK TECH	MAIN SHUT DOWN	REMARKS	SOURCE
11/22/2002					Flange leak is repaired using leak seal method during main shut off (MSO).	CHRONO
8/8/2003		YES			At location above found heavy vapor coming from MH - found MH flooded pumped same, Installed 37" stack over same. Water from heavy rains.	SIT
9/21/2003					Weld leak on patch at bottom of pipe in drain manhole in west crosswalk is identified.	
11/9/2003					Flange leak is repaired by leak seal method during MSO.	CHRONO
11/29/2003					File 3 bend, flange and patched section of pipe west of the drain manhole in the west crosswalk repaired by relay during MSO.	CHRONO
12/20/2003		YES			Re: Vapor condition. In drain MH at 41st w/o Lex. Ave found no leaks or heat. No water in the MH. Remove stacks and pump. Inspected the MVMH at 41st e/o Lex. Ave. Found the west 3" BOV leaking through. Installed 3x1 assembly on same. Should replace all BOV's in the MH. Valves leak through. The condition in the intersection did not change. Should pinpoint the area from the intersection to the MVMH.	SIT
1/14/2004	0.06				Complaint - vent stack	SOMIS
1/18/2004	0.56				At above location complaint of 37" stack knocked over. Reinstalled same.	SIT
2/13/2004					At the above location investigated area for leak. Checked single head MH in intersection found slight leak on flange. Unable to determine where on flange. Found no heat direction thru housing. Found heat and vapor entering shaftway up high toward east side of MH. Checked drain MH west of no heat or water. Checked sewers in surrounding area. Unable to get good direction. Checked MVMH s/o 42nd St. Heat from south. Checked MV e/o 41st - no heat -tight housing. Need to continue. Believe leak is on tee. Need to find depth of same.	SIT
2/26/2004					Weld leak on the 8-inch weldolet in the east crosswalk repaired during MSO. Repaired weld leaks on the 20 X 16-inch reducer and the 8-inch main in the east crosswalk during second MSO.	CHRONO
4/13/2004	1.17	YES			Respond to complaint of vapor in street. Upon arrival found NYPD securing MH cover. After removing cover found water touching main. Pumped out MH and installed 37" stack + grading. MH has history of flooding during times of heavy rain. While pumping out MH DEP arrived and inspected catch basin and sewer. Possible cracks in catch basin. Stack can be removed once rain stops.	SIT
4/15/2004	(4th day of rain) 0.07	YES			At above location found MH flooded. Pumped out same and left OK. Also removed 32" stack and barricades.	SIT
7/13/2004	0.95	YES			At above loc pumped and installed 37" stack, grating and barricades over MH. Heavy rain causing vapor.	SIT
7/14/2004					First indication of leak seal "cables" around 20-inch flange. Slight leak sound noted.	CHRONO
7/14/2004	(3rd day of rain) 0.36	YES	Leaking		Pumped out MH in intersection. Water in MH due to rain. Removed stack. Flanges in MH has leaktech cable around flange. Need to be repumped. Slight leak sound from flanges.	SIT
7/15/2004					Leak seal vendor cannot work due to depth, lack of ventilation and rescue equipment. Flange determined not to be leaking. Very slight leak sound noted from east manhole wall.	CHRONO
7/15/2004		YES	Repumped		At above location met LeakTech for repump. Flange not leaking. Very slight leak sound from east MH wall. Pump out MH and secured same.	SIT
8/16/2004	(4th day of rain) 0.46				At above location received complaint of vapor condition, unable to pump MH, installed 37" stack over same.	SIT
9/18/2004	(2nd day of rain) 2.19				At above location Installed 37" stack, grading and barricades. Installed same to vent MH. Verizon working in area.	SIT
9/21/2004					Removed 37" stack and barricades from above location.	SIT
3/24/2005	(2nd day of snow) 0.10	YES			1:45:00 AM - Vapor from above loc. Install 37' stack grading & barricade in the intersection of 41st & Lex to vent vapor. Check DMH 41st w/o Lex found water in same. Pumped out same. Next to the slab on the south side there is a hole on the asphalt. Also the catchbase by the N.W.C. of 41st & Lex is clog. Same needs cleaning by the sewer dept. Installed MAC on the hole. In DMH need ext ladder to insp same, but you can see water penetrating bet. the roof and shaft. Also pumped out one head MH in the intersection. Left 37" to vent. Leak in MH possibly on the flange gasket. Leak's to *(sic)* moderate to check while the main is on.	SIT

3/24/2005	(2nd day of snow) 0.10	YES			9:00 PM - At above location pump out MH. Strong leak & vapor from same. Could not inspect MH. Too much heat. Possible leak on flanges. Need to check on blow down.	SIT
3/30/2005		YES		YES	At the above location welder temp repaired hole in pipe on M.S.O. Also, bottom of pipe is dented where saddle & roller was located. Flanges were leaktech'd previously. Should consider breaking out MH & relay pipe in near future. Removed 37" stack.	SIT
3/30/2005					Repaired a hole in a dent immediately west of the 20-inch flange during MSO.	CHRONO
4/8/2005	(2nd day of rain) 0.38	YES			Vapor from MH - During heavy rain. Found MH flooded, pumped out secured same. Need long ext ladder for inspection. Repair & inspection of MH was done recently I was informed.	SIT
7/8/2005	1.46	YES			Responded to heavy vapor condition with FDNY at loc. At above loc - upon arrival, street was closed by NYPD. Heavy vapor coming out of MH in middle of intersection of 41st & Lex. Also at loc Steven Turner, we pump out with air pump. Upon further inspection found leak on 20" flange at 8 o'clock facing east. 20" Flange was leak tech'd, need MSO so Leak Tech could repump flange. Installed 37" stack, steel grading *(sic - meant grating)* and 2 barricades. MH to be checked over weekend and monitored.	SIT
7/8/2005					20-inch flange reported leaking.	CHRONO
7/11/2005			Repumped	YES	Leak Tech 20" flange.	SOMIS
7/11/2005					Flange leak sealed during MSO	CHRONO
7/17/2005	0.42		Installed Clamp	YES	At the above location Leaktech installed clamp around flange & repumped flange. After turn-on, heard leak sound in MH and found flange is leaking from two bolt holes the one's are at 3'oclock & 9'oclock. Very slight. Remove stack.	SIT
7/17/2005					Vendor installs flange clamp during MSO. Slight leaks from two bolt holes remain after the main is reenergized	CHRONO
8/18/2005		YES			Sent to above location to inspect one head MH and take measurements for upcoming repair of flange leak. Upon arrival, found MH flooded, pumped out same. Took the following measurements: Main to Wall - North 19.5", South 7", Main to floor - 13", Main to ceiling - 50", Clamp to wall - North 9.5", South 7", Clamp to floor - 6" Note: 2 stage extension ladder is needed for this location.	SIT
8/18/2005					Measurements are taken to replace the flange with a welded filler piece.	CHRONO
8/24/2005					Planning for pipe relay job near east crosswalk is begun.	CHRONO
9/1/2005					Inspection is performed to check for welder accessibility. Although the space is adequate, an excavation is needed to allow removal of the clamped flange. A sewer limits manhole clearance.	CHRONO
9/3/2005					MSO is taken to remove the flange. However, the job is postponed due to unsafe atmospheric conditions. Leak sealing is performed, but the flange is still leaking at the 6 o'clock position.	CHRONO
9/4/2005			Repumped		Unable to do relay. LeakTech called in to repump 20" flange. LeakTech sealed all but bottom of the flange at 6 o'clock. On turn-on the flange leaked at 3 o'clock, 9 o'clock and 6 o'clock. The MH needs to be broken out to relay for permanent repairs.	SIT
10/9/2005	0.01	YES			Sent to above location on vapor condition after rainfall. Found 13" of water in manhole. One head MH w/flange. Pumped out same. 32" cover needs to be replaced. 0% coating on same.	SIT
12/29/2005	0.56				At above loc installed 37" stack + grating and barricades to vent out one headed MH. There's a leak sound in the MH but could not inspected (sic) at this time, vapor and heat is heavy. Could not get in MH. 32" cover has no coating.	SIT
1/4/2006					Planning meeting discussion - design review for replacement of the flange was initiated.	CHRONO
1/6/2006			Repumped	YES	Attempt leak seal with main shut off (MSO)	SOMIS
1/7/2006					Flange leak is repaired using leak seal method during MSO.	CHRONO
1/26/2006					Planning meeting discussion - one headed manhole requiring excavation for permanent repair of flange	CHRONO
5/16/2006	(2nd day of rain) 0.67	YES			Complaint of heavy vapor coming from MH. Found one head manhole flooded, pumped out same. Installed 37" stack, grating + barricades to vent.	SIT
6/6/2006		YES	Need to repump		Re: Vapor condition. On inspection, found water in the MH and pumped out same. The flange was LeakTech'd and has to be repumped. There is a leak on the flange at 9 o'clock looking east. Reset stack and barricades over the MH.	SIT

6/7/2006	1.36		Unsuccessful		Location above assisted LeakTech on MH repair. LeakTech crew unable to make repair on 20" flange. No room.	SIT
6/7/2006					Vendor cannot leak seal. Leak is 6 to 7 o'clock position and there is not enough room to drill.	CHRONO
6/8/2006					Planning meeting discussion - removal of flange, interference layout for excavation work, and opening permit.	CHRONO
6/10/2006					Not enough water in MH to pump. Moderate vapor from stack.	SOMIS
6/14/2006					Engineering forwards sewer plates, water plates, WPA plates, electric plates and gas plates to steam construction. It is determined that a layout is not required.	CHRONO
6/17/2006			Unsuccessful	YES	MSO. Could not repump flange due to turn on.	SOMIS
6/17/2006					Measurements taken for an enclosure for the flange during MSO, but the flange is not leak sealed due to lack of time on MSO	CHRONO
6/20/2006					Planning meeting discussion - vendor may need to fabricate a custom-made clamp.	CHRONO
6/23/2006	0.62		Repumped	YES	Assisted Leak Tech with 20" flange. Slight leak remains.	SOMIS
6/24/2006					Flange is leak sealed during MSO. A slight leak remains at 12 o'clock position on the flange.	CHRONO
9/3/2006	(3rd day of rain) 0.01				At above location was sent to check SK job. Checked MH in I/S, heard slight leak, sound coming from same. Possible 20" flange leak, same was previously Leak Tech'd, same may need to be repumped. Also need fall protection to do job.	SIT
9/10/2006			Repumped	YES	At above location after MSO assist Leak Tech: After turn-on flange still leaking relieved by 11-7 shift. Leak was very slight when we left. Also found heat from east MH wall. Possible buried leak. Vapor from electric MH east.	SIT
9/10/2006					Flange is leak sealed during MSO. Slight leak is found on turn-on; flange is leak sealed with main in service. Heat is entering the manhole from the east.	CHRONO
10/19/2006	0.01	YES			At the above location while pinpointing area, pumped out MH. Leak on flanges. Need to repump. Need extension ladder.	SIT
10/20/2006					Area is pinpointed and a possible buried leak near a base anchor is identified. 10' X 8' area is marked out for excavation.	CHRONO
10/23/2006					Permit M01-2006296-081 issued for SOMIS 20062606	CHRONO
10/29/2006	0.07	YES	Repumped	YES	At above loc pump out MH and repump 20" flange with Leak Tech. Job's done. Used 1 tube sealant, 1 liquid, 3 Ing 1/4 valves, 4 Ing 1/8 valves.	SIT
10/29/2006					Flange leak is repaired using leak seal method.	CHRONO
11/8/2006	3.6	YES			At above loc pump out D.M.H and installed 37" stack, vented cover and installed 37" stack vented cover and barricades. Rainwater entering MH. Need long ladder to do inspection.	SIT
11/11/2006					Excavation over the 8-inch main near east crosswalk reveals that the leak is to the north. Further investigation is required. The roadway is restored 11/16/06.	CHRONO
12/6/2006		YES			Pumped out small amount of water, set up fall protection and inspected 1-head MH. Found very slight leak from flange cover at approx 1 o'clock looking west to east. Did not see any water entering, nor any heat direction from either housing. No insulation on main.	SIT
12/6/2006					Very slight leak from the flange is identified at 1 o'clock position.	CHRONO
12/10/2006			Unsuccessful		(Copy of 12/11/06 SIT Remarks) LeakTech did not do the repair. The mechanic claimed the leak is at 6 o'clock, the hole is too hot and it is difficult to make the repair without an MSO. Reset stack with vented cover and barricades over the MH.	SOMIS
12/10/2006					Vendor could not seal very small leak on flange at 6 o'clock position due to heat in manhole.	CHRONO
12/11/2006					At the above location LeakTech did not do the repair. The mechanic claimed the leak is at 6 o'clock, the hole is too hot and it is difficult to make the repair without an MSO. Reset stack with vented cover and barricades over the MH.	SIT
12/19/2006					Complaint of 37" stack down. Met the gas crew on loc. Reset 37" stack.	SIT
12/23/2006	0.78				Installed barricades around 37" stack & removed the broken barricades that was (sic) on location.	SIT
12/28/2006					Permit M01-2007018-046 issued for SOMIS 20063530	CHRONO
1/28/2007	0.05				Location above - found 37" stack knocked over. Reset same & replaced broken barricades. OK now.	SIT
3/3/2007					Move 37" stack from intersection to the D.M.H 41st w/o Lex. Ave.	SIT
3/3/2007					Excavation begins over base anchor and various welds near east crosswalk to locate and repair buried leak.	CHRONO
3/14/2007		YES	Repumped	YES	Sealed flange. Repaired 20" X 8" weld-o-let.	SIT
3/14/2007					Flange leak is repaired using leak seal method during MSO.	CHRONO
3/23/2007					Permits M01-2007082-024 and M01-2007082-025 issued for SOMIS 20063530.	CHRONO

4/11/2007					CARS found cracks on concrete slab around casting for flange MH. Need to break out and replace same.	SIT
4/12/2007	1.38	YES			Vapor complaint from FDNY. Found MH in intersection (Flg in one headed MH) flooded. Pumped out same. Also left stack over road plates at the NE corner of Lex. Ave. Installed 2 stacks and barricades over road plates. Re-check on later shift.	SIT
4/27/2007	2.04	YES			At the above location received request to pump area - Heavy vapor in area due to rain. Pumped out 1 headed MH in intersection. Installed (2) - 37" stacks on plated excavation. Secured area with horses, cones, and tape. Contractor needed to open plates. Excavation should be checked at a later time - Pedestrian traffic in area.	SIT
4/27/2007					Permit M01-2007117-113 (reissue of M01-2007082-025) for SOMIS 20063530.	CHRONO
6/4/2007	2.29	YES			Complaint of steam in street. Met contractor on location. Assisted them with shifted plate. Checked MH in the intersection, found water touching fittings. Started pumping out until relief came.	SIT
6/12/2007	1.18				Install stack due to vapor from the rain water.	SOMIS
6/19/2007					Permit M01-2007170-032 issued for SOMIS 20063530	CHRONO
6/25/2007					Buried leak is repaired and the 8-inch branch connection near east crosswalk is re-laid and street restored.	CHRONO
6/28/2007					Job 20063530 closed out in SOMIS Thurs 6/28/07.	SOMIS
Souces		SIT - Steam Investigation Tickets				
		SOMIS - Con Edison Steam Operation and Maintenance Information				
		CHRONO - Chronological of repairs provided by Con Edison				

Attachment D

Leak Sealing History

Lexington Ave & 41st Street - 20-inch Flange Leak Sealing History (2005 - 2007)

Products Injected

DATE	#1 Liquid Quart	2W Liquid Tube	Sealant 1X Tube	Sealant 2X Tube	Valve Pack AX Tube	Main Status On/Off	Comments
11/22/2002				30	1	OFF	Leak Tech- Due to gap filled w/asbestos could only use cable. Also hole in side of flange.
11/9/2003				30	1	OFF	Leak Tech. Mainline occurred during injection, may require repump. No guarantee.
7/11/2005	2	0	0	6	2	OFF	System was offline when injection was done. Got travel and pressure, when at gun pressure it dropped suddenly, possible mainline.
7/16/2005	0	0	0	13	1	OFF	Install flange clamp & inject. Sealed. If job leaks, Con Edison will enter manhole inspect job and mark leaking areas.
7/17/2005	0	3	0	3	1	OFF	Clamp was pumped offline. Leaked moved to stud bores when turned back on. Since sealed 99%, leak moved to spot we can't get to on line. Hole & pipe too hot.
9/4/2005	3	0	1	6	1	OFF	Incomplete. After drilling eleven new injection ports on flange & drilling out flange clamp, we began to inject sealant to stop leak. Leak is stopped everywhere except 6:00 on flange. Encountered mainlining. Leak is only a drip. Informed Con Ed supervisor of situation.
12/30/2005	N/A	N/A	N/A	N/A	N/A	ON	Incomplete. One manhole. Deep. Request work offline with elephant trunk. Same setup as when we put clamp on. Supervisor concurs.
1/6/2006	3	0	2	3	1	OFF	Sealed. Heavy mainlining occurred during injection. Do not feel leak is sealed. Will wait for main turn-on to see results of repair. Leak is sealed, may require a re-injection.
6/7/2006	N/A	N/A	N/A	N/A	N/A	ON	One manhole. Very hot conditions. Clamp is leaking at 6 to 7 o'clock. No room to drill or to get in and due (sic) work.
6/17/2006	N/A	N/A	N/A	N/A	N/A	ON	Measured up for enclosure. Supervisor on site said they had to turn main back on so we didn't have time to try re-pump.
6/23/2006	1	0	0	1	0	OFF	Drill and tap. 41st and Lexington.
9/11/2006	3	0	0	10	0	ON	Not sealed. Leak keeps moving from stud to stud everytime its getting injected with sealant. Spoke to Con Ed crew and supervisor that it might have to be repumped.
9/11/2006	4	0	0	10	0	OFF	Sealed. Might need repump due to main being off, and not a good travel or pressure of the sealant.
10/29/2006	1	0	3	0	0	ON	Repump. Sealed.
12/10/2006	N/A	N/A	N/A	N/A	N/A	ON	Incomplete. One manhole deep. Con Ed had only 1 blowere on hole. Extremely hot. Found very small leak at 6:00. With shutdownhole should get cool enough to get under pipe.
3/14/2007	4	0	0	3	1	OFF	Sealed.
TOTAL	21	3	6	115	9		

Attachment E

Photo Taken June 24, 2006

(41st + Lex Ave)

Single Head right
Flange leak

Previous weld repair
Pipe is dented & pitted in several
places. Should change pipe!

Attachment F

DPS Office of Consumer Services Report

Customer Service Operations

Summary

DPS Office of Consumer Services (OCS) Staff assessed Con Edison's actions to address human needs in response to the steam pipeline rupture on July 18, 2007 and determined that the Company adhered to its plans, procedures and policies for emergencies and customer communications in response to the incident. Staff reviewed Con Edison's August 2007 report regarding their response to the incident and assessed the Company's compliance with its 2007 Comprehensive Emergency Response Program and its various emergency response and customer service procedures including the Public Affairs Crisis Communication Plan, the Customer Care Emergency Response Plan, the Corporate Event Response Plan, and the Corporate Response to Incidents and Emergencies. In addition, Staff evaluated Con Edison's performance during the steam incident to ensure that the Company had fully implemented the recommendations that resulted from Staff's investigation of the electric outages in Long Island City and Westchester County in 2006.

Staff's review focused on assessing Con Edison's response to customer needs and its efforts to maintain communication with customers, municipal and elected officials, emergency response organizations and the news media in the aftermath of the steam incident. Staff concluded that Con Edison implemented an effective communication program and adhered to its emergency plan procedures for addressing outage events.

Communications

Office of Consumer Services (OCS) Staff reviewed Con Edison's efforts to respond to customer needs and maintain communication with customers, municipal officials, emergency response organizations and the news media in the aftermath of the steam pipeline rupture. As part of its review, Staff evaluated the Company's August 2007 self-assessment report, its customer relations center process, its Comprehensive Emergency Response Program and its follow-through on Service

Commission (PSC) recommendations stemming from the 2006 outage events that occurred in Westchester County and Long Island City. Staff reviewed Con Edison's outreach activities such as daily briefings with public officials and emergency response organizations, the use of customer service outreach vans, dissemination of information to customer service representatives, posting of information on the Company's Web site and the implementation of a reimbursement program for damaged goods.

OCS Staff established and maintained communication with the Company in the aftermath of the incident. Con Edison worked directly with OCS Staff to keep the Department apprised of all the Company's outreach activities. Following the steam incident, OCS Staff received daily updates on the restoration activities and emerging issues/concerns regarding the incident and participated in the daily conference calls with elected officials Between July 19th and August 23rd, Staff received daily status reports from the Company regarding outreach activities at its customer service vans, as well as up-to-date statistics on customer inquiries, claims for personal losses and disposal of soiled or damaged goods. The Company continued to provide claims, inquiry and disposal statistics weekly (or as requested by Staff) between August 23rd and September 26th.

During the first few weeks of the steam incident, OCS Staff provided regular updates to the PSC Executive Office on the Company's progress with restoration activities, emerging issues, and Con Edison's outreach activities as described below:

A. Municipal/Public Officials

During the outage, Con Edison's Government Relations group, within the Public Affairs organization, served as the primary communications liaison to federal, state, and local elected officials. The Government Relations group maintained contact with Governor Spitzer's office, City borough presidents, Council Speaker Christine Quinn, New York City Mayor Bloomberg and other elected officials. Con Edison held daily conference calls with officials on July 19th and 20th, during which Company staff provided an update of field conditions and then answered questions from call participants. Specific requests for information were followed-up after the conference call and responses were

provided accordingly. Con Edison also provided officials with copies of relevant press releases (as recommended by Staff following the 2006 outage events) and answered inquiries on an individual basis throughout the event.

OCS Staff monitored the Company's conference calls and received copies of the press releases. Staff was satisfied with Con Edison's performance in this area and determined that the Company took appropriate measures to keep public and municipal officials informed.

B. Emergency Service Providers

According to Con Edison's August 2007 self-assessment report, its emergency staff personnel and a Mobile Command Center bus were dispatched to the incident site on the evening of July 18, 2007. The Company's emergency staff met with a Fire Department of New York (FDNY) chief on-site and advised that the incident area be treated as contaminated by asbestos (from the steam pipe insulation), and that the potential asbestos hot zone would include all areas with debris on the streets. In addition to the FDNY, Con Edison staff briefed representatives of the New York City Office of Emergency Management (OEM) and the New York Police Department (NYPD) Manhattan Borough Commander on the situation. Additional emergency responders present included New York Department of Environmental Protection (DEP), New York City Transit and the Mayor's Community Assistant Unit. Con Edison later discussed street closures and the status of subway and commuter rail service with OEM and NYPD.

On July 19, the OEM established a schedule of interagency meetings every four hours which were attended by Con Edison's Emergency Planning staff and its Environmental Health and Safety (EH&S) Officer, as well as representatives of the relevant emergency agencies responding to the event. After day three, meetings were held every eight hours. During the meetings in the incident area, a Con Edison representative discussed the status of its electric, gas, and steam systems and identified recent accomplishments and goals for the next 12-hour period. The Company continued follow-up meetings with representatives of the responding emergency agencies as issues and updates emerged. On July 25, 2007, the incident was downgraded from "full scale" to "serious" and

OEM held its last meeting. The Con Edison's Mobile Command Center bus left the site that day.

Overall, Con Edison met Staff's expectations regarding communicating and working with emergency responders. Throughout the incident, the Company coordinated activities and maintained constant communication with emergency responders noted above, as well as the United States Environmental Protection Agency, the New York City Department of Housing, the New York City Department of Transportation (DOT) and the Metropolitan Transit Authority (MTA). The exchange of information between the agencies and Con Edison was used to facilitate cleanup, recovery, inspections, and the restoration of normal public infrastructure services. Con Edison and the City of New York jointly provided status information about traffic patterns to the public via their Web sites.

C. Media

According to the Company's August 2007 self-assessment report, Con Edison's Media Relations office communicated directly with all print, broadcast, and electronic media outlets throughout this event. The Media Relations staff distributed numerous press releases providing updates on the incident including the status of systems conditions and restoration activities, information regarding proper handling of clothing and belongings contaminated with site-related dust or debris and procedures and criteria for reimbursement of claims. Based on the central topic of the press release, the information was distributed to an established list of media outlets, to appropriate Manhattan elected officials and to all elected officials in Con Edison's service territory. The press releases were posted on the Company web site along with other pertinent information such as the locations of the customer outreach van locations and reimbursement procedures. The Media Relations office also stated that they initiated and responded to hundreds of calls daily from local, national and international print, television and radio journalists.

In addition to the press releases issued throughout the incident, Con Edison participated in numerous news media briefings. On the evening of July 18, 2007, Con Edison's Vice President of Emergency Management attended a news conference with Mayor Bloomberg and representatives from

the city's police and fire departments. The Vice-President answered reporters' questions at the midtown site about the steam system and the incident's impact on customers. Later that evening, Con Edison's Chairman held a news conference at the site and provided an update on Con Edison's response to the incident and the repair work underway, including the fact that the Company was testing for the presence of asbestos. The Chairman also participated in Mayor Bloomberg's briefing on July 19th and indicated that the Company had posted a customer service van in the area to assist customers and the public. On July 20, Con Edison initiated its own on-site briefing to inform the news media that it was working on restoration and would project when repairs would be complete following a full damage assessment.

Con Edison's efforts to maintain contact with the news media were in compliance with its internal procedures and Staff is satisfied with its performance. Using press releases and news briefings, and by responding to inquiries, the Company's Media Relations office kept the press updated on the status of the incident and its impact on Con Edison customers, New York City residents and businesses, and the public.

D. Verizon

The steam pipe rupture also resulted in damage to Verizon facilities in the incident area and caused service outages to several buildings within the hot zone. Con Edison and Verizon worked cooperatively with each other and with other agencies to coordinate damage assessment and restoration efforts. Staff contacted Verizon to determine the communication activities that were underway and if the company intended to implement Staff's recommendations from the October 2006 snowstorm that struck Western New York, such as issuing regular news releases and conducting daily conference calls for local officials. Verizon maintained a command center on-site, contacted the owners and managers of the affected buildings and communicated with the Grand Central Partnership to get information to affected landlords. Company personnel were present at the OEM briefings. Staff followed up with company regarding issuing a press release and holding a conference call with local officials. In the company's view, the extent of the outages did not constitute a major outage and therefore it decided

not to issue any news releases nor conduct conference calls.

E. Customer/General Public

A vital piece of the Con Edison's outreach effort was focused on providing information and assistance to the residents and businesses impacted by the incident, the Company's customers and the public in general. The Company used a variety of methods to get information to the public including the use of outreach vans to bring knowledgeable staff directly to the incident area to meet with the affected people as well as posting important information about the incident on its Web site. The Company also worked with customers and the public to process claims for goods soiled or damaged in the incident.

Customer Service Outreach Vans

Con Edison's Customer Operations dispatched two Outreach Vans to the incident location. The first van arrived at East 42nd Street and Third Avenue at 9:00 p.m. on the evening of the incident, and the second van arrived at the northwest corner of East 45th Street and Lexington Avenue at 1:30 p.m. on the following day. The vans operated at these locations every day from 7:00 a.m. to 9:00 p.m. until July 27, at which time the Lexington Avenue site was closed due to decreased customer traffic. The NYPD and OEM requested that Con Edison relocate the remaining van to minimize interference with bus traffic on Madison Avenue. On August 5, the van was moved to the nearest Con Edison location at 14 West 30th Street and remained in operation from 7:00 a.m. to 3:30 p.m., Monday through Friday until August 30, 2007. OCS Staff monitored the Company's outreach efforts throughout the course of the event.

The outreach vans served multiple functions for the Company – a public information center, a drop off location for contaminated clothing and belongings requiring proper disposal and a place for people to file reimbursement claims. The vans provided the Company with an on-site presence where customer outreach staff provided up-to-date information about the incident to the public. Information and signage was provided in 22 languages to accommodate the diverse population in the Company's service territory.

In addition to providing timely customer information, the vans were used as disposal centers for contaminated goods and reimbursement claims processing locations. People were encouraged to bring clothing and belongings that may have been soiled with site-related dust and debris to the vans for proper disposal, and could speak with Con Edison's Claims Department representatives regarding the claims process and file claims for personal losses. Those who visited the vans were provided with a claims card which contained information about how to file for reimbursements.

Over the course of the event, the number of people who filed claims and/or made inquiries through the outreach vans was tracked and recorded by the Company and updates were provided to OCS Staff. Con Edison's outreach van staff processed 3,739 requests for information and 2,187 reimbursement claims. They also collected 1,787 bags of clothing and belongings and arranged for disposal.

Company Web Site

Con Edison consistently used its Web site to post pertinent information regarding the incident. On July 18th, shortly following the rupture, the Company placed a statement regarding the incident on its homepage. Over the course of the incident and restoration, the Company used the Web site to provide updates on the incident and restoration efforts, as well as information about the locations of the customer service vans, information on asbestos and proper disposal of soiled clothing and belongings, reimbursement/claims procedures and Company press releases regarding the incident. The Company also included links to relevant New York City government information. The Company tracked activity on its site during the incident and found that the "Newsroom" link on the homepage experienced an increased number of visits for several days but returned to normal by July 22, 2007.

Company Call Center

Calls regarding the incident were addressed by customer service representatives in the Company Call Center. On July 18th, following the incident and in anticipation of related inquiries, Con Edison increased Call Center staffing levels by 49% for the 5:00 p.m. to 12:00 a.m. shift. Staffing levels were returned to standard levels the next day and through-out the duration of the

restoration activities. According to the Company, the incident did not result in a significant increase in call volume to the Call Center.

Throughout the event, Con Edison prepared information sheets to provide its customer representatives with the most up-to-date information on the steam incident and the claims process for people contacting the Company's Call Center. The initial set of information sheets were issued to Con Edison Staff in the morning on July 19th and updated sheets were issued in the afternoon and evening. The sheets provided outreach representatives with information on the incident, the location and hours of the outreach vans, proper procedures for turning in potentially asbestos-exposed clothing to Con Edison, the claims procedures, and contact information for Con Edison departments and various New York City agencies. The sheets were also provided to OCS call center staff.

The OCS Call Center did not receive any calls regarding the steam pipeline incident.

Additional Assistance

Con Edison's Steam Operations staff determined that 18 steam customers lost service as a result of the rupture and immediately began restoration service to these affected customers. By the morning of July 20, service was restored to thirteen customers. Four of the five remaining customers without steam service were offered boiler trucks at Company's expense (one customer was inaccessible due to street closings) but only one customer accepted the offer. All service was restored by July 28.

Typically, an outage incident would involve the use of the dry ice program due to power outages. The Company did not have to use the dry ice program or contact critical care customers (LSE) in this incident because there was no power outage reported, and only business customers were affected.

Overall, Staff was satisfied with Con Edison's efforts to communicate with its customers and the general public regarding the steam incident. The use of outreach vans was an effective method of providing Con Edison with an on-site presence and brought knowledgeable personnel directly to the impacted area and affected customers. Con Edison personnel working in the vans collected half of the overall

reimbursement claims filed with the Company. In addition, the Company successfully used its Web site to provide pertinent and timely information to its customers regarding restoration status, the claims process and decontamination procedures.

F. Claims

Con Edison is not required in its tariffs to provide claim reimbursement to customers during incidents such as this. However, the Company chose to offer reimbursement and developed a policy for reimbursing customers and the public who were affected by this event. In its August 2007 self-assessment report, the Company stated that the steam incident affected members of the public, street-level businesses, and a number of commercial tenants in the buildings in the immediate area. As noted above, Con Edison used a variety of methods such as the outreach vans, the Company Call Center, press releases and its web site to inform customers about the potential for debris-related contamination, proper disposal procedures and reimbursement/claims process for soiled or damaged goods.

Con Edison also reached out directly to local businesses and agencies to assist in filing claims for damages to business and commercial tenants in the incident area. Company representatives walked the area between East 42nd and East 40th streets and between Park and Third Avenues to assess the scope of the property damage and met with businesses to discuss the reimbursement process. In addition, Con Edison partnered with the Chanin Building which was affected in the incident and established a claims information desk in the building staffed by Company Claims representatives. The claims information desk began operation on July 30, the first day tenants were allowed back into the Chanin building. Con Edison’s claims reimbursement information was also posted on the Chanin Building’s web site. The Company also partnered with the New York City Department of Small Business Services (SBS) to provide affected businesses with information and assistance in filing claims. On July 30, SBS opened an intake center for claim forms located in the Commerce Bank at 317 Madison Avenue at East 42nd Street. Con Edison and SBS jointly established a claims information desk which was staffed Monday through Saturday, 8:00 a.m. to 6:00 p.m.

Finally, Con Edison handled the reimbursement claims for vehicles damaged by the steam pipe rupture. The Company advised the owners of 23 vehicles that their vehicles would be considered a total loss. As of January 18, 2008, the Company had resolved 26 vehicle claims. For those vehicle owners that wanted the contents of their cars returned, Con Edison developed a decontamination and retrieval protocol to address this issue.

As of January 18, 2008, Con Edison had received a total of 5,327 claims; of which, 4,999 were for clothing and personal belongings, 58 for personal injury, 11 for lost wages, 30 for vehicle damage, 159 for commercial businesses and 70 for insurance subrogation. To date, Con Edison has mailed 3,336 reimbursement checks totaling $2,700,735.

Conclusion

Staff analyzed Con Edison's efforts to ensure effective communication and information exchange with its customers, the public, State/municipal/public officials, the media, emergency response organizations and other relevant entities during this event. The Company has implemented OCS Staff recommendations from previous incidents. Con Edison actively maintained consistent and continued communications with relevant entities while adhering to its emergency plan procedures for handling outage events. Throughout the event Con Edison worked collaboratively with public officials, emergency response agencies, news media representatives and the affected businesses in the incident area. The Company met customer information needs by maintaining on-site customer service centers, answering inquiries through their Call Center and providing up-to-date and timely information on its Web site. The Web site provided information concerning cleanup and restoration efforts, claims reimbursement procedures, proper handling of potentially contaminated clothing and belongings and pertinent contact information for New York City agencies. The Company was responsive to customer needs and concerns and maintained communication efforts throughout the incident. Staff is satisfied with Con Edison's overall performance, including its efforts in areas such as the offer of boiler trucks to customers who lost steam service, the partnerships with local businesses and the development of a claims reimbursement program.