

Wayne, MI Pipeline Failure



December 29th, 2010

- Overview
- Pre-Incident
- Emergency Response
- Investigation and Cause
- Applicable Code
- Takeaways

- Threaded coupling failure
- Furniture store explosion and subsequent fire
- 600,000 cubic feet of natural gas released
- 2 fatalities, 2 injuries
- \$2,573,000 in damages
- Affected
 - Furniture store
 - Adjacent structures
 - Passing vehicles
 - Utility customers

Keep In Mind

- Leak survey procedures
- Leak Investigation procedures
- Emergency response procedures

How would you handle the situation?

- Gas main located in abandoned alley/right-of-way
 - 2” bare steel
 - Cathodically Unprotected
 - Installed in 1940
- Residential Fence built above gas main in ROW
- Concrete wall built directly around gas main
- Sanitary sewer directly next to gas main
 - Travel parallel for 233 ft to back of furniture store
 - Manhole 18 in from failure

Incident Area



Incident Area



- Mobil leak survey months prior – no leaks found
- Difficult to complete walking survey due to fences
 - No records
- 2 separate leak calls
- No significant pressure changes recorded
- 21 °F day of

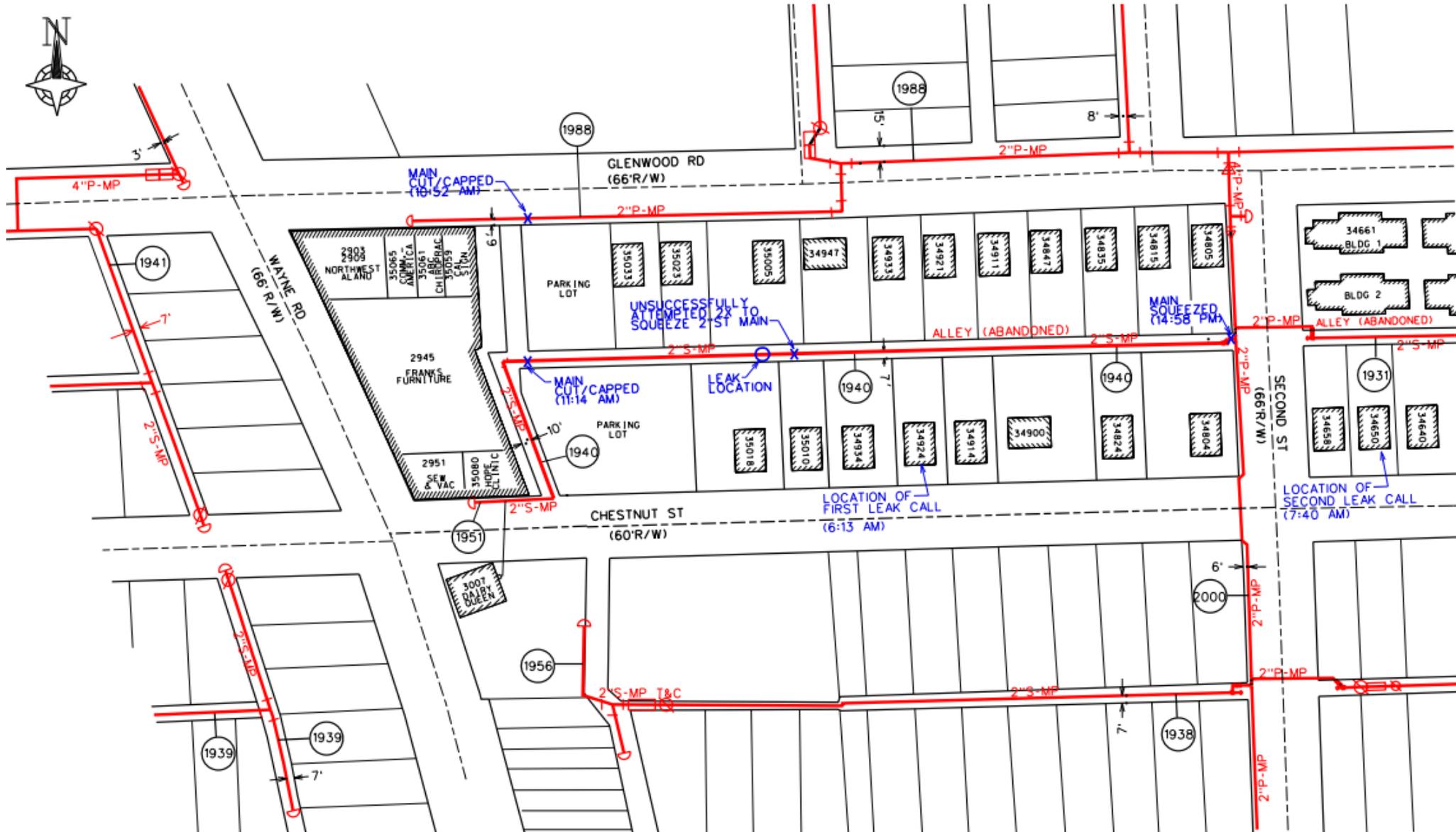
1st Leak Call

- 6:13am, employee arrived at 6:40
- Inside air readings
- Bar hole testing at service riser
- Fittings inspected with gas detector
- Shadow testing on meter
- Investigated manhole and neighboring houses
- No positive reads, or unusual gas flows detected
- Notified occupant of results
- Drove around neighborhood with windows down
- Completed work order and left at 7:00am
 - No leaks detected but occasionally smelt gas in air

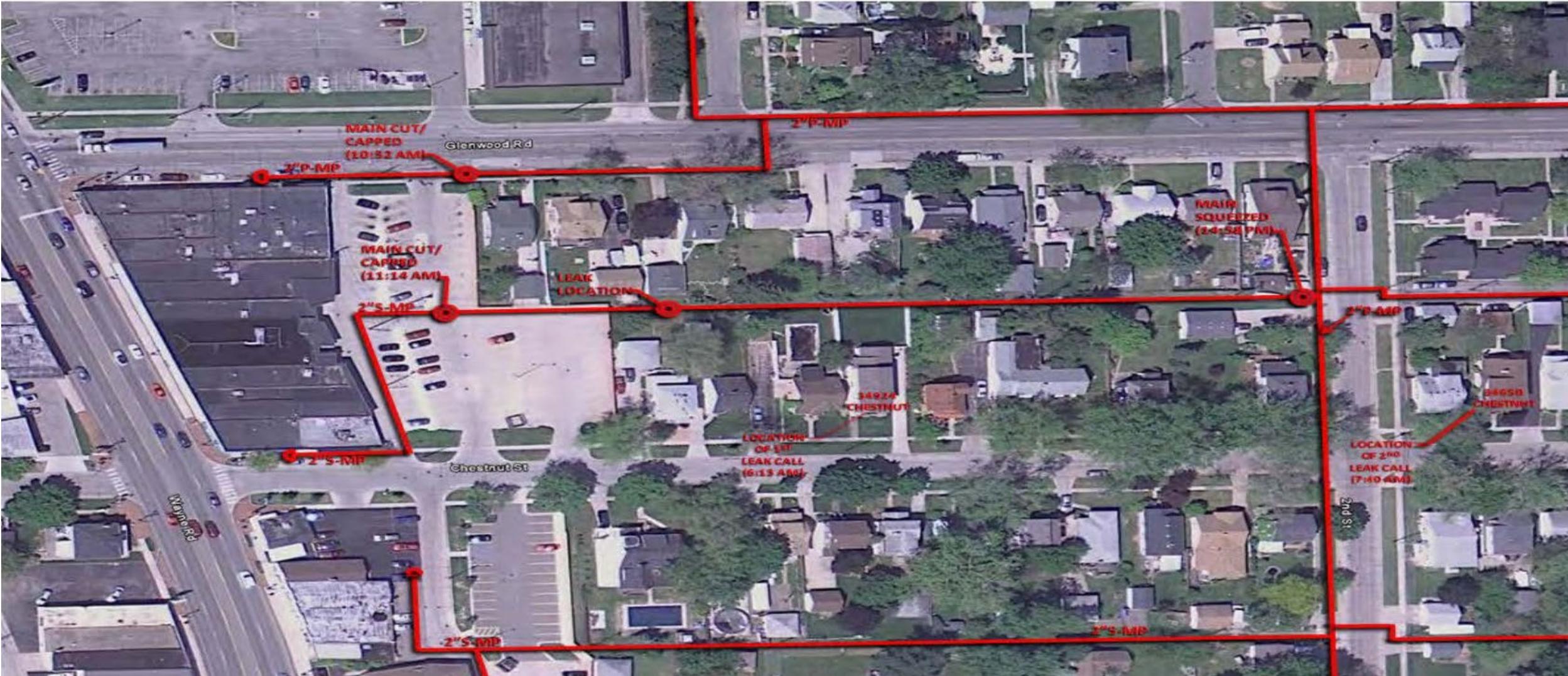
2nd Leak Call

- 7:04am, employee arrived 8:02am
- Fire department on site
- Took air reads around the house
 - No positive reads, no smell
- Bar hole test from riser to main connection
 - No positive reads, no smell
- Bar hole test along main to the West (down wind)
 - No positive reads
 - Sporadically smelt gas
- Air reads driving west down the street
 - No positive reads, continues smelling gas
- Contacted supervisor for support with mobile leak detection unit
 - Explosion occurred before unit was dispatched

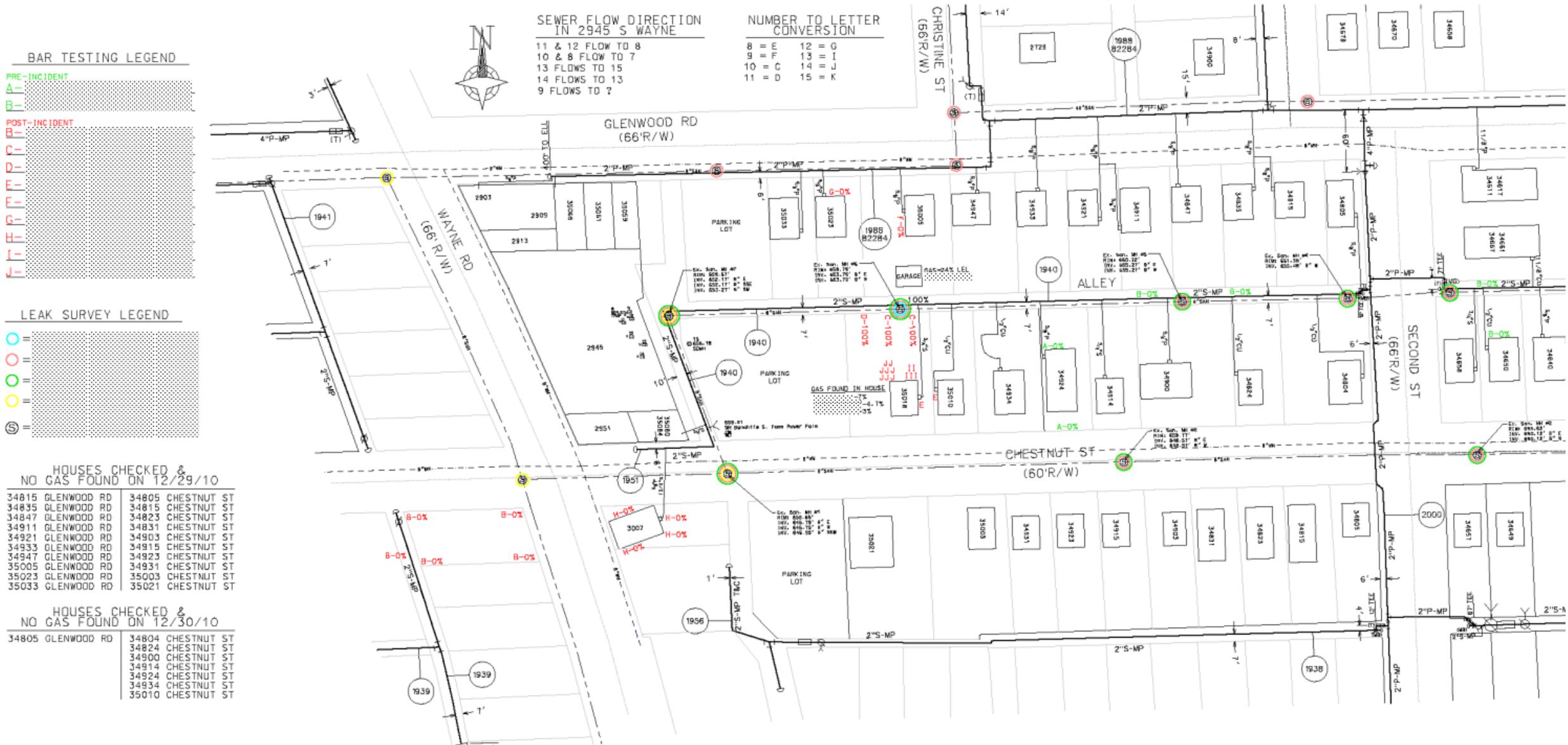
Leak Calls



Leak Calls



Leak Calls



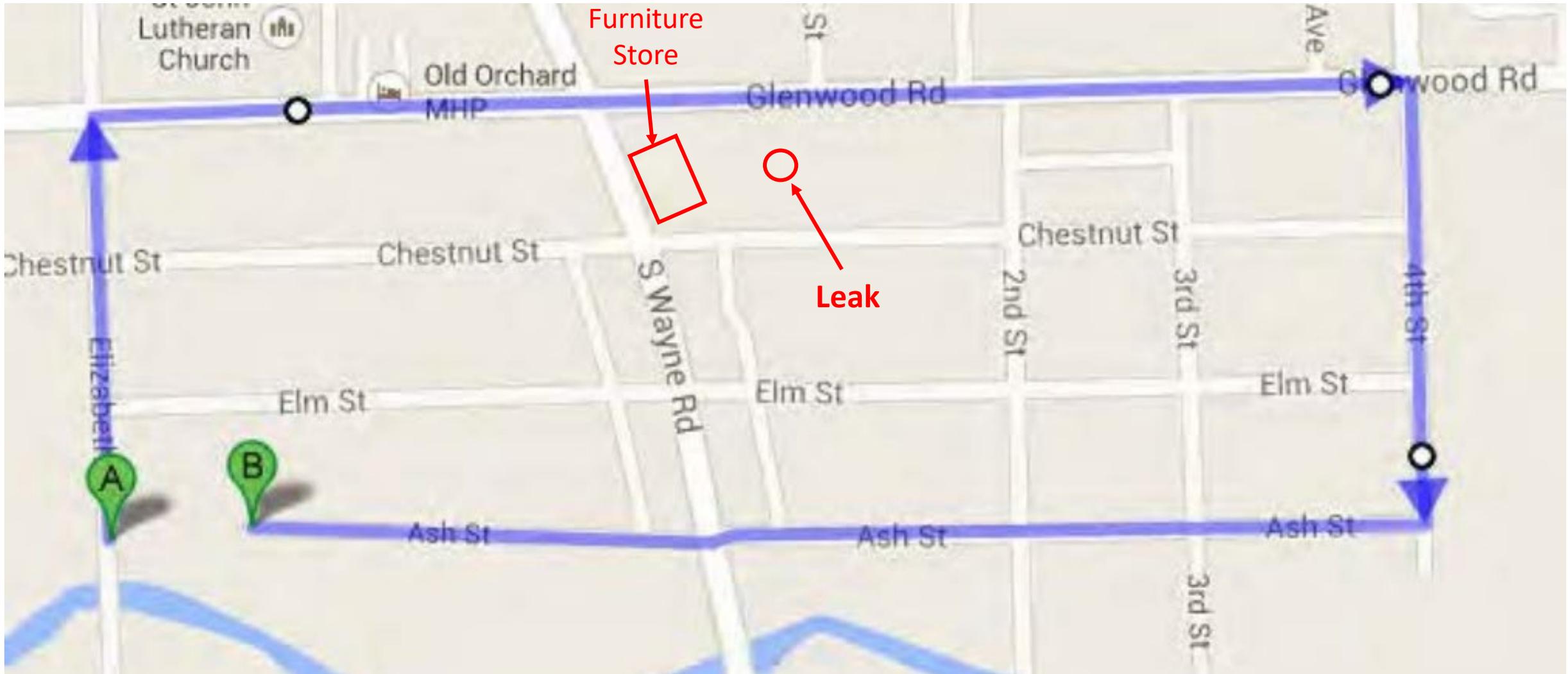
Emergency Response

- 2nd leak call employee heard explosion and notified field leader
 - First responders mobilized
- Fire dept. arrived at 9:08 am, followed by police, medical, search and rescue, investigation, etc
- First responders smelt gas from the meter – damaged from explosion
- Operator employees arrived at 9:20 am
- RMLD and CGI used for mobile surveys with a block radius
- Notified MPSC at 9:59 am and NRC at 10:29 am
- 10:52 am a 2-inch plastic main to the north was cut and capped
- 11:14 am the 2-inch steel main serving furniture store was cut and capped
- Smell of gas in air still reported by 5 personnel
- MPSC and PHMSA responded on site between 12:00 pm and 2:00 pm

Emergency Response

- Between 12:30 pm and 1:30 pm the leak source was found
 - 100% gas read in sanitary sewer manhole east of furniture store
- Bar-hole tested above 2-inch steel main near sewer
 - 100% gas read and gas noted to be blowing out of the hole
- Hand dug over leak location
- Removed sewer cover to vent
- Adjacent blocks evacuated
- Removed manhole covers in 6 block radius
- Bar-hole and gas in air testing done in vicinity of leak
 - Gas discovered in house on parallel street at 7% LEL
 - Gas discovered in garage on same street at 24% LEL
 - Gas migrated underground from main failure to houses

Evacuation Zone



Emergency Response

- 1:50 pm attempt to squeeze steel main upstream
 - Each attempt resulted in seam failures
- 2:58 pm squeezed plastic main further upstream
- 3:05 pm found no gas freely flowing at leak location
- 4:30 pm excavated leak location and found failed threaded coupling
- Continued leak surveys to the next day
- Bar-hole tested leak location daily for 8 days
 - Repeated detection of gas
 - Soil was excavated, replaced, and no more gas was detected



Return to Service

- Service interrupted to 20 customers
 - 9 residential
 - 11 business
- Temporary service installed to houses
 - Free air reading given before returning to homes
- Permanent main installed 1 week later
- Additional businesses returned to service almost 4 months later



Operator Investigation

- No standards or procedures need modification
- Produced advisory bulletin to restate/reinforce current procedures
 - Employees must follow leak survey standards
 - Must record encroachments to the pipeline
 - Continuing investigation until leak is located and classified
 - Discuss findings with field leader when no leak is found
- All gas employees completed review of gas procedures, proficiency, and competency

- Observation during...
 - Emergency response
 - Return to service
 - Post-incident testing and analysis
- Interviews of employees and witnesses
- Review of records and procedures
- Review of related third-party and Company reports
- Analysis of accident site layout
- Took 3 feet of pipe from each side of failure point for testing

- Arrived on site about 2 hours after explosion
- Made contact with Operator field leader and requested briefing
- Identified that employees were following relevant standards
- Requested info
 - Internal Incident Investigation Report
 - Leak survey history
 - Operating pressure charts
 - Dispatch logs
 - Service installation records
 - Main or service repair records
 - Cathodic protection records
 - Maps
 - List of employees that responded and respective duties
- Remained onsite unit about 8 pm

Field Leader

- Ground frost only encountered in one spot, and was about 4 inches deep

1st Leak Call Employee

- Source of gas was probably an inefficient furnace emitting unburned gas
- Equipment used was bump tested the morning prior, and calibrated every 3 months

Nearby Resident

- Sinkhole near manhole discovered 2 years prior
 - City filled with dirt
- Second sinkhole filled a couple months prior

Fire Department Responder

- Gas could still be smelled inside furniture store after shutting off flow to the meter

Adjacent Business Owner

- Did smell odor when entering his building, but did not recall if it was gas or from work
- Turned on light and adjusted furnace
- Explosion happened when he turned on another light
- Did not smell gas in air ever before the explosion
- Concrete wall had been there for 20-25 years

Leak Survey Employee

- Walking survey was completed on the main in the alleyway using RMLD
- No documentation to prove

- Concluded that damage to the meter manifold was due to explosion
 - Regulator and meter show no sign of fire exposure
- Multiple concrete footings for fenceposts rested on the gas main
- Used cameras and smoke to inspect sections of sewer system
 - Smoke permeated through foundation walls
 - Potential vacuum pulling gas toward building
- All lines connected to the failure point passed pressure tests
 - Rule out cause from any other leaks
- Main was excavated both sides of the concrete wall
 - East Side: Deflection of 4-³/₄ inches upward and 6-¹/₂ inches south
 - East Side: Prominent bend observed
 - West Side: Minimal bend slope downward 1 inch to failure point

MPSC Investigation



MPSC Investigation



- Four leak detection units exceeded calibration dates
- Leak survey for cathodically unprotected steel services
 - Completed on 5-year interval (3-year interval required)
- Standards require odorant sniff test after an explosion and determination of extent of leakage
 - Employees indicated that the gas odor was noticeable
 - No documented odorant sniff test

- Conducted:
 - Visual examination
 - Photographing of samples
 - Tensile testing
 - Hardness testing
 - Metallurgical examination
 - Radiographic examination
 - Scanning electronic microscopic examination
 - Physical measurements
 - Collection of soil samples from the pipe
- Engineering and stress load analysis
 - Estimated 1,200 lbs necessary to yield the pipe at the threaded coupling by 2 inches
 - Misalignment of the pipe would estimate an actual load significantly higher
 - Separation occurred due to rapid crack propagation (no cyclic fatigue detected)
- Metallurgical examination determined separation was due to material overload condition
 - Crack initiated in threaded portion of coupling are spread around entire circumference

Contributing Causes

- Overstress of the threaded and coupled joint on 2-inch bare steel main
 - Main was directly encased into concrete wall footing (no sleeve)
 - Chain-link fence with concrete footings installed directly above the gas main
 - Joint separated and misaligned by 2.5 inches
- Installation of sanitary sewer system directly next to the gas main
 - Migration of gas through sewer system into the furniture store
 - Contributed to external forces on the gas main
- Failure of Operator to identify and document the encroachment on the main
 - Form of 3rd party damage
- Reported Sinkhole in the vicinity of the main failure
 - Settlement of soil may have contributed to external forces on main
- Inadequate leak response by the Operator

§192.13 What general requirements apply to pipelines regulated under this part?

(c) Each operator shall maintain, modify as appropriate, and follow the plans, procedures, and programs that it is required to establish under this part.

- No documented sniff test conducted by the first Operator employee to arrive on scene post-explosion
- 4 leak detection units exceeded the 3 calendar months calibration requirement
 - 3 months and 4 days overdue
 - 2 months and 15 days overdue
 - 28 days overdue
 - 5 days overdue

§192.723 Distribution systems: Leakage surveys.

(b) The type and scope of the leakage control program must be determined by the nature of the operations and the local conditions, but it must meet the following minimum requirements:

(2) A leakage survey with leak detector equipment must be conducted outside business districts as frequently as necessary, but at least once every 5 calendar years at intervals not exceeding 63 months. However, for cathodically unprotected distribution lines subject to § 192.465(e) on which electrical surveys for corrosion are impractical, a leakage survey must be conducted at least once every 3 calendar years at intervals not exceeding 39 months.

- 2 service lines that are cathodically unprotected are leak surveyed on a 5-year interval instead of the required 3-year interval for unprotected lines

§192.605 Procedural manual for operations, maintenance, and emergencies.

(a) General. Each operator shall prepare and follow for each pipeline, a manual of written procedures for conducting operations and maintenance activities and for emergency response. For transmission lines, the manual must also include procedures for handling abnormal operations. This manual must be reviewed and updated by the operator at intervals not exceeding 15 months, but at least once each calendar year. This manual must be prepared before operations of a pipeline system commence. Appropriate parts of the manual must be kept at locations where operations and maintenance activities are conducted.

- First leak call did not follow procedures
 - Employee did not conduct any bar test over the main
 - Employee did not contact the field leader when gas odor was present, but no leak found

- 2012: Operator published advisory bulletin to employees
 - Employees performing leak surveys must follow relevant standards, including recording encroachments to the pipelines
 - Must be continuous investigation until leak is located or otherwise identified as foreign gas or no leak found
 - Surveyors must discuss findings with a field leader when no leak is found but encroachment is present
- MPSC proposed civil penalty of \$90,000 on the Operator for several violations of leak surveying
 - Frequency of surveys
 - Following procedures
 - Calibration dates
 - Documenting sniff tests

PSC 135.723 Distribution systems: leakage surveys additions [49 CFR 192.723].

(cw) Every operator shall maintain a gas leak-detection program and shall maintain records of operation under the program. The program shall consist of not less than the following:

(7) When a leak complaint is received and the odor of gas indicates that there is a leak in or near the premises, a search shall be conducted until the leak is found.

- First leak call not conducted correctly
 - Employee smelt gas, did not find the leak, and did not conduct any follow up

- Leak Surveys
 - Fully completed
 - Notice unusual activity
- Leak Investigations
 - Find the leak
 - Double check
- Gas Migration

PSC Contact Information

- **Phone:**
 - General Inquiries: 1-888-816-3831
 - Consumer Affairs: 1-800-225-7729
- **Web Site:** <https://psc.wi.gov/Pages/Home.aspx>
- **Facebook:** <http://www.facebook.com/PSCWisconsin>
- **Twitter:** <http://twitter.com/PSCWisconsin>
- **Address:** 4822 Madison Yards Way
Madison, WI 53705-9100
- **Email:** PSCRECS@wisconsin.gov

Questions?