# Physical Properties, First Response, Gas Leak Classification, Gas Leak Pinpointing, Incident Investigation/Lessons Learned

Ron Six, Instructor
Senior Utility Consultant
Loss Control Division

AEGIS Insurance Services, Inc.

201/417-2487

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# AEGIS

**A**ssociated **E**lectric **G**as **I**nsurance **S**ervices

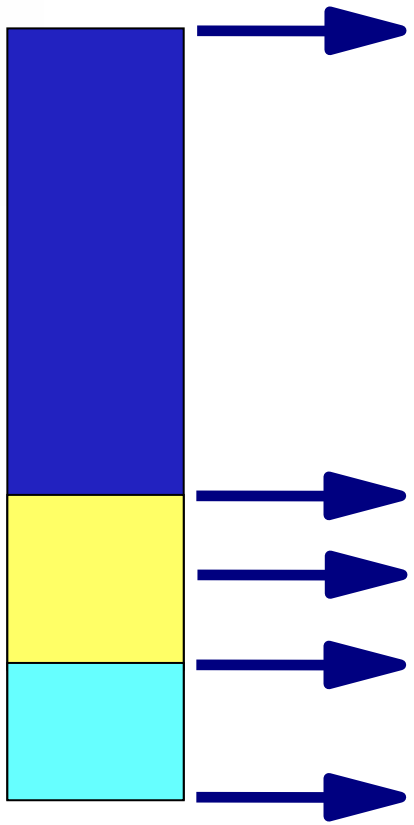
# AEGIS
## Background Information

- Utility Mutual Insurance Company (member owned)
- Formed in 1975 by 22 gas utilities
- Electric Utilities began joining in 1977
- 490 members – 95% utilities and related energy

# Physical Properties of Various Explosive Liquids and Gases

| Material | Chemical Formula | Specific Gravity Air=1 | Ignition Temp Deg. F in Air | Lower Expl. Limit (% gas) | Upper Expl. Limit (% gas) |
|---|---|---|---|---|---|
| Methane | $CH_4$ | .55 | 1193 | 5.3 | 15.0 |
| Natural Gas | Blend | .65 | 950-1200 | 5.0 | 15.0 |
| Ethane | $C_2H_6$ | 1.04 | 993-1101 | 3.0 | 12.5 |
| Propane | $C_3H_8$ | 1.56 | 957-1090 | 2.2 | 9.5 |
| Butane | $C_4H_{10}$ | 2.01 | 912-1056 | 1.9 | 8.5 |
| Hexane | $C_6H_{14}$ | 3.0 | 437 | 1.1 | 7.5 |
| Gasoline | Blend | 3-4.0 | 632 | 1.4 | 7.6 |
| Acetone | $C_3H_6O$ | 2.0 | 869 | 2.5 | 12.8 |
| Benzene | $C_6H_6$ | 2.8 | 928 | 1.2 | 7.8 |
| Carbon Monoxide | CO | 1.0 | 1128 | 12.5 | 74.0 |
| Hydrogen | $H_2$ | .1 | 932 | 4.0 | 75.0 |
| Hydrogen Sulfide | $H_2S$ | 1.2 | 500 | 4.0 | 44.0 |

# Flammable Range for Natural Gas



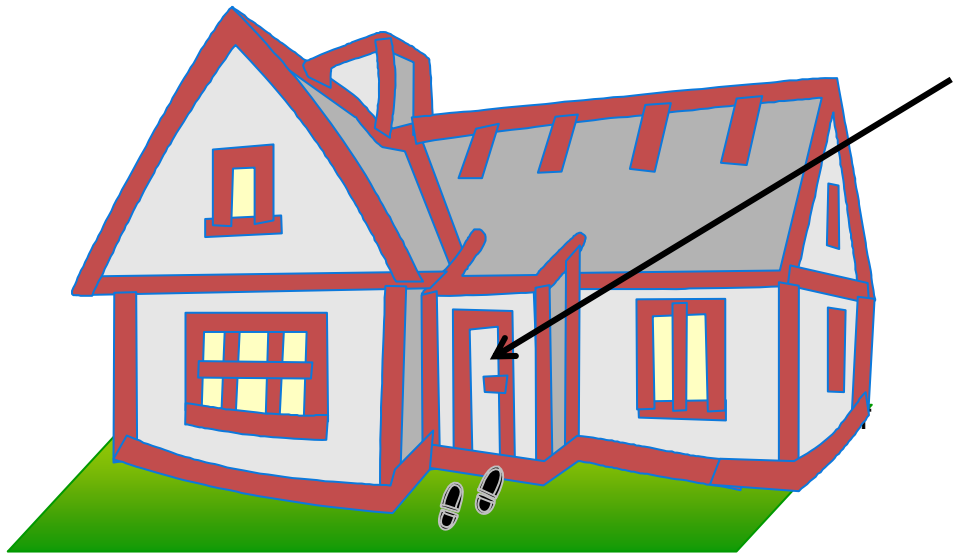
100% Gas

15.0% Gas (U.E.L.)

10% Gas (Optimum)

5.0% Gas (L.E.L.)

0% Gas




You arrive and get a 20% LEL (1% Gas/Air reading) in the atmosphere, just as you enter the front door.

**What would you do?**

# Potential Ignition Sources

- Doorbell
- Light Switch
- Pilot Light
- Flashlight
- Telephone
- Electrical appliance
- Automobile

- Security system
- Matches, lighter
- Cell phone/pager
- Back-up generator
- Lightning
- Static electricity
- And many others

# Sources of Combustible Vapors

- Natural gas -
  - Methane, Ethane
- Heavy hydrocarbons -
  - Gasoline, Propane, Butane
- Soil and landfill gas -
  - Methane, $CO_2$
- Gases in sewers -
  - Solvents, Alcohols
- Sewer gas -
  - Methane, $CO_2$, $H_2S$

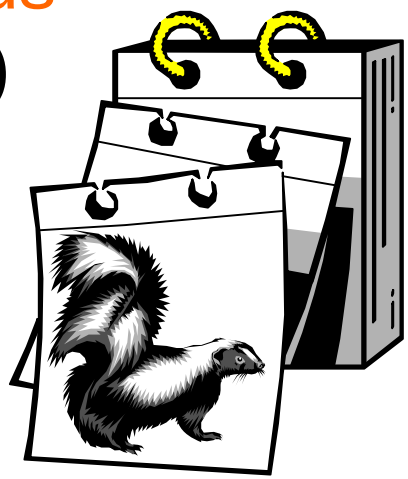
# Federal Odorization Standard 192.625 (2-22-88)

(a) A combustible gas in a distribution line must contain a natural odorant or be odorized so that at concentration in air of one-fifth of the LEL (lower explosive level), the gas is readily detectable by a person with a normal sense of smell.

(f) To assure the proper concentration of odorant in accordance with this section, each operator must conduct periodic sampling of combustible gases using an instrument capable of determining the percentage of gas in air at which the odor becomes readily detectable.

*Odorant is the customer's leak detector.*

Odorization must be continuous (every day)



and it must be adequately documented!

# Effects of Natural Gas on Soil and Vegetation

- Displaces soil atmosphere
- Drying effect
- Eliminates aerobic bacteria
- Reduces soil components
- Changes pH

- Natural gas is a simple asphyxiant
- Carbon monoxide is a chemical asphyxiant

*It takes far less CO to be deadly!*

# Carbon Monoxide

- Odorless
- Colorless and tasteless
- Product of incomplete combustion
- Deadly in very small amounts


# Potential Effects of Carbon Monoxide Exposure

## Excerpts from OSHA chart based on industrial use

| PPM | Effects & Symptoms | Time |
|---|---|---|
| 50 | Permissible exposure level | 8 Hrs. |
| 200 | Slight headache | 3 Hrs. |
| 400-600 | Headache, discomfort | 1-2 Hrs. |
| 1000-2000 | Headache, confusion, nausea, may stagger | 1.5 Hrs. |
| 2000-2500 | Heart palpitation | 30 Mins. |
| 2500-3500 | Unconsciousness | 30 Mins. |
| 4000 | Fatal | 30 Mins. |

*Effects may vary from person to person!*

# Major Causes of Leaks

- Corrosion
- Mechanical failure
- Improper installation
- Improper design
- Faulty materials
- Outside damage - “Dig-Ins”

- In the last 20 years, over 40% of natural gas-related incidents/explosions have been a direct result of “dig-ins” or outside damage!
- This is the major reason why we should always promote the “Call Before You Dig Program.”

#682

#686


4” Plastic Main 45 PSI
ASH ST
Water Main
Dead Cast Iron Gas Main

Public Law 109–468
109th Congress

An Act

Dec. 29, 2006
[H.R. 5782]

To amend title 49, United States Code, to provide for enhanced safety and environmental protection in pipeline transportation, to provide for enhanced reliability in the transportation of the Nation's energy products by pipeline, and for other purposes.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,*

Pipeline Inspection, Protection, Enforcement, and Safety Act of 2006.
49 USC 60101 note.

SECTION 1. SHORT TITLE; AMENDMENT OF TITLE 49, UNITED STATES CODE; TABLE OF CONTENTS.

(a) SHORT TITLE.—This Act may be cited as the "Pipeline Inspection, Protection, Enforcement, and Safety Act of 2006".

(b) AMENDMENT OF TITLE 49, UNITED STATES CODE.—Except as otherwise expressly provided, whenever in this Act an amendment or repeal is expressed in terms of an amendment to, or a repeal of, a section or other provision, the reference shall be considered to be made to a section or other provision of title 49, United States Code.

(c) TABLE OF CONTENTS.—



SEC. 2. PIPELINE SAFETY AND DAMAGE PREVENTION.

(a) ONE CALL CIVIL ENFORCEMENT.—

(1) PROHIBITIONS.—Section 60114 is amended by adding at the end the following:

"(d) PROHIBITION APPLICABLE TO EXCAVATORS.—A person who engages in demolition, excavation, tunneling, or construction—

"(1) may not engage in a demolition, excavation, tunneling, or construction activity in a State that has adopted a one-call notification system without first using that system to establish the location of underground facilities in the demolition, excavation, tunneling, or construction area;

"(2) may not engage in such demolition, excavation, tunneling, or construction activity in disregard of location information or markings established by a pipeline facility operator pursuant to subsection (b); and

"(3) and who causes damage to a pipeline facility that may endanger life or cause serious bodily harm or damage to property—

"(A) may not fail to promptly report the damage to the owner or operator of the facility; and

"(B) if the damage results in the escape of any flammable, toxic, or corrosive gas or liquid, may not fail to promptly report to other appropriate authorities by calling the 911 emergency telephone number.

"(e) PROHIBITION APPLICABLE TO UNDERGROUND PIPELINE FACILITY OWNERS AND OPERATORS.—Any owner or operator of a pipeline facility who fails to respond to a location request in order to prevent damage to the pipeline facility or who fails to take reasonable steps, in response to such a request, to ensure accurate marking of the location of the pipeline facility in order to prevent damage to the pipeline facility shall be subject to a civil action under section 60120 or assessment of a civil penalty under section 60122.

"(f) LIMITATION.—The Secretary may not conduct an enforcement proceeding under subsection (d) for a violation within the boundaries of a State that has the authority to impose penalties described in section 60134(b)(7) against persons who violate that State's damage prevention laws, unless the Secretary has determined that the State's enforcement is inadequate to protect safety, consistent with this chapter, and until the Secretary issues, through a rulemaking proceeding, the procedures for determining inadequate State enforcement of penalties.".

(2) CIVIL PENALTY.—Section 60122(a)(1) is amended by striking "60114(b)" and inserting "60114(b), 60114(d),".

(b) STATE DAMAGE PREVENTION PROGRAMS.—

(1) CONTENTS OF CERTIFICATIONS.—Section 60105(b)(4) is amended to read as follows:

"(4) is encouraging and promoting the establishment of a program designed to prevent damage by demolition, excavation, tunneling, or construction activity to the pipeline facilities to which the certification applies that subjects persons who violate the applicable requirements of that program to civil penalties and other enforcement actions that are substantially the same as are provided under this chapter, and addresses the elements in section 60134(b);".

(2) IN GENERAL.—Chapter 601 is amended by adding at the end the following:

"§ 60134. State damage prevention programs

"(a) IN GENERAL.—The Secretary may make a grant to a State authority (including a municipality with respect to intrastate gas

Our main job is *not*
finding & fixing leaks

Our main job is
public safety

# Combustion Chamber Demonstration

Lessons Learned:

- Natural gas is lighter than air
- Flame wave moves up-over-down
- Pressure wave moves upward first
- The optimum mixture (10%) creates the most efficient burning
- The greatest forces are created when there is a low point of ignition
- The two major by-products of the combustion process are carbon dioxide ($CO_2$) and water vapor ($H_2O$)

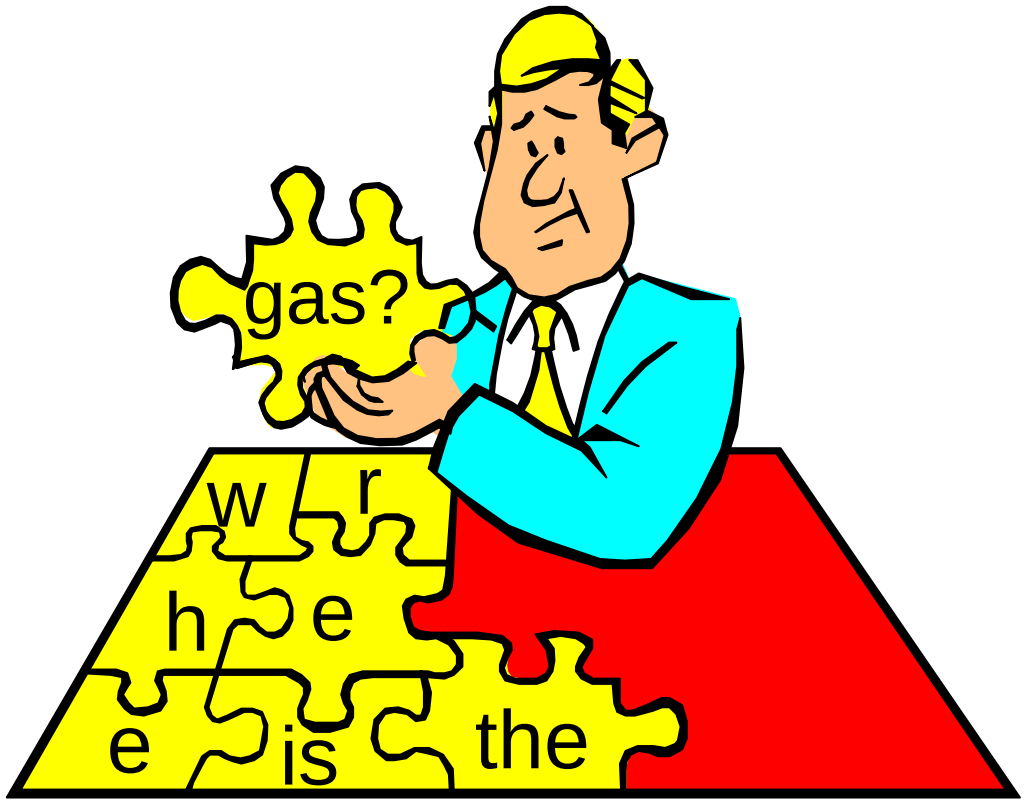
**Relative damage in a natural gas-related incident is related to:**

- Point of ignition-vertically
- Point of ignition-horizontally
- Source of ignition
- Type of leak=volume of gas
- Type/structure of building
- Other combustibles in area

# Gas Leak Classification

# Evaluating The Leak

**Where is the gas?**



# Evaluating The Leak

- **W**here is the gas?
- **H**ow much is there?
- **E**xtent of hazard (migration)
- **R**elation to other structures
- **E**valuate/evacuate

# Factors Affecting Gas Migration

- Soil type
- Soil moisture
- Surface cover/frost
- Line pressure
- Depth of burial
- Leak size and age
- Change in elevation=slope
- Path of least resistance

## Remember:

- The biggest built-in safety factor of natural gas is that it is lighter than air; however…

  it will vent to the atmosphere someplace!

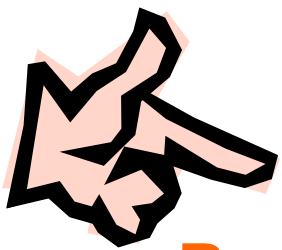
# “Centering” = Where is the Gas?

# The Combustible Gas Indicator

- CGI should be used to:
  - Classify an atmosphere
    - Inside a building or in a confined space
  - Classify underground leakage
    - Determine “Where is the gas?”
  - Pinpoint underground leakage
    - Determine “Where is the leak?”
- You must know:
    - How to properly use it
    - What readings might constitute a hazardous condition

# Centering The Leak

- Probe holes must be of sufficient depth
- Test all available openings
- “Zero out” N-S-E-W
- You must have sufficient information to make a good judgement



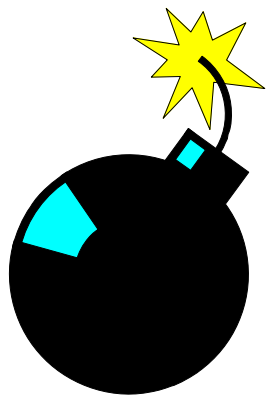
**Be Careful –** “Don’t make a leak, looking for a leak.”

# GPTC Guidelines
## Leak Classification

- The following establishes a criteria by which leakage indications of flammable gas can be graded and controlled.  When evaluating any gas leak indication, the initial step is to determine the perimeter of the leak area. When this perimeter extends to a building wall, the investigation should continue into the building.

# GPTC Guidelines
## Grade 1 Definition

- A leak that represents an existing or probable hazard to persons or property, and requires immediate repair or continuous action until the conditions are no longer hazardous.



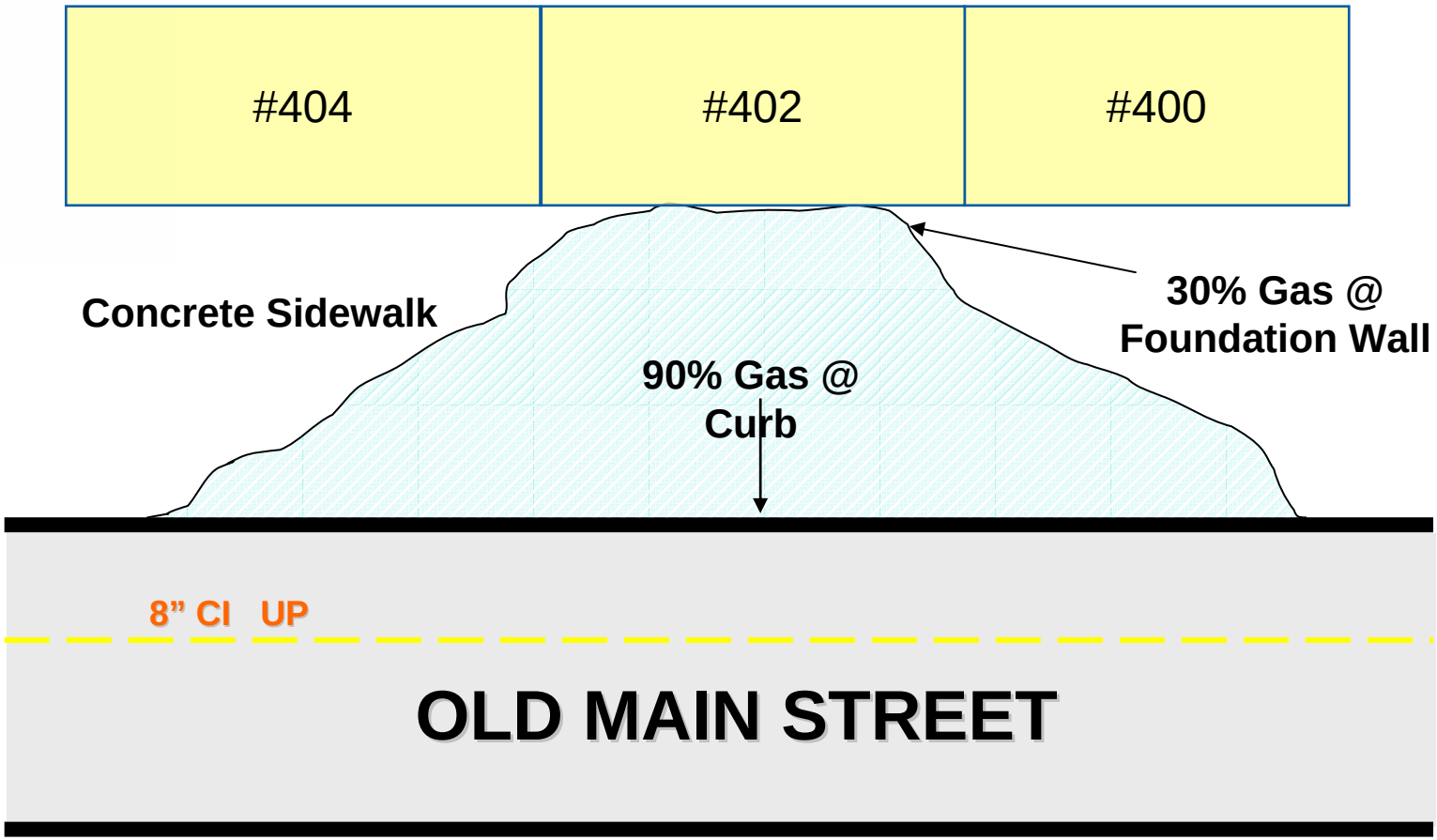
# GPTC Guidelines
## Grade 2 Definition

- A leak that is recognized as being non-hazardous at the time of detection, but justifies scheduled repair based on probable future hazard.

# GPTC Guidelines
## Grade 3 Definition

- A leak that is non-hazardous at the time of detection and can be reasonably expected to remain non-hazardous.

# How would you classify the following leaks and why?


#404
#402
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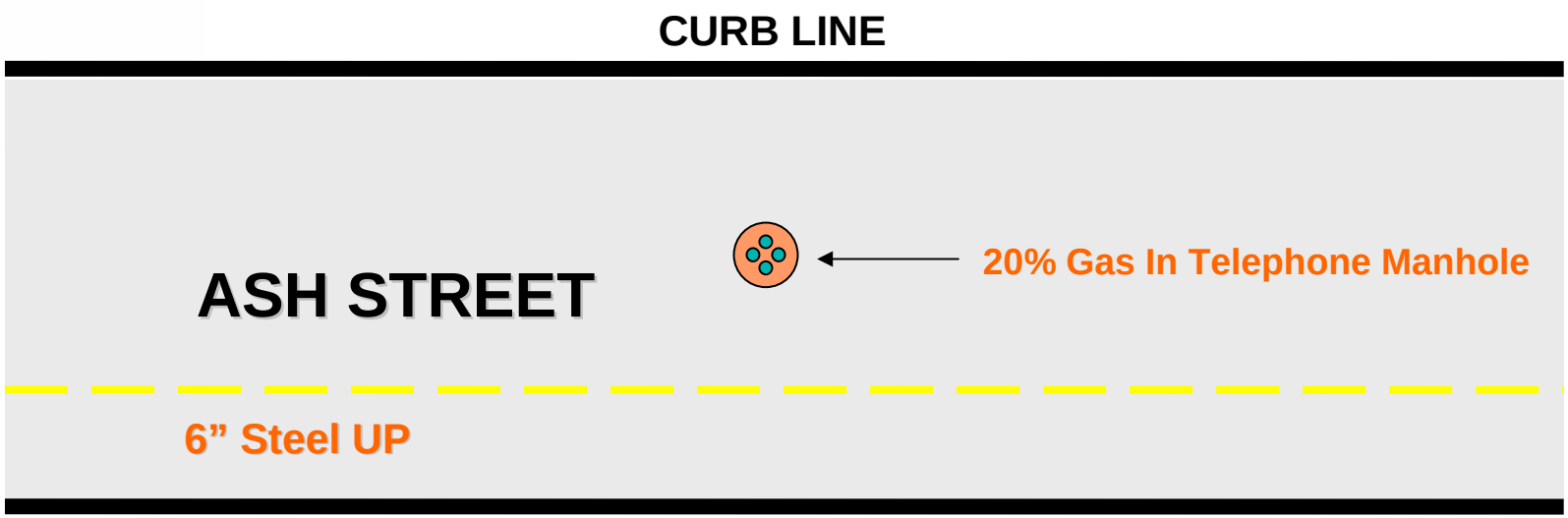
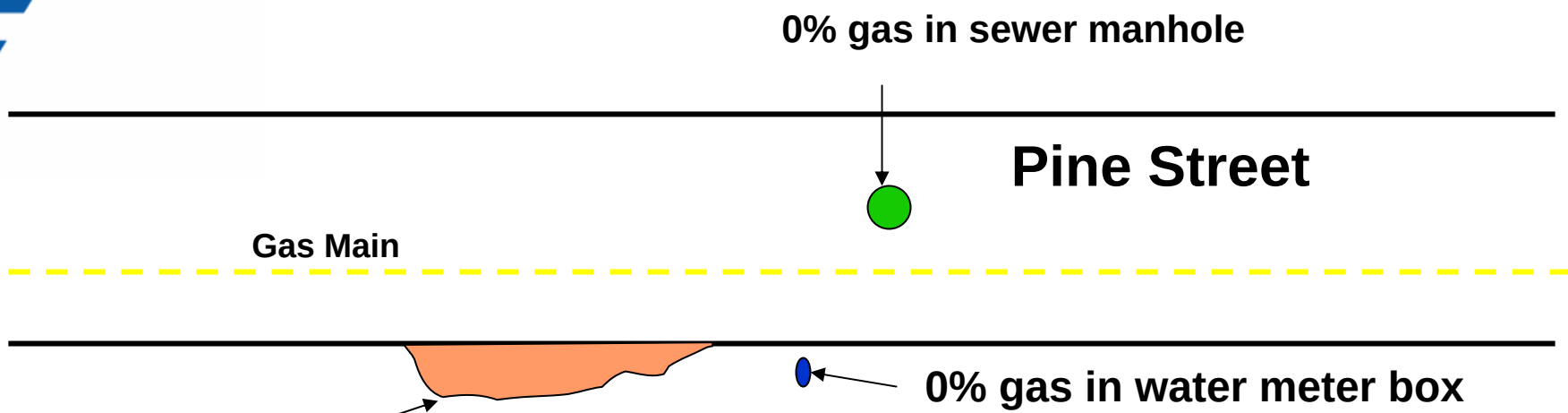
Concrete Sidewalk
30% Gas @
Foundation Wall
90% Gas @
Curb
8” CI UP
OLD MAIN STREET

Gas Main

River Road

**4% gas in gas valve box. No houses or buildings in the vicinity, no migration and no odor. "Not a hazard & not expected to become a hazard".**


CURB LINE
ASH STREET
20% Gas In Telephone Manhole
6” Steel UP




20% gas at curb, very limited migration from curb area. House sits 75' from curb area. "A leak that is not hazardous at the time of detection, but based on probable future hazard will be put on a repair schedule".

655

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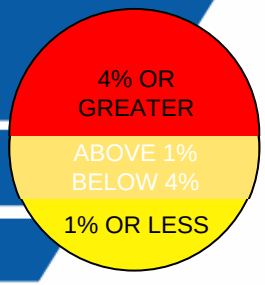
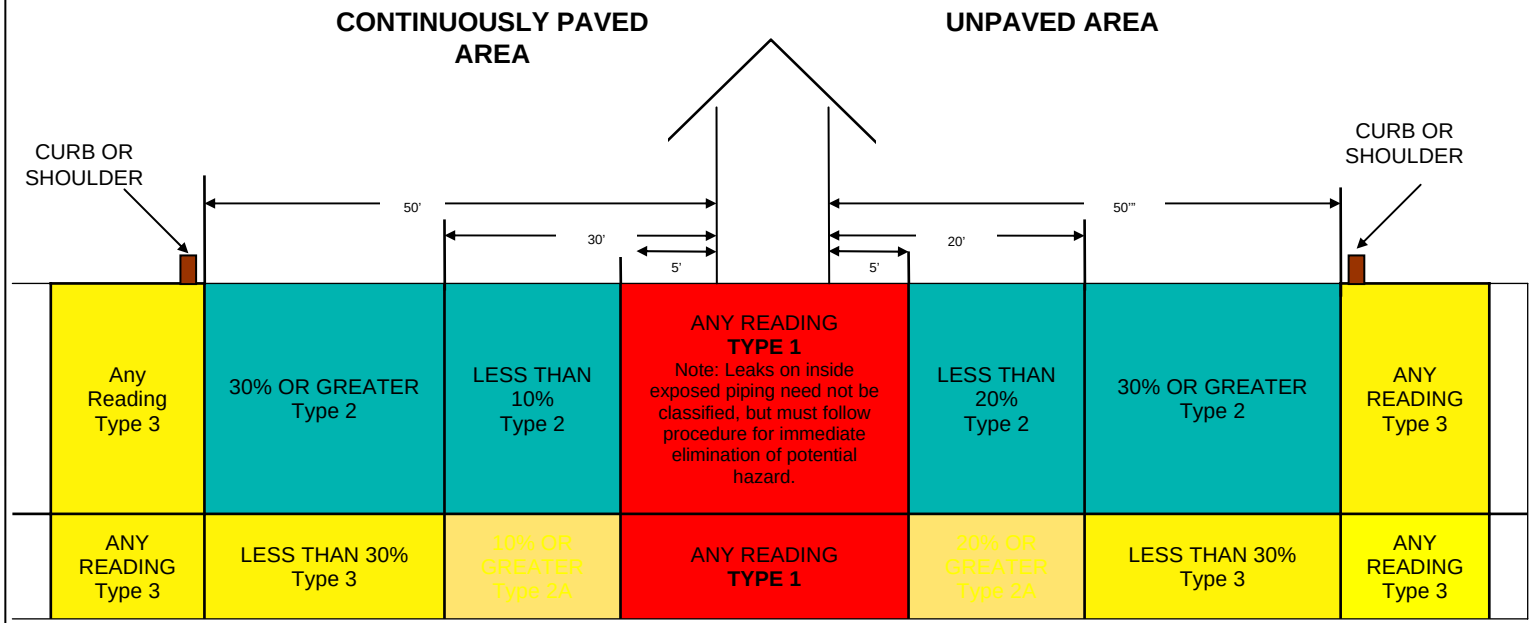
# GRAPHICAL PRESENTATION OF THE CLASSIFICATIONS OF HAZARDS WHICH RESULT FROM GAS LEAKAGE & REQUIRED ACTIONS IN ACCORDANCE WITH 16 NYCRR PART 255.805-817

## MANHOLES, VAULTS OR CATCH BASINS




Readings are percent gas-in-air with structure in normal condition. Type 2 leak shall be rechecked at least every 2 weeks and repaired within 6 months.




| CLASSIFICATION | ADDITIONAL CLASSIFICATIONS | REQUIRED ACTION | NOTE |
|---|---|---|---|
| **TYPE 1** | ANY LEAK JUDGED TO BE POTENTIALLY HAZARDOUS AT THE SCENE BY THE OPERATING PERSONNEL; THIRD PARTY DAMAGE CAUSING LEAKAGE; GAS ENTERING TUNNELS OR BUILDINGS | IMMEDIATE EFFORT TO PROTECT LIFE AND PROPERTY; CONTINUOUS EFFORT TO REMOVE HAZARD; DAILY SURVEILLANCE UNTIL SOUCE OF LEAK HAS BEEN CORRECTED | **TYPE 1, 2A OR 2 REPAIR REQUIRES FOLLOW-UP INSPECTION AT LEAST 14 DAYS AFTER, BUT WITHIN 30 DAYS UNLESS REPLACED OR INSERTED** |
| **TYPE 2A** | TYPE 2 OR 3 LEAKS THAT COULD MIGRATE UNDER FROST OR OTHER CONDITIONS IN THE JUDGEMENT OF OPERATING PERSONNEL AT THE SCENE | REPAIR WITHIN 6 MONTHS, SURVEILLANCE AT LEAST EVERY 2 WEEKS | |
| **TYPE 2** | TYPE 3 LEAK THAT COULD MIGRATE UNDER FROST OR OTHER CONDITIONS IN THE JUDGEMENT OF OPERATING PERSONNEL AT THE SCENE | REPAIR WITHIN 1 YEAR, SURVEILLANCE AT LEAST EVERY 2 MONTHS | |
| **TYPE 3** | ANY LEAK NOT CLASSIFIED AS TYPE 1, 2A OR 2 | RECHECK AT NEXT SURVEY OR WITHIN ONE YEAR, (WHICH EVER IS LESS) | |
| Type 4 | No Leak | | |

ALL READINGS ARE IN PERCENT GAS-IN-AIR AND ARE "READINGS AS DEFINED IN PART 255. 3 (a) (27)

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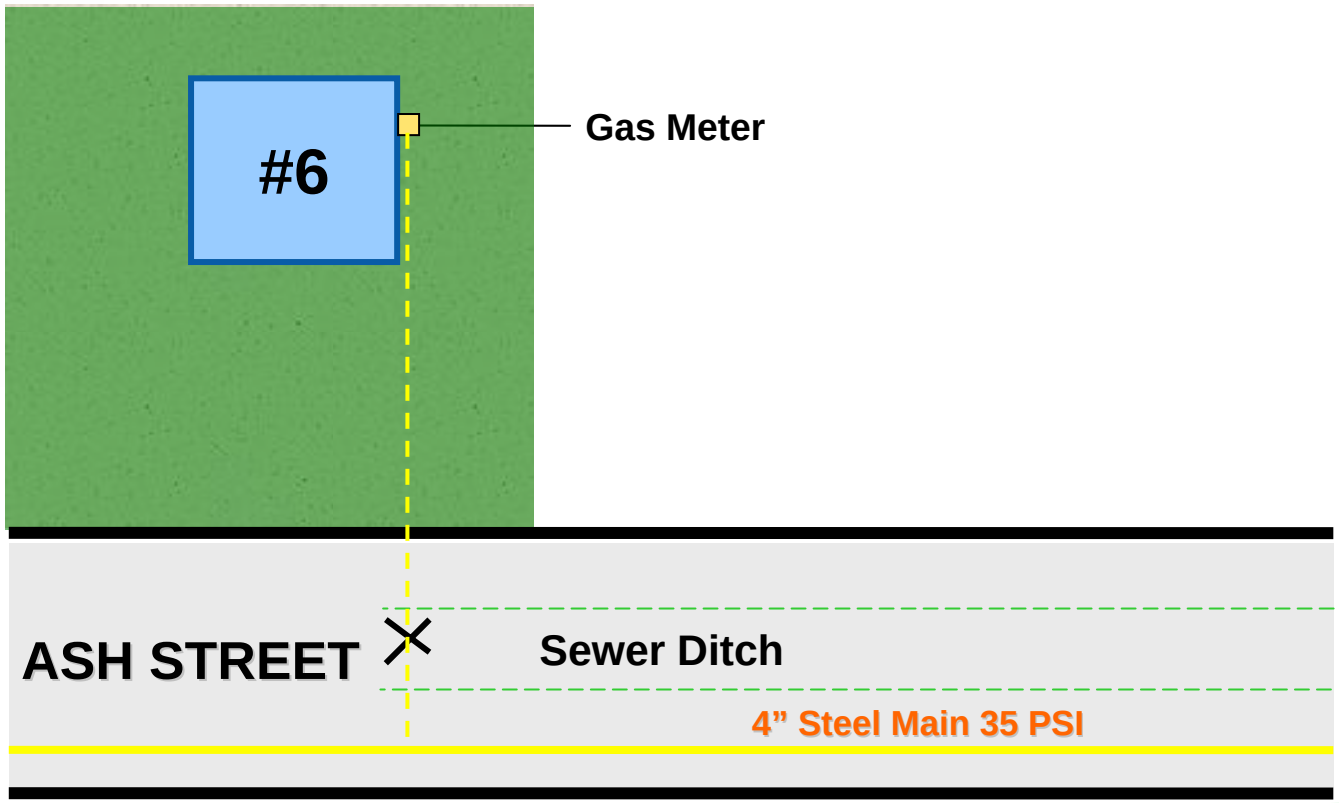
**HAZARD**

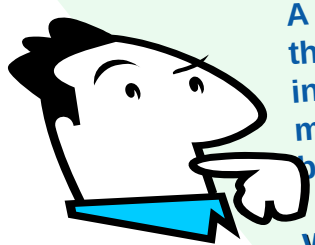
**EXTENT**

**LIFE**

**PROPERTY**

## Figure # 1



A contractor has snagged the 1” steel service and bowed it in the ditch. A small hole was made in the line and gas is blowing in the ditch.

**What would be your actions?**

# Incident (1998)
## Company Retention $5M

- A contractor working on a highway reconstruction project struck the service line to a house, causing the service line to separate from a compression coupling near the gas main.
- The gas company was called at 11:15 am; a serviceman arrived on the scene at 11:45 and immediately called for a crew. Thinking the gas was venting out into the street, he sat in his truck for 20 minutes until the crew arrived. Although the damage location was only 32 feet from the incident site, no attempt was made to check nearby buildings with a combustible gas indicator for the presence of migrating gas.

# Incident (1998)
## Company Retention $5M

Cont'd.

- The leaking gas migrated to the house where an explosion occurred killing an elderly woman and severely burning 3 children, the explosion occurred at 1:00 pm. The children received burns to over 45% of their bodies with most of the burns occurring in the facial areas.
- In the settlement the contractor also paid more than $15,000,000.00 in claims.

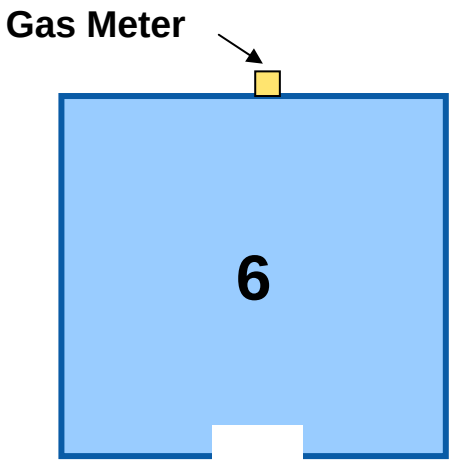
## AEGIS Incurred $15 Million

# What Happened?

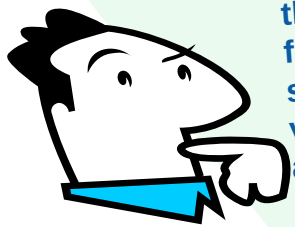
- First Responder failed to recognize the gravity of the situation and made the assumption that the pulled line was leaking in only one place.
  - The First Responder's main job on a reported gas leak is to determine "Where is the gas?" and "Is it affecting people or property?" The appropriate way of determining this is with a combustible gas indicator (CGI) – Test Don't Guess!
- Our first priority must always be focused on

Public Safety

## Figure # 2




**PINE STREET**

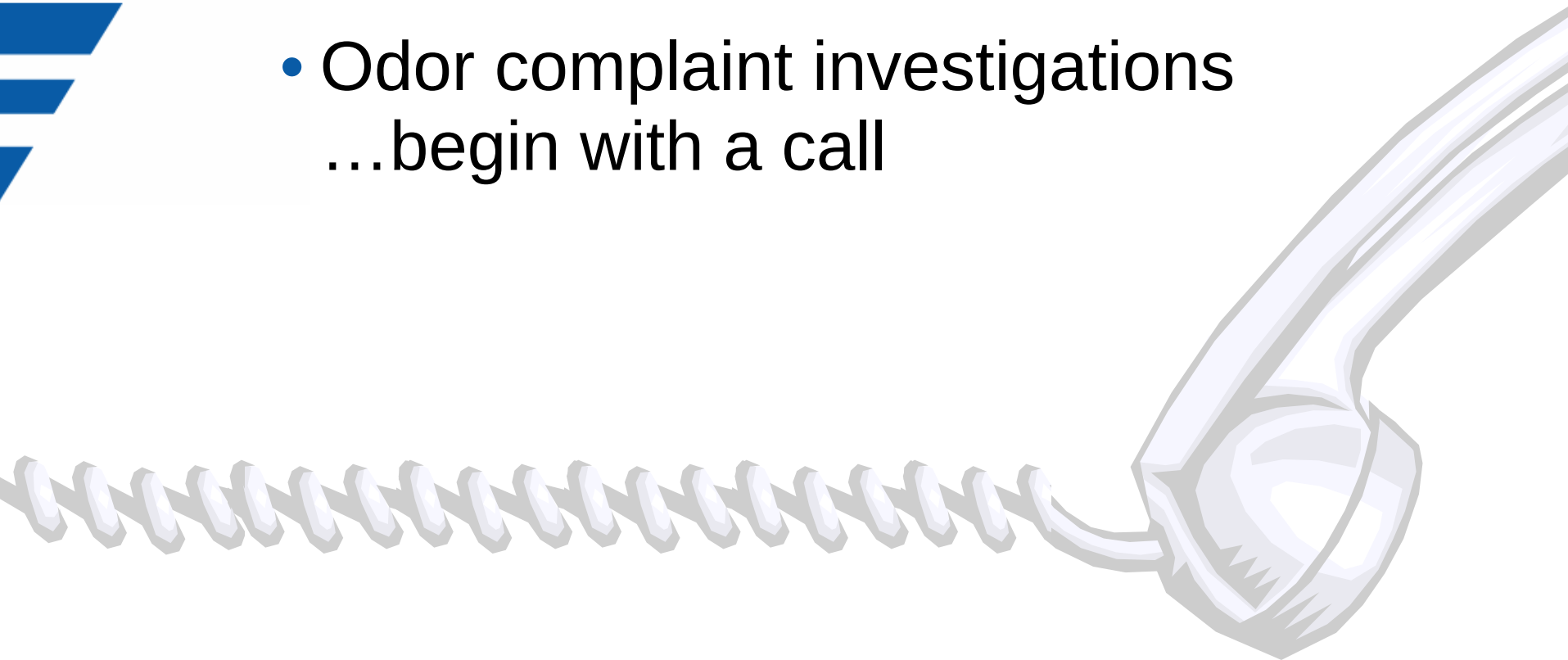


Dispatch reported to you that the homeowner has damaged a fuel line while moving the gas stove. You arrive and smell a very strong odor of gas as you approach the house.

**What would be your actions?**

# First Response/Odor Complaint Investigation

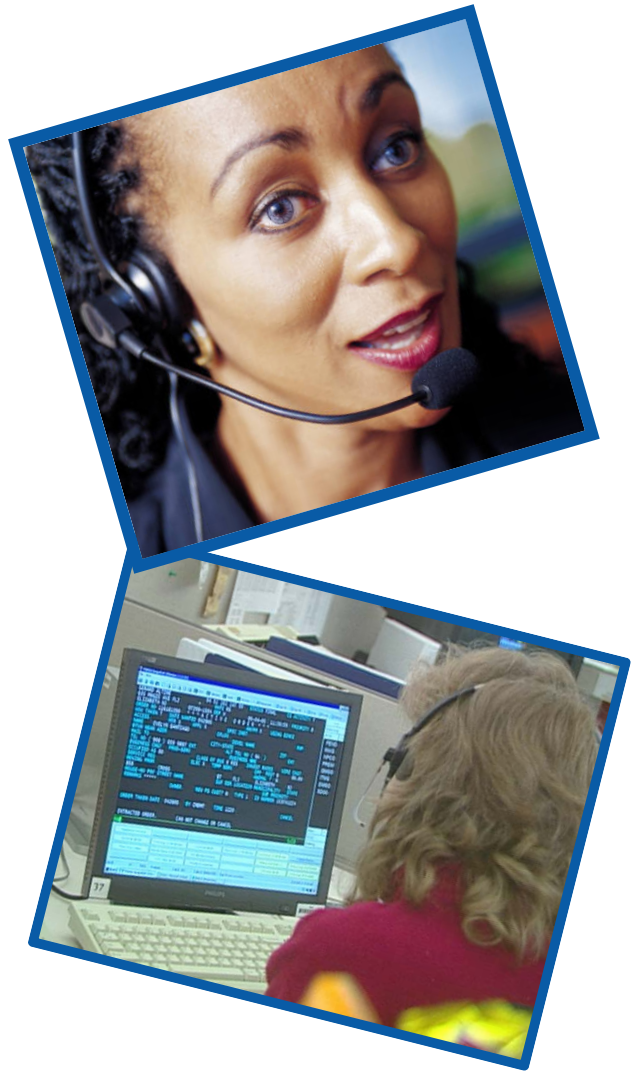
- Odor complaint investigations …begin with a call



- An odor complaint call should be considered a Grade 1 leak… until *proven* otherwise.

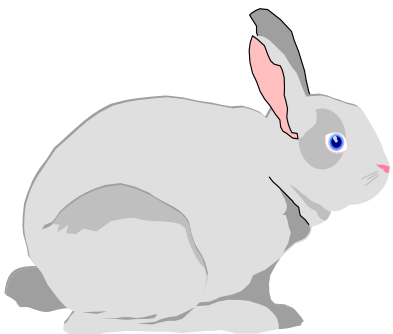
# The Key Is Listening

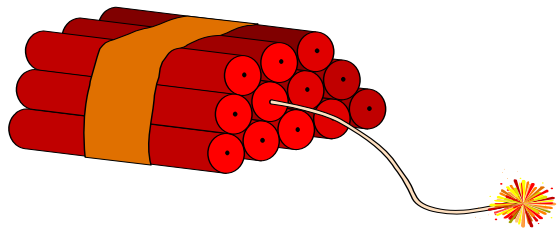
- Not every call is a gas emergency
- Listen to the customer and ask questions in order to gather the information needed



# Is It Static Or Dynamic?

| | | |
|---|---|---|
| Where is the odor? | = | At gas range vs. throughout |
| How long smelled? | = | For a week vs. just noticed it |
| How strong is the odor? | = | Barely smell vs. making me sick |
| Can you hear anything? | = | No vs. hissing sound |
| Anyone moved recently? | = | No vs. apartment next door moved |
| Any plumbing done? | = | No vs. husband just installed range |
| Any construction in area? | = | No vs. backhoe digging out front |





# Steps to Consider When Receiving a Dynamic Call

- Ask the customer to leave the premises until help arrives
- Advise the customer to leave the phone off the hook and not to operate any lights or turn any appliances off or on

**Leave things as they are… leave the premises immediately**

# Routine “Stable” Calls

**Listen, ask questions, and transfer accurate information**

| | |
|---|---|
| 1. **Where do you smell it?** | **This information will alert the first responder where to start checking.** |
| 2. **Is the odor constant?** | **This information may help indicate if the leak is inside or outside or if there may be a problem with an appliance.** |

# Responding to Odor Complaint Calls

Remember:

- You must consider it to be a hazardous condition until you *prove,* by use of instrumentation, that it is not!

# What Equipment Is Available?

- **Combustible Gas Indicator**
- Bead Sensor
- FI Unit (not intrinsically safe)
- Leak Detection Solution
- CO Detector
- Probe Bar
- Wrench/flashlight

# Conducting The Investigation

Do Not Assume Anything!

Test, Don’t Guess

# Approaching The Building

- Visual observations
  - Vegetation damage
  - Construction activities
  - Meter observations
- Olfactory senses
  - Do you smell anything?

# Entering The Building

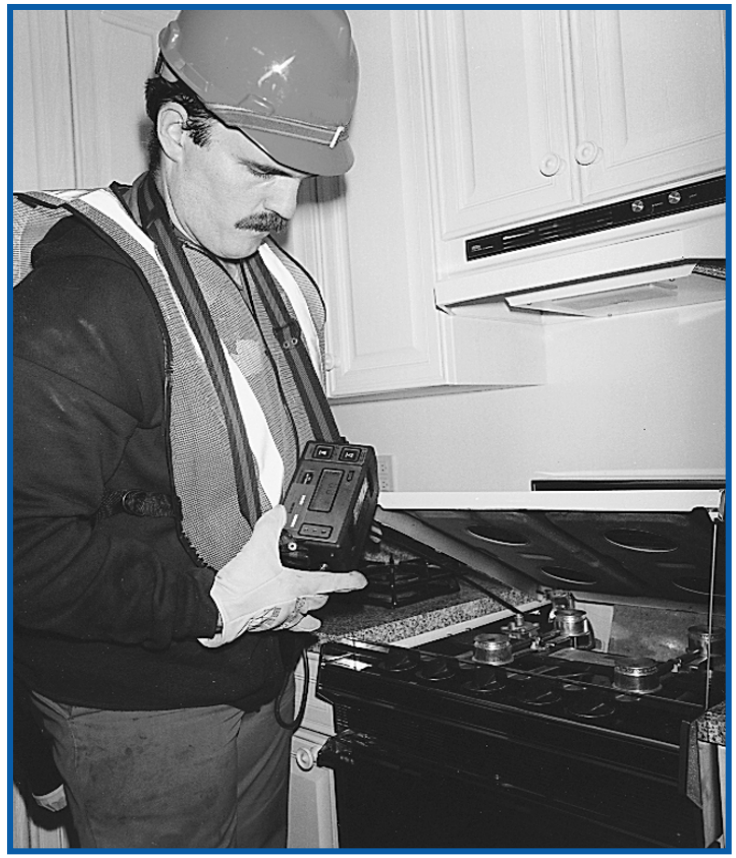
- CGI zeroed before entering
- Enter on LEL scale
- Check the problem area
- Continue search even if leak is found
- Did you find "*a*" leak or did you find "*the*" leak?

# Expanding The Search

- Check the entire gas system
- Visual inspection of appliances and piping
- Check all utility entrances and floor drains

# Other Conditions To Observe

- Carbon monoxide
- Other flammables
- Lack of make up air, vent size
- Scalding
- Other code violations



# Completing The Investigation

- Shut in test/clock meter
- Test meter/leak detection fluid
- Bar test
  - At the meter (riser), service, along main and check all available openings
- Expand search if odor detected
- Document findings

**Procedures and policies may vary**

# Action When A *Hazardous* Condition Is Found

- Red or “Danger” Tag
  - Document
  - Communicate
  - Disconnect
  - Follow up

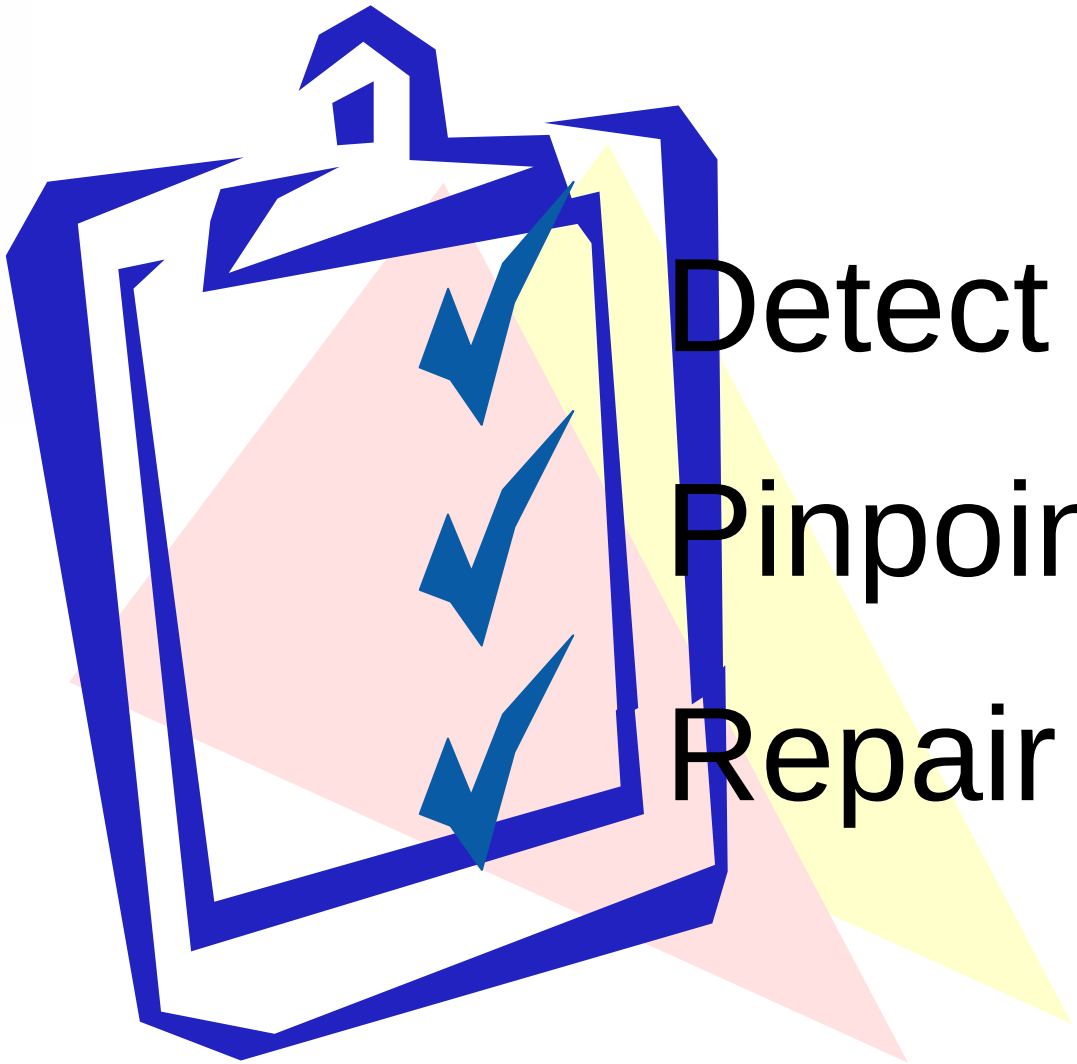
**Policies may vary from company to company**

# Leaks Found On Odor Complaints Must Be:

- Repaired
- Shut off & tagged
- Classified (is it safe?)

*There should be no other options!*

# Gas Leak Pinpointing



Detect

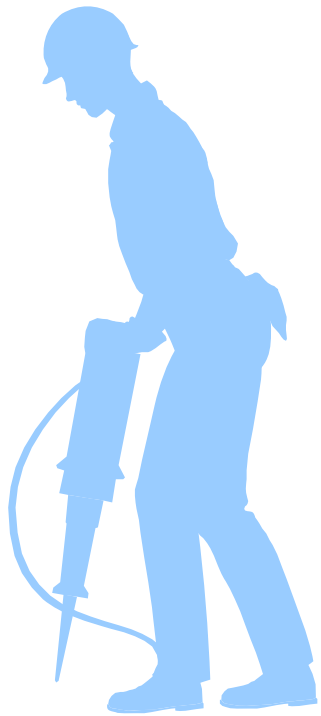
Pinpoint

Repair

# Pinpointing

Is not an exact science.

It is a developed skill which is learned and perfected through your mistakes and your successes.



- Centering = Where is the gas?
- Pinpointing = Where is the leak?
- The leak must be centered before it is pinpointed

# Methods Of Locating The Line

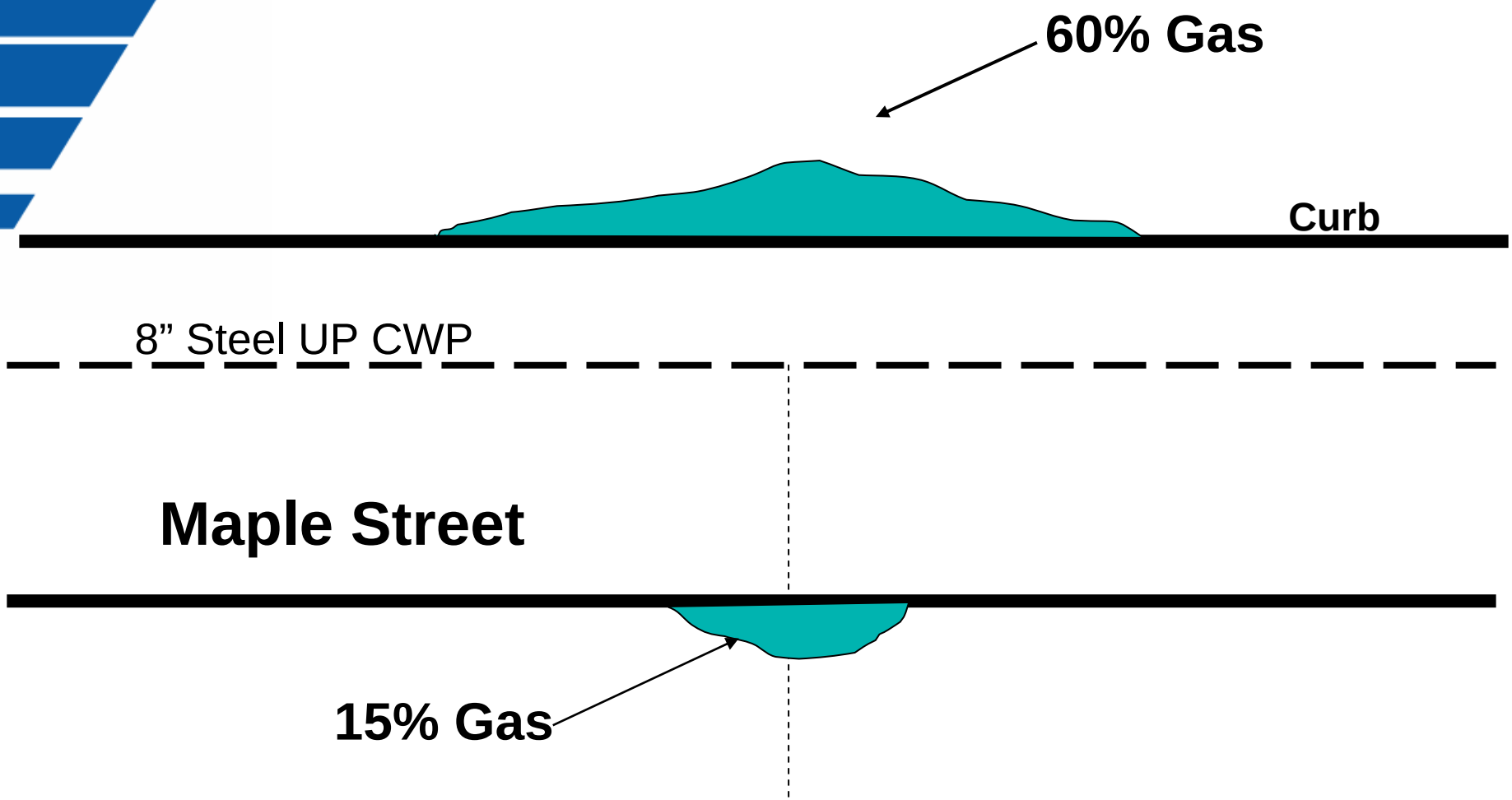
- Maps
- Records
- System experience
- Electronic locators
  1. Basic principles of operation
  2. Inductive vs. Conductive
  3. Overcoming problems

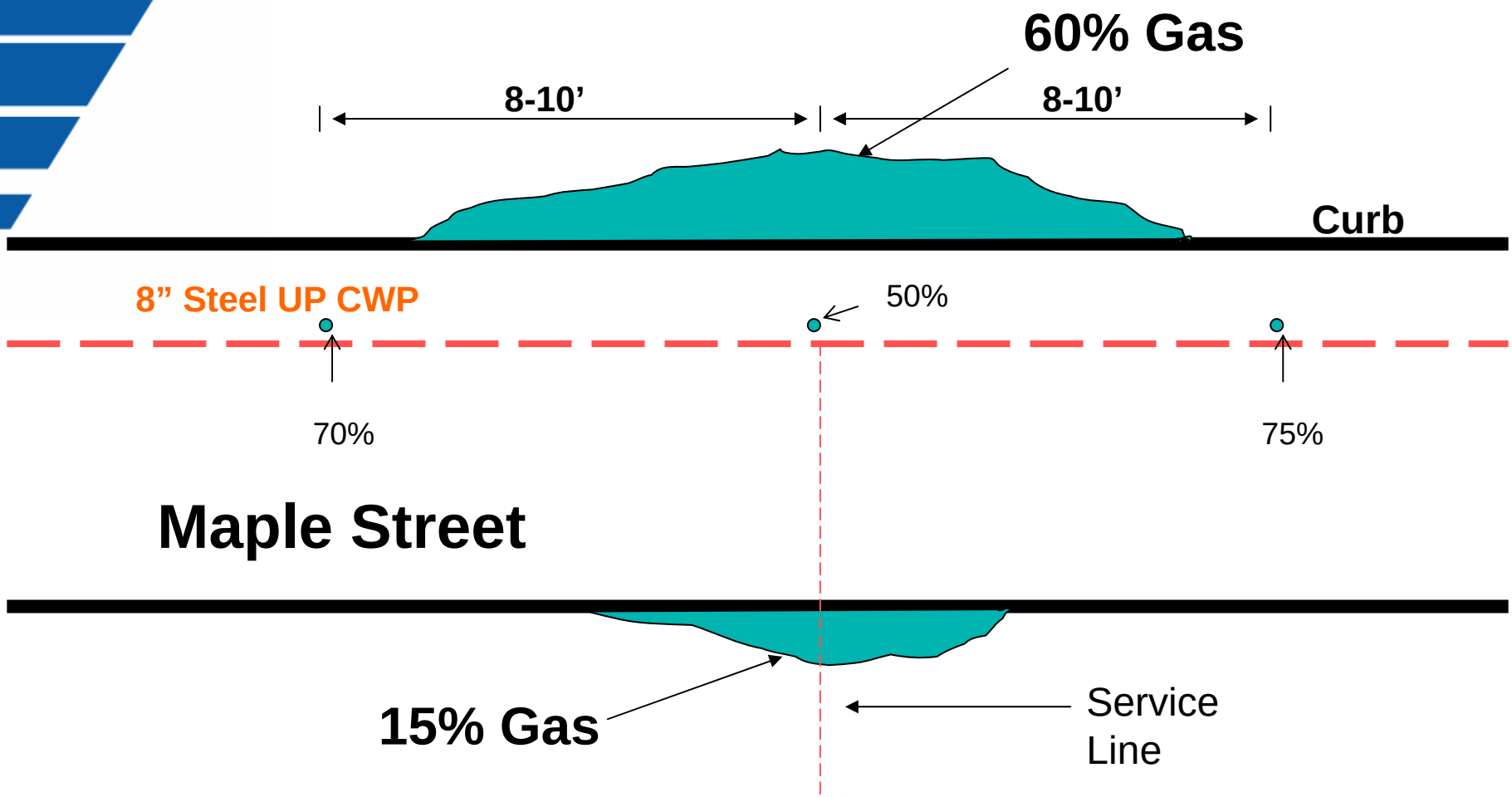
# Consistency = Success

- Exact location of main, services etc.
- Size of test hole (aeration is the key)
- Depth of test hole (must be consistent)
- Location of test holes (same side of main)
- Instrument use (consistency in testing)

AEGIS®

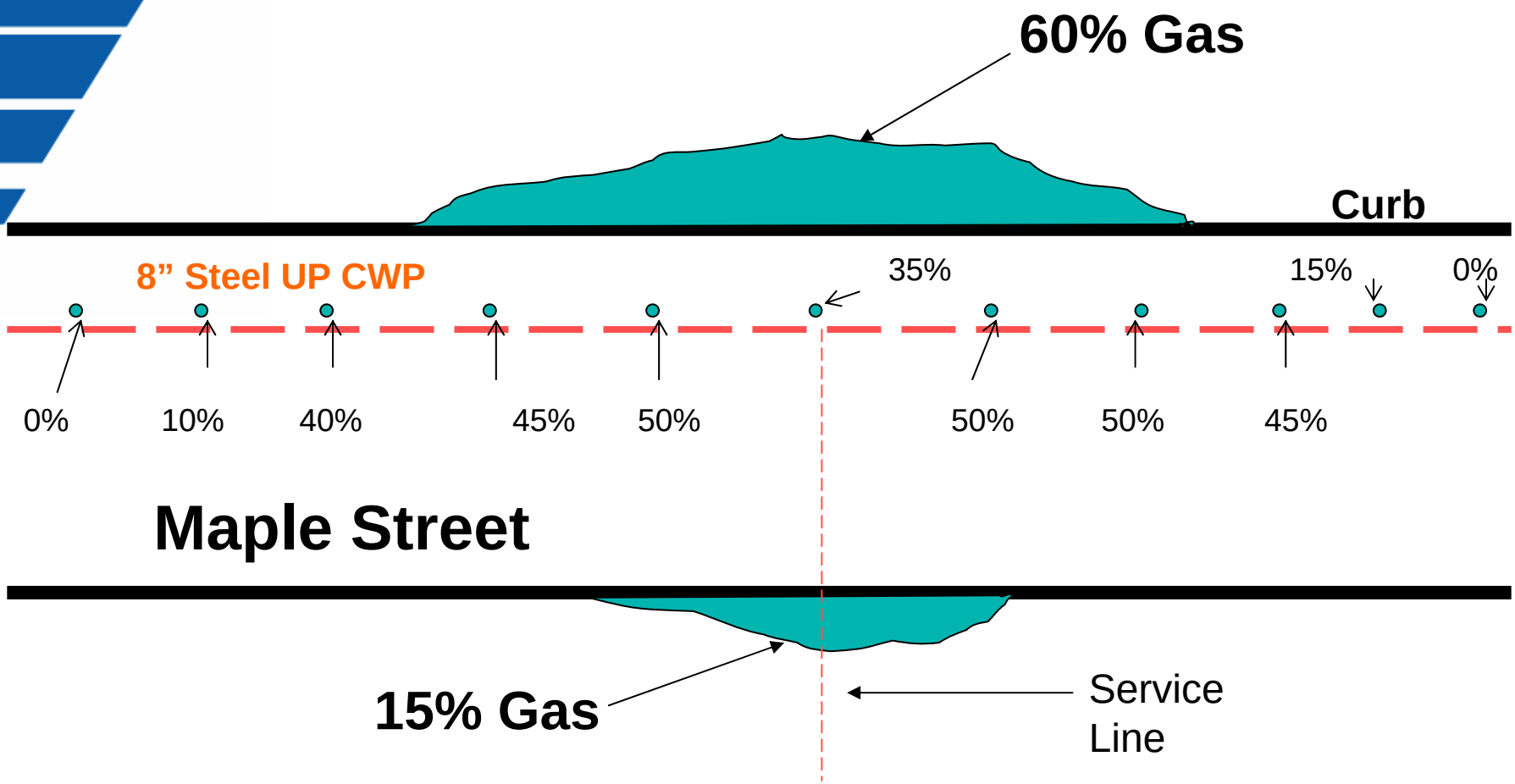
# SAVE ANOTHER MISSED EXCAVATION


60% Gas
Curb
8” Steel UP CWP
Maple Street
15% Gas


60% Gas
8-10’
8-10’
Curb
8” Steel UP CWP
50%
70%
75%
Maple Street
15% Gas
Service
Line

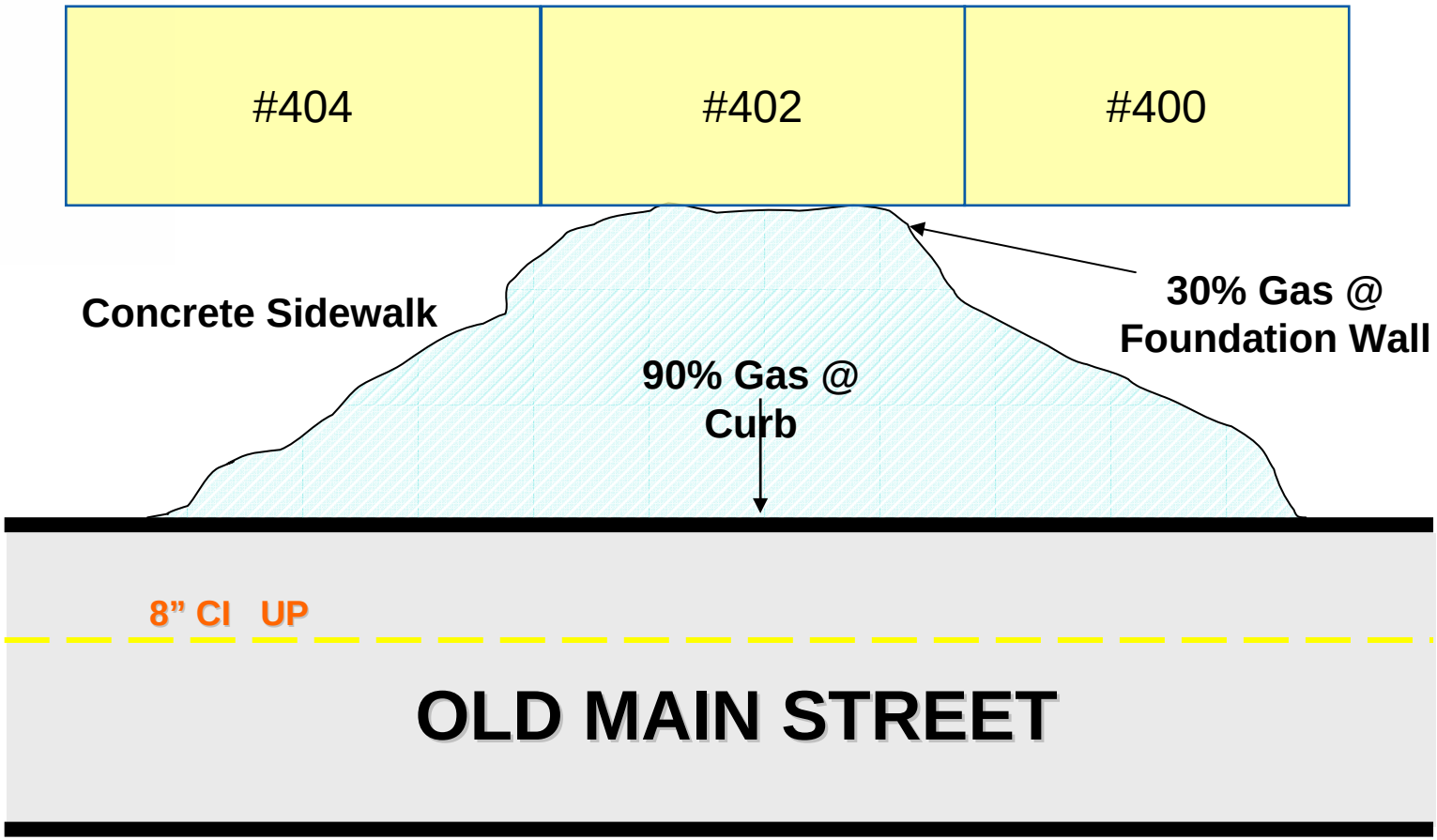
# Test Methods

- Combustible gas indicator
  1. Top & bottom of hole
  2. Time the readings
- Natural ventilation
  1. Wait…let holes vent
- Blow pipe – vapors/soap top of hole
- Odor


60% Gas
Curb
8” Steel UP CWP
35%
15%
0%
0%
10%
40%
45%
50%
50%
50%
45%
Maple Street
15% Gas
Service
Line

# Using The Soil Purger In The Pinpointing Process

- Purge from a hole where you know that the leak is not
- Plug holes near purge point
- *Dense soil or moisture* – time the purge/purge each hole
- Use it only when all other methods have failed


#404
#402
#400
Concrete Sidewalk
30% Gas @
Foundation Wall
90% Gas @
Curb
8” CI UP
OLD MAIN STREET

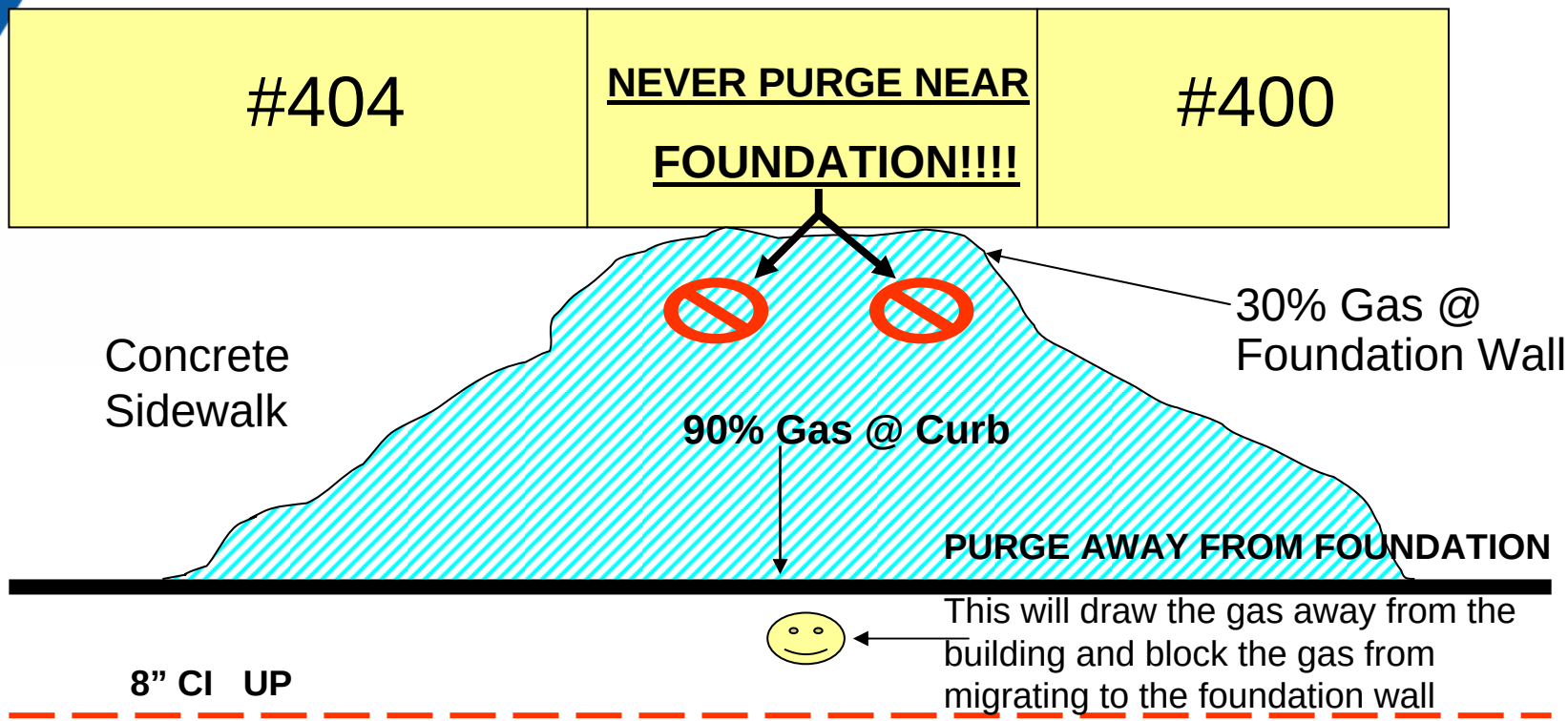
# Use Of Soil Purger

- Should not be used on every leak
- Operation:
  1. In the pinpoint process
  2. As a safety tool –

     *Never use near foundation of building*
  3. Residual gas
- Choosing a purge point is the *key*
- Techniques

# Use Of Soil Purger (cont'd)

- The soil purger is your best friend or worst enemy, depending on where and how it is used




# Old Main Street

# “Make Your Mark”

**Using Your Experience**

**Using Test Results**

**Using System Design**

Remember:

- It is much cheaper to drill than to dig.
- Do you have enough holes to give you enough information about the leak?

# The Dry Hole

- Probe along the pipe
- Expose *all* of the pipe, not just the top
- Learn from your mistakes
- Use the hole to your advantage…
  no one “hits” them all
- Is it our gas?

# Checking After The Repair

- Did we find "*the*" leak?
- Residual gas – when will it go away?
- Cleanup/plugging the test holes
- Importance of proper documentation

# Remember: The Job Is Not Completed

- Until all paperwork/documentation is completed:
  - Neatly
  - Thoroughly
  - Accurately
- You may do everything right, but you may be judged by what is or is not documented

# Incident Investigation

Natural Gas is a very safe product, but incidents do occur. After the fact the main job is **Public Safety** and the Prevention of Related Incidents. Once the scene is made safe the Investigation can begin to determine **What** happened, **How** it happened and **Why** it happened.

# The Ultimate Objective In The Investigation Is To Determine:

| | |
|---|---|
| Type of explosion | • High order vs. low order |
| Nature of explosion | • Type of fuel/explosive involved |
| Source of ignition | • Cause of explosion |
| Reason for the presence of the fuel | • Responsibility |

- The purpose of the investigation
  must be to find the cause –
  not just to find who is at fault

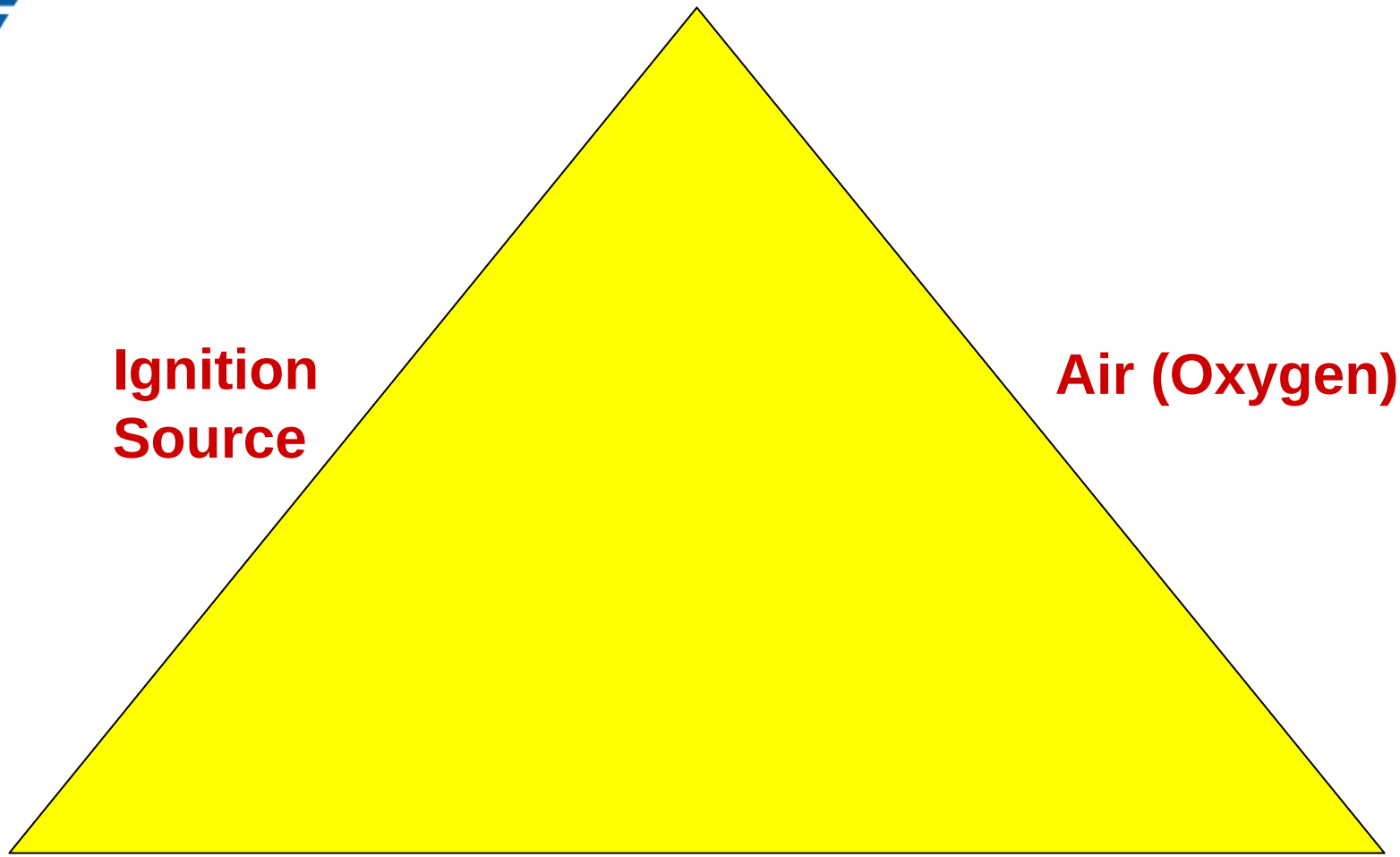
*and*

- Take corrective actions

# Establishing An Investigative Team

- **Establish** team leader, individual must be open-minded and able to handle pressure
- **Members** from various departments i.e. engineering, service, construction
- **Coordinate** with legal and claims departments
- **Determine** procedures, equipment needed, availability, operators who are trained to use the equipment
- **Identify** labs and outside expertise
- **Coordinate** meet and **train** civil authorities
- **Identify** high risk areas, such as problem contractors and meet with them
- **Review** standards/procedures and reports
- **Establish** each member's responsibility

# The Explosion Triangle



# Types of Natural Gas Explosions

- **High Order Explosion -** a rapid pressure rise or high-force explosion characterized by shattering effect of the confining structure or container and long missile distance i.e. ripping & shredding. (**Detonation**)

- **Low Order Explosion -** a slow rate of pressure rise or low force explosion characterized by pushing or dislodging effect on the confining structure and short missile distance i.e. pushing & shoving.
  **(More typical of Natural Gas incidents)**

# Gas Incident Risk Exposures

- “One call” locating
- Odor complaint investigations
- Leakage detection surveys
- Regulator/pressure maintenance
- Construction, repair & maintenance
- Service related work (inside)

# Where Things Go Wrong

- Complacency — "We've Done This Job Dozens of times."
- Tunnel Vision — Not focusing on the overall picture.
- Shortcuts — Not following the approved procedures.
- Lack of Training/ Inexperience — Have never experienced this situation.

***(All of the above highlight the importance of the use of Mock Emergency Drills & Emergency Response pre-planning.)***

# Atmospheric Ignition of Natural Gas Inside a Building

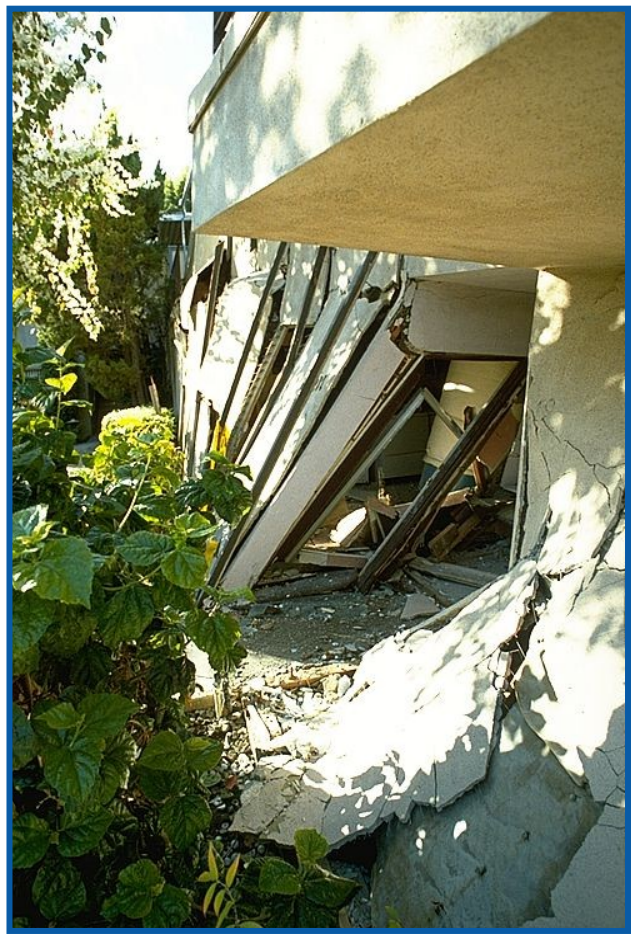
- There should be some evidence of an overpressure:
  - The roof laying on the foundation
  - A wall blown out or bowed
  - Possibly only some ceiling tiles lifted
- It all depends on:
  - The amount of gas
  - Point of ignition
  - Type of structure

# Dry Explosion – No Fire

- Note “pushing and shoving” effect
- 2 x 4’s intact, not ripped/shredded as would occur in “high order” explosion or from solid explosives such as dynamite

# Dry Explosion – No Fire

- Foundation damaged, but upper portion of house intact
  - Overall structural damage directly related to building's design
  - Pressure wave takes path of least resistance



# Dry Explosion – No Fire

- Notice the car on the right
  - The building was completely lifted and landed on the car, yet walls are intact
  - Exemplifies the “pushing and shoving” effect typical to natural gas explosions

- Fire after the explosion; not much left; detailed investigation still warranted
  - Reviewing floor plans; recovering piping
  - Car in garage may indicate gasoline is possible accelerant

- Be aware of the images captured in your photos
  - Notice the old meter and range connector in the bottom left of the photograph

# Pre-planning is Essential

- Personnel readiness
- Personnel training
- Communication
- Emergency plan
- Coordination with fire service
- Availability of special equipment
- System records
- Involvement of claims & legal depts.
- Public relations - media response

# Determining When to Conduct An Incident Investigation

- Company policy
- General practice
- Reporting requirements to state/federal agencies

- The purpose of the investigation must be to find the cause – not just to find who is at fault

*and*

- Take corrective actions

# Basic Equipment Needed to Conduct an Investigation

- Safety gear, ID card
- Combustible gas indicator
- Probe bar
- Hydrogen flame ionization unit
- Odorator/odorant testing device
- SLR camera & film (type of camera to be determined in advance i.e. digital photography)
- Calibration test kits
- Detailed investigative forms
- *Trained personnel* to use the equipment

# Additional Equipment for Conducting the Investigation

- Latex gloves
- Ruler/measuring tape
- Tape recorder
- Maps of area
- Marking flags paint
- NFPA 921 guide
- Drawing tools

# Incident Scene Procedures

# The Ultimate Objective of the Investigation is to Determine:

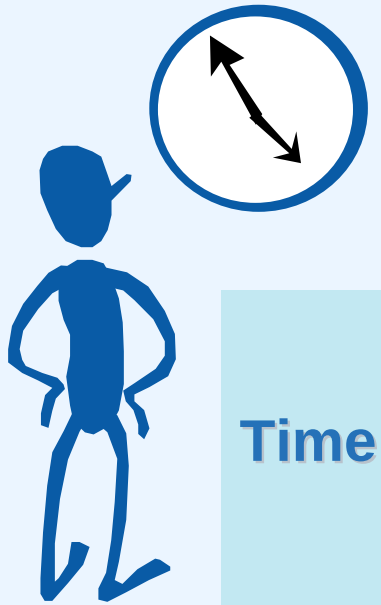
| | |
|---|---|
| **Type of explosion** | • High order vs. low order |
| **Nature of explosion** | • Type of fuel/explosive involved |
| **Source of ignition** | • Cause of explosion |
| **Reason for the presence of the fuel** | • Responsibility |

# Supervisory Responsibility

- Review of actions taken
- Initiate additional measures
- Establish liaison with emergency response personnel
- Establish gas spread
- Makesafe operations

# Makesafe
## Actions to Consider

- Implement emergency plan
- Call for additional help
- Notify police/fire departments
- Evacuate premises
- Block off the area
- Stop the flow of gas
- Eliminate ignition sources
- Vent area



**Time Is Critical**

**Remember Public Safety!**

# After An Incident
## Actions to Consider

- Prevention of related incidents
- Calling for additional assistance
- Coordination of efforts with civil authorities
- Preliminary search for gas by testing adjacent structures, bar-holing testing available openings… use good judgement
- Record results of tests positive or negative
- Focus only on the immediate area of concern

**“It is not over until it’s over…**
**don’t be part of history”**

# After an Incident
## Other Actions to Consider

**These Actions Should Not Be Considered Until The Area Is Secured**

- Have a skilled photographer on the scene ASAP, photographic documentation
- Sniff tests, odorant tests, witness and document
- Names and addresses of witnesses
- Verify equipment calibration/document
- Pressure testing - only when skilled employees and proper equipment are at the scene and *only* according to your standards
- Develop an event timeline

# Fire Service Personnel

The main focus of the fire department should be in securing the area and the gas company's focus should be in securing the gas. The main focus of both should be Public Safety!

(Bergenfield, New Jersey December 13, 2005)

# Fire Department Relationships

- Understand that once the Fire Department is on the scene, they are in charge.
- It is very important to develop a relationship with them prior to an emergency.
- AEGIS “Recognizing and Avoiding Hazard” Volumes I & II are designed to assist in developing this relationship.

# Initial Assessment Scene

- Has area been made safe?
- Do additional structures need to be checked or evacuated?
- Who is the contact for fire department?
- Gas company supervisor in charge?
- Need additional personnel/equipment?
- What has been done thus far?
- Are additional personnel/equipment needed?
- Have the appropriate people/agencies been notified?

# Initial Assessment of Scene

- Have the surrounding homes been checked?
- Have the available openings been checked?
- Has bar testing been performed?
- Are pictures being taken of the incident scene/investigation by gas company personnel?
- Are gas company employees wearing the appropriate safety equipment?
- Has someone been contacted to perform an odorant tests in the vicinity?

# Initial Assessment of the Incident Scene

- Who will be documenting the activities of the investigation?
- Is Form 11 (Pipeline Failure Investigation Report) being used as a guide in the investigation?
- Does it appear that the use of outside experts will be necessary and who will notify them to be prepared?
- Will a  vapor sample be needed or pressure test be needed and is the proper equipment to perform these task on site or in route?

# Points to Determine during the Investigation

- Type of fuel involved?
- Source of the fuel?
- How was the fuel ignited?

  - ✓ The type of fuel appears to have been from an outside leak (natural gas), it appears to have migrated into the structure by following a recently installed water line (source of fuel) and it apparently was ignited when the homeowner turned on the light switch upon entering her home (ignition source).

# Photographic Documentation of the Incident Scene

- Photographer — must be trained in investigative photography. The photographer should be called in ASAP.
- Camcorders — may be used to document the proceedings, but be careful about audio recordings.
- Digital Cameras — may be used to document the proceedings; however, since the pictures can be altered it may lead to problems down the road.

*Discuss this with your attorney!*

# Photographic Documentation

- The pictures taken should tell a story.
- Take only pictures pertinent to the investigation or possibly to future litigation.

# Vapor Sample Collection for Analysis

**Do not delay!!**

- Use good sampling techniques (practice)
- Lab will dictate sampling device
- Take a spare sample and/or a comparison sample
- Chain of custody form, if needed

*It costs nothing to take the sample and you have it should you need it!*

# Vapor Sample Collection for Analysis

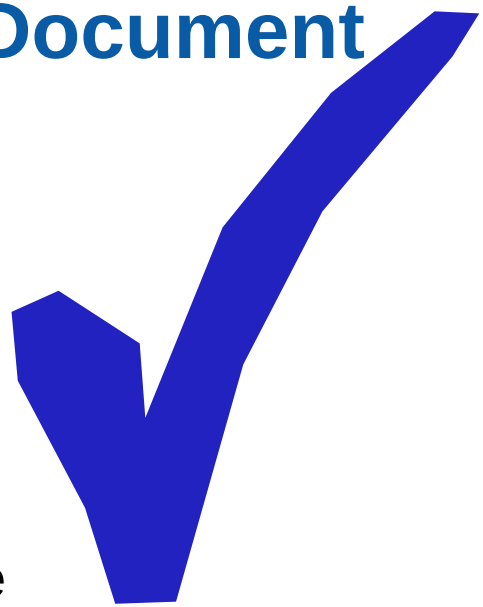
## Documentation -

1. Date & time
2. Location (drawing or sketch)
3. Name of person who took sample
4. CGI reading (verify calibration)
5. Witness and photograph

# Incident Investigation Considerations

- Attempt to gain immediate access to the incident scene
- The investigative team leader should coordinate this through fire officials, supervision and the legal department
- Photograph and document all aspects of the investigation
- Use of outside experts as site investigators; they must be contacted immediately
- Obtain complete floor plans
- Documentation of the investigation; must be concise and accurate
- NFPA 921 (reference, but use it only as a guide)

# Evidence to Look for and Document



- Structural damage
- Evidence of over-pressures
- Extent of fire damage/burn pattern
- Evidence of combustible vapors/volume
- Distribution of debris/epicenter
- Condition of all appliances
- Condition of customer fuel lines
- Condition of meter, regulator, service
- Condition of electrical system
- Condition of sewer system, traps, vents
- Evidence of code violations
- Evidence of stored flammable liquids

# Security of Evidence

- Preserving the scene
- Securing the evidence
- Chain of custody forms
- Secure storage area
- Documentation

# Handling of Physical Evidence

| | |
|---|---|
| **Meters & Regulators** | These are your property; if possible maintain custody. If not possible, insure a chain of custody and protect your right of access. |
| **Pressure Testing** | Conduct *integrity* testing, not *strength* testing. This testing should only be performed by trained individuals with the proper equipment. It must be a non-destructive test. This test should be witnessed and documented. |
| **Customer Piping** | If possible, recover and reconstruct the interior piping system. Watch for missing piping and clean threads. Test with monometer at operating pressure (ounces). |
| **Caution:** | **Testing piping exposed to fire/heat** |

# Dealing with the Media at the Scene

- Gas company should have one person whose responsibility is to deal with the media at the scene; this person should be easily accessible.
- Miranda warning – “anything you say can and will be used against you.”
- Public’s initial impressions formed will carry forward.
- A “no comment” statement vs. “the matter is still being investigated.”

# Debriefing First Responders

- Debrief initial responders as soon as possible
- Conduct debriefing in a relaxed atmosphere
- Express importance of honest and accurate information
- Question responders about what they *personally* saw and did at the scene and during the time frame. They should not speculate on the cause or actions of others at the scene.
- Document their responses
- Verify instrument calibration

# Initial Analysis of the Situation

- Gas company employee meeting
- Review & document actions taken
- Review records
- Establish level of the investigation

# Typical Evidential Documents




- Reports of incoming calls
- Service orders and reports
- “One call” records
- Repair orders and reports
- Employee training records
- Engineering records
- Leakage survey records and reports
- Pressure testing records of line in question
- Maps and valve location records
- Employee/contractor qualification
- Odorant tests and injection records
- Instrument calibration records

# Analysis of Facts are Based On:

A. Test results
B. Observations
C. Statements of witnesses
D. Photographic evidence
E. Statements of employees
F. Laboratory analysis
G. Reports (verbal or written) of outside experts

***Conclusions must be based on facts!***

# Laboratory Analysis

- The sampling devices must be obtained in advance (vacuum bottles, evidence bags etc.)
- Lab should have someone who is qualified to testify as to how the samples were handled and analyzed
- In case of metallurgical samples, be aware that this generally takes a considerable period of time to conduct the analysis

❖ Field tests kits (charcoal filters, ethane identifiers, stain tube tests) should be substantiated with a lab analysis

❖***These tests, by themselves, should not be considered as a technical analysis in the event of litigation***

# Giving Depositions

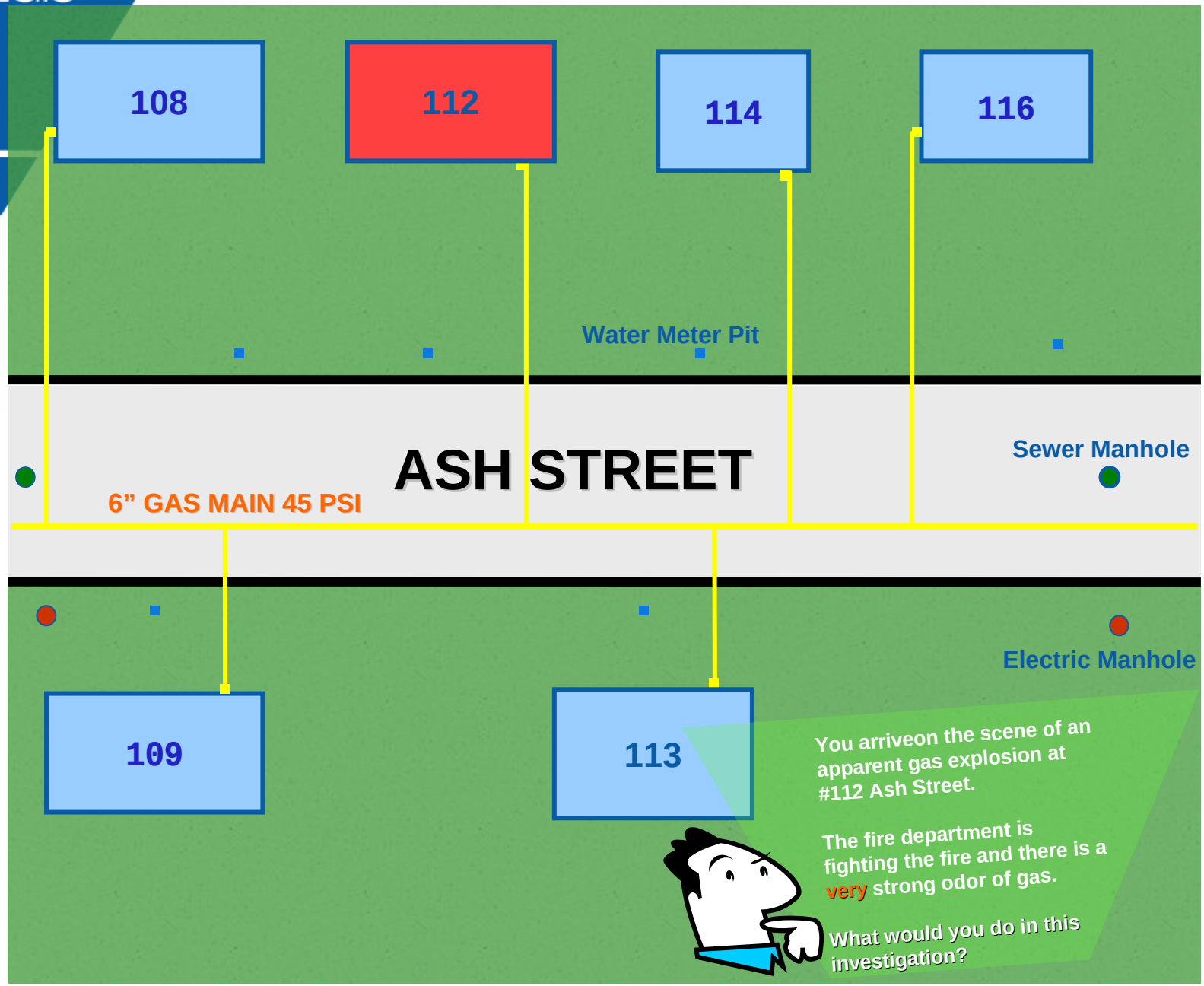
- Work with your attorney
- Follow his/her instructions
- Be honest*…honesty is always the best policy!*

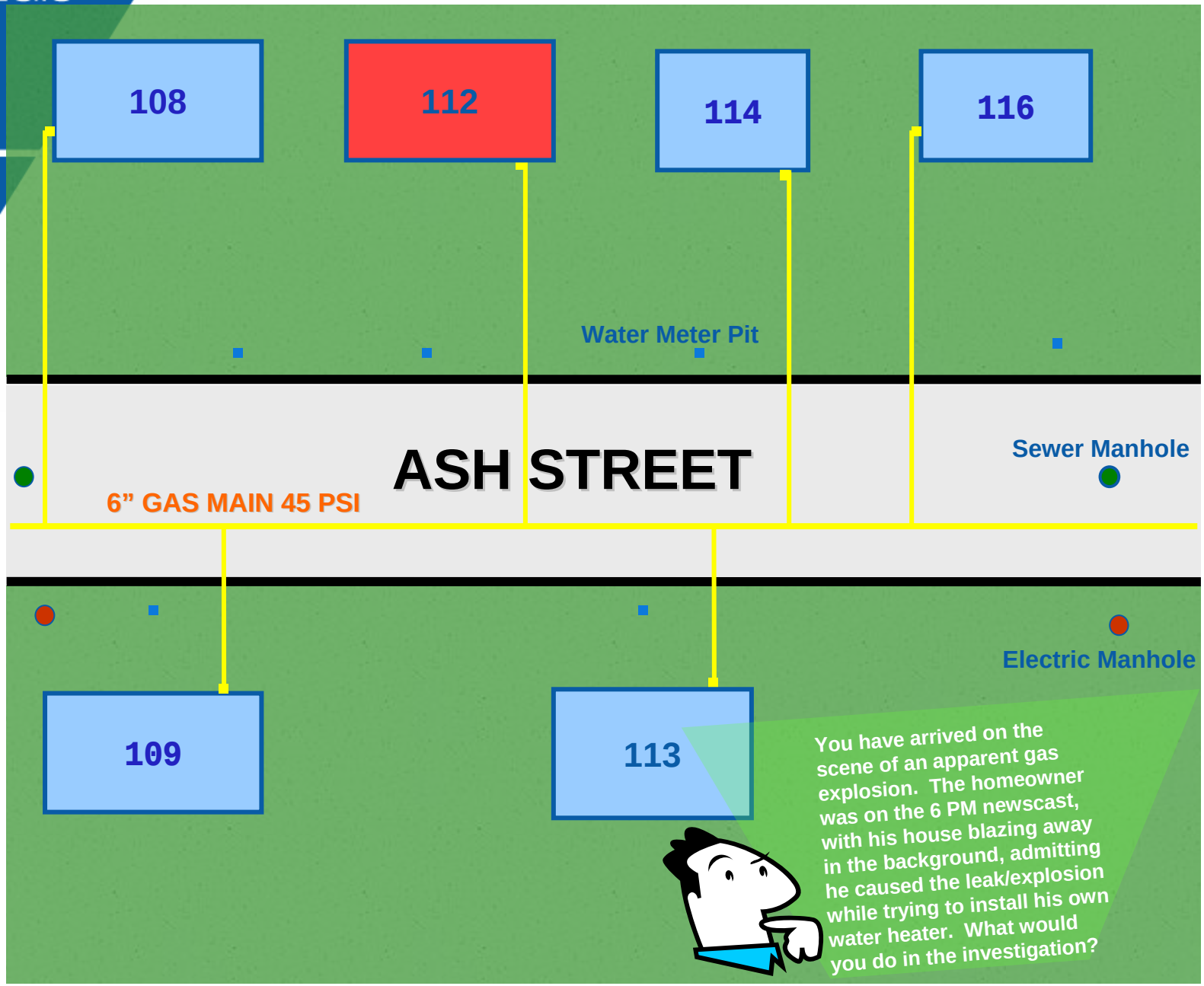
# Report Preparation

- Reports should be based only on the facts that can be substantiated.
- Reports should be concise and to the point. Refrain from descriptive adjectives and flowing dialog.
- The report may be part of your defense should it go to trial and may be discoverable. Reports should not be prepared too far in advance.
- Be careful in the acceptance of written reports from outside experts (oral vs. written).
- Working through an outside attorney may help with certain “client-attorney” privileges.

# Defense Preparation

- The role of the investigator is to be the technical arm of the attorney and act as an advisor in the area of determining cause.
- Realistically, the only time that a case would go to trial is when the true cause cannot be established. This fact alone should establish the need for a detailed and unbiased investigation.
- Remember, the fact that natural gas was not involved is not good enough.  The true cause of the incident must be determined.
- Winning does not always mean a jury verdict, it may be through an out-of-court settlement.


108
112
114
116
Water Meter Pit
ASH STREET
Sewer Manhole
6” GAS MAIN 45 PSI
Electric Manhole
109
113
You arriveon the scene of an apparent gas explosion at #112 Ash Street.
The fire department is fighting the fire and there is a very strong odor of gas.
What would you do in this investigation?


108
112
114
116
Water Meter Pit
ASH STREET
Sewer Manhole
6” GAS MAIN 45 PSI
Electric Manhole
109
113
You have arrived on the scene of an apparent gas explosion. The homeowner was on the 6 PM newscast, with his house blazing away in the background, admitting he caused the leak/explosion while trying to install his own water heater. What would you do in the investigation?

# Incident (1996)

## Company Retention $1M

- An explosion and fire destroyed a mobile home severely burning its occupants a man and his wife.  The husband spent 44 days in the hospital undergoing 6 surgical treatments and his wife spent 77 days and underwent 12 surgeries.

# Incident (1996)

## Company Retention $1M

Cont'd.

- The cause of the leak was attributed to natural gas leaking from an open fuel line below the mobile home. The open fuel line was the work of a plumber hired to move the gas line. Not being "viable" – having sufficient assets or insurance coverage – he was not named as a defendant in the case.
- That left the local gas company as the sole defendant with the plaintiff only alleging that the gas was improperly odorized (no readily detectable odor).

# Incident (1996) Cont'd.

## Company Retention $1M

Cont'd.

- Since the gas company performed and documented an odor-level test immediately after the incident, which indicated that the gas was readily detectable at levels 3 times the federal requirement, it was believed that the allegation would be difficult to prove.

# Incident (1996) Cont'd.

## Company Retention $1M

Cont'd.

- During the trial, the odor meter used to conduct the test was introduced as evidence. When it was shown to the jury, its flexible tubing, which transports gas samples from the source into the instrument, had a distinct odor of gas; it should have borne no odor.
- The tubing, not being made of material intended for use with the instrument, retained odorant molecules – thus the smell.

# Incident (1996) Cont'd.

## Company Retention $1M

Cont'd.

- The plaintiff argued this nullified the company's odor readings taken immediately after the incident.
- The jury originally found for the plaintiff and awarded $6,500,000.00. Based on the improbability of a successful appeal, the utility accepted a negotiated settlement of $4,100,000.00

**AEGIS Incurred $3.1 Million**

# What Happened?

- The concept of proper operation, calibration and normal maintenance of test instrumentation consistent with their manufacturers' recommendations cannot be over emphasized – not only for odor meters, but combustible gas indicators, flame ionization instruments, carbon monoxide detectors, oxygen level instruments and other safety and hazard detection instruments.
- Calibration and training in the proper operation and maintenance of these instruments is essential.
- The instrument is only as good as the operator who uses it.

# Suggested Books & Reference Materials For Root Cause Analysis

**Pipeline Failure Investigative Report**

Located on the Pipeline and Hazardous Materials (PHMSA) website:

PHMSA www.phmsa.dot.gov in the search box type Pipeline Failure Investigation Report

- **"Root Cause Analysis For Beginners" (Free article)**

  American Society For Quality www.asq.org in the search box type Root Cause Analysis For Beginners

- **NFPA 921 Guide for Fire and Explosion Investigations**

NFPA http://catalog.nfpa.org in the search box type NFPA 921 ($50.00)

# AEGIS Insurance Services, Inc.

## Thank You

## Please visit our website at www.aegislink.com