

# Introduction to Failure Investigation



**PHMSA Training and Qualifications**

# Investigators of What?

- Incidents
- Failures
- Accidents



# **§192.617**

## **Investigation of failures**

Each operator shall establish procedures for analyzing accidents and failures, including the selection of samples of the failed facility or equipment for laboratory examination, where appropriate, for the purpose of determining the causes of the failure and minimizing the possibility of a recurrence.

# Accident Investigation

- **§195.402** Operator shall prepare & follow a manual of written procedures...
- **§195.402 (c)(5)** Analyzing pipeline accidents to determine cause
- **§195.402 (c)(6)** ...and the possibility of recurrence of accidents analyzed under paragraph (c)(5) of this section.





# FAILURE

(1) Omission of occurrence or performance

i.e. – failing to perform duty or expected action

(2) Inability to perform a normal function

(3) A falling short or deficiency

# What is a FAILURE?

## **breakdown of something**

a breakdown or decline in the performance of something, or an occasion when something stops working or stops working adequately

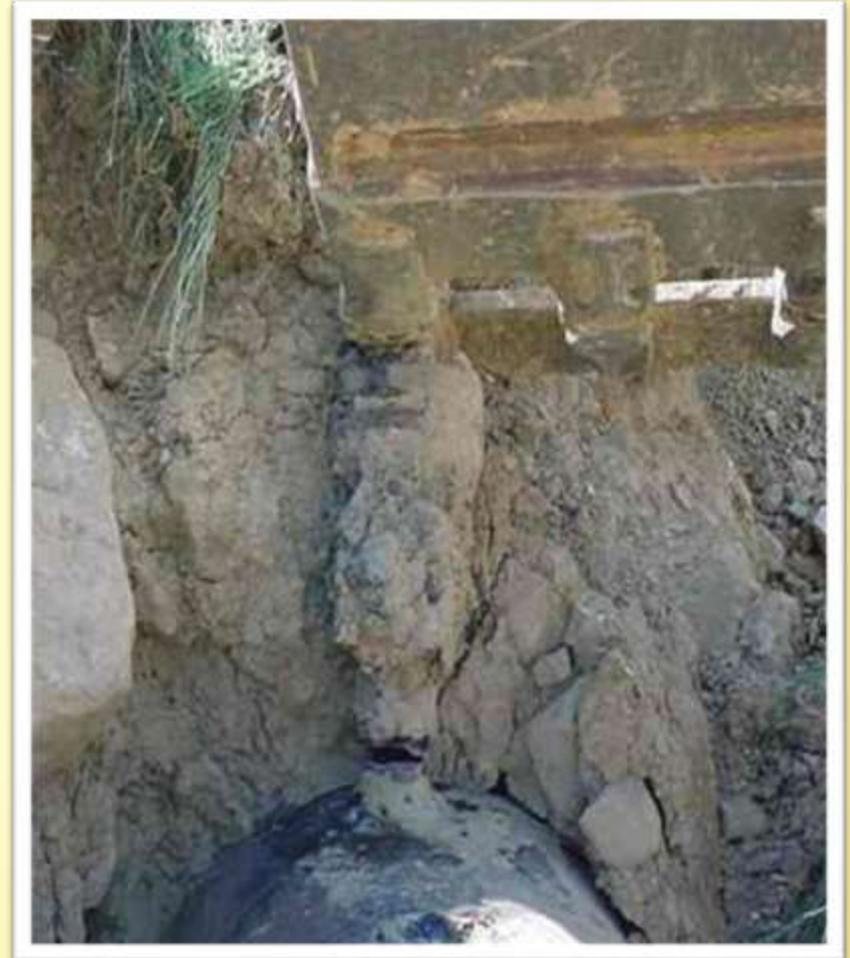
**or**

## **something less than that required**

something that falls short of what is required or expected

# Accident

- 1) An event occurring by chance or arising from unknown causes
- 2) An unfortunate event resulting from carelessness, unawareness, ignorance, or a combination of causes



# Incident - GAS

## §191.3

Event that involves a release of gas and results in one or more of the following consequences:

- Death or personal injury requiring in-patient hospitalization
- Estimated property damage of  $\geq$  \$50,000
- Unintentional gas loss of  $\geq$  3,000,000cf (3,000 mcf)
- Other event that operator deems significant

# Accident

## **§195.50 requires an accident report for:**

Release of 5 gallons (19 liters) or more of hazardous liquid or carbon dioxide, except that no report is required for a release of less than 5 barrels (0.8 cubic meters) resulting from a pipeline maintenance activity if the release is:

- (1) Not otherwise reportable under this section;
- (2) Not one described in Sec. 195.52(a)(4);
- (3) Confined to company property or pipeline right-of-way; and
- (4) Cleaned up promptly;

# Accident

**§195.50 requires an accident report for:**



- Explosion or fire not intentionally set by the operator.
- Death of any person
- Personal injury necessitating hospitalization
- Estimated property damage of  $\geq$  \$50,000



# Incident, Accident, Failure

- Attract media and government attention
- Deteriorate over time
- Interrupt operations
- Damage Image
- Adversely affect financial position

**No reference to magnitude or severity**

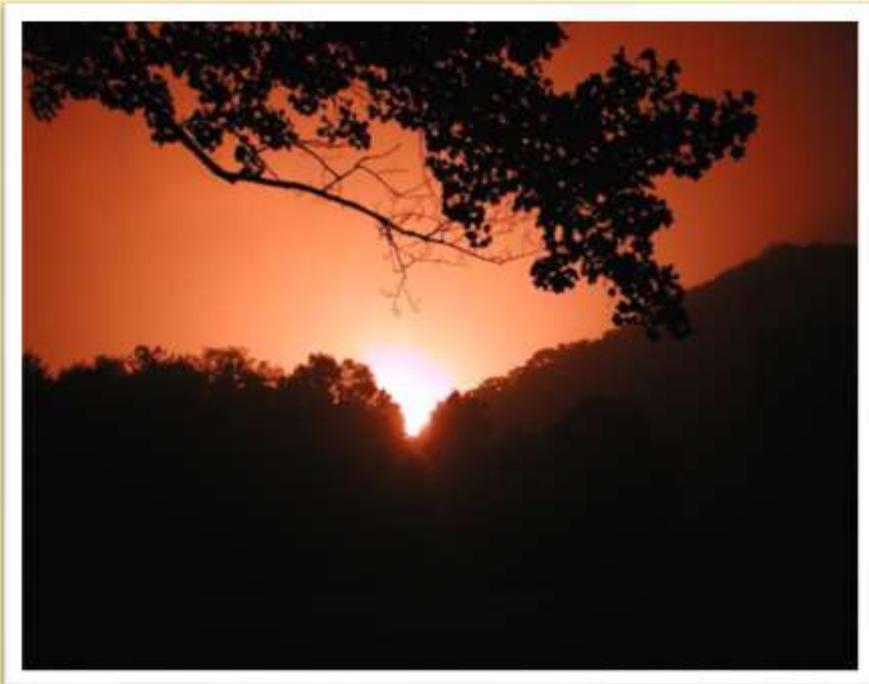
**All have negative connotations**

**Worst Case situation will:**

# What is a Failure ?

Failures can be catastrophic events

- **A reportable incident or accident**



# What is a Failure ?

- Whenever the carried product comes out of the carrier

*unintentionally*

- Leak
- Third party damage



# So, What is a Failure?

Abnormal Operation or near miss with no escape of product

- Regulator failure which causes an over pressurization
- Systemic problem with equipment



# So, What is a Failure?

- Procedural failure
  - Inadequate or incomplete procedures
  - Failure to follow procedures
  - Use of wrong equipment
- Other
  - As determined by company or state regulators

# So, What is a Failure?

## Design Failure

- Failure to consider all factors affecting facility
- Use of wrong equipment





# Leaks

- Leak reports are failure reports
- § 192.459, 192.475, and 195.569 require metallic pipe inspection when exposed or cut
- New gas annual reports require reporting of leaks by 9 threat categories
- Integrity Management requires failure identification of leaks

# Mechanical Fitting Failures

- Mechanical fitting failure reports as required by §191.12 are failure reports
- Integrity management (§192.1009) require reporting of mechanical fitting failures



# So why investigate?

- §192.617 – Investigation of failures  
.....procedures for analyzing accidents and failures
- §192.605 (e)
  - The procedures required by ..... and §192.617 must be included in the manual required by paragraph (a) of this section

# So why investigate?

- **§192.615(a)(10)**
  - Beginning action under §192.617, if applicable, as soon after the end of the emergency as possible



# So why investigate?

- **§195.402(c)** Manual required by section must include procedures to provide safety during operations
- **§195.405(c) (5, 6)** analyzing pipeline accidents to determine causes and minimize the possibility of recurrence

# Investigate

To observe or study by close examination and systematic inquiry

- examination:
- to inspect closely,
- to test the condition of,
- to inquire carefully



# What to Investigate

Do all failures, accidents, leaks or other events need to be investigated?

Operator should specify in written procedures when investigations are needed as well as how detailed the investigation needs to be.

# Operators Procedures

## Written procedures

- Detailed in types of failures or events to investigate
- Who, what, when where, and how
- Disposition of report

PROCEDURE NUMBER: 220.004.002  
PROCESS OWNERSHIP: Field Services

VERSION NUMBER: 3  
RELATED PLAN:

### Incident / Near Miss Investigation and Root Cause Analysis Process

#### 1.0 Scope

This procedure describes the process for documenting and performing an incident investigation and analysis.

This procedure should be used to investigate all DOT Reportable Incidents (even if later rescinded). This procedure may be used when investigating the events pertaining to a Safety Related Condition or Abnormal Operation. Refer to Plans 220.05.01 DOT Incidents - Reporting and Investigating Requirements, 220.05.02 Safety Related Conditions - Reporting and Investigating Requirements, or 220.05.03 Abnormal Operations for additional information.

Depending on the nature and extent of a Facility Failure, as defined in Section 8, these procedures may be used during the investigation.

The Incident/Near Miss Investigation and Root Cause Analysis process applies to health and safety, vehicle, or equipment failure investigation and analysis. This procedure describes the steps that may be followed to document the incident, the history leading up to the incident, and identifying the root cause(s). Following this procedure will help to ensure consistency in investigations and to help in determining root causes. Understanding the true root cause or causes of an incident is necessary to help prevent incidents from reoccurring and may be used to improve operational practices, maintenance procedures, designs, and equipment & material specifications.



**WARNING:** Use caution when performing inspections or investigations where slip, trip and fall, hazards exist or when bending, striking against objects, contacting sharp edges, touching electrical fences or coming in contact with pinch points.

#### 2.0 Procedures

2.1 Any incident or near miss will be reported by the employee to their team leader.

2.2 Employee and/or team leader must notify the Monitoring Center of all vehicle accidents, safety incidents, and other incidents, as appropriate.

2.3 Employee and Team Leader Perform Initial Investigation within 24 to 48 Hours  
The team leader will create a Maximo work order, and associate the Incident Investigation and Root Cause Analysis Job Plan.

PROCEDURE NO. 220.004.002

EFFECTIVE DATE: 01/16/2020

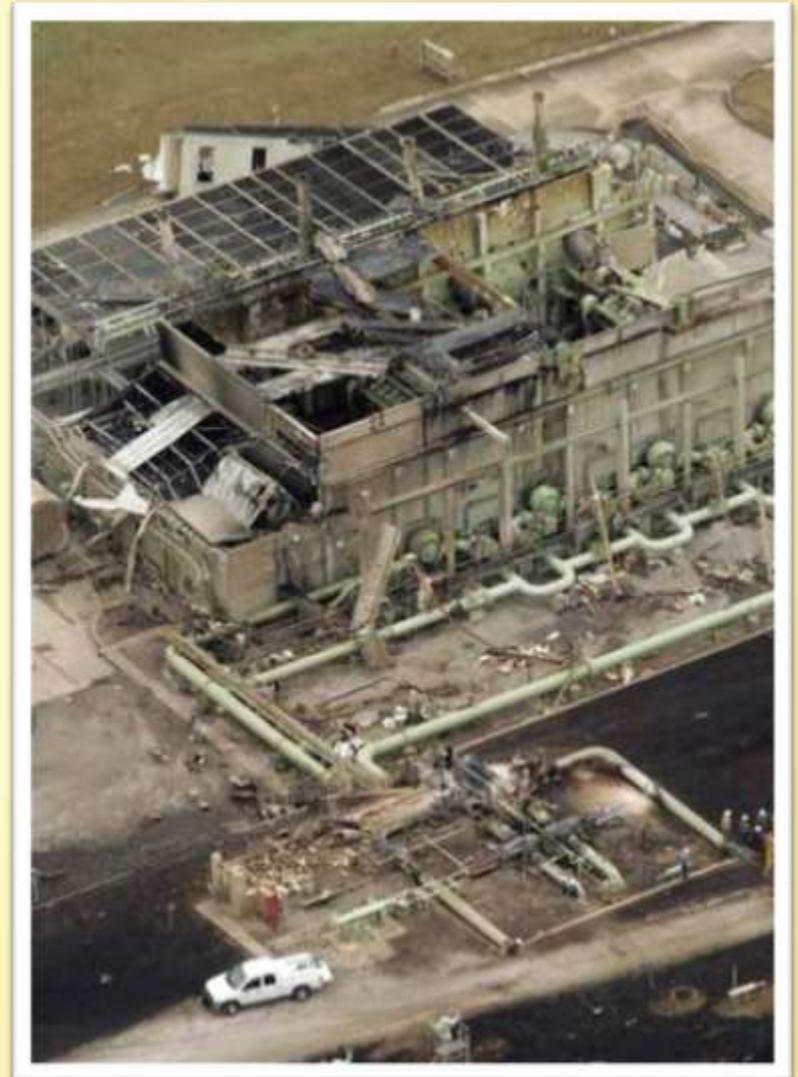
DOCUMENT CONTACT: Codes and Standards

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# Not all failures need investigation

Some failures are obvious

- Weather related events such as hurricanes, tornados
- Automobile accidents
- Other obvious events



# Not all failures need investigation

Bullet hole in pipeline



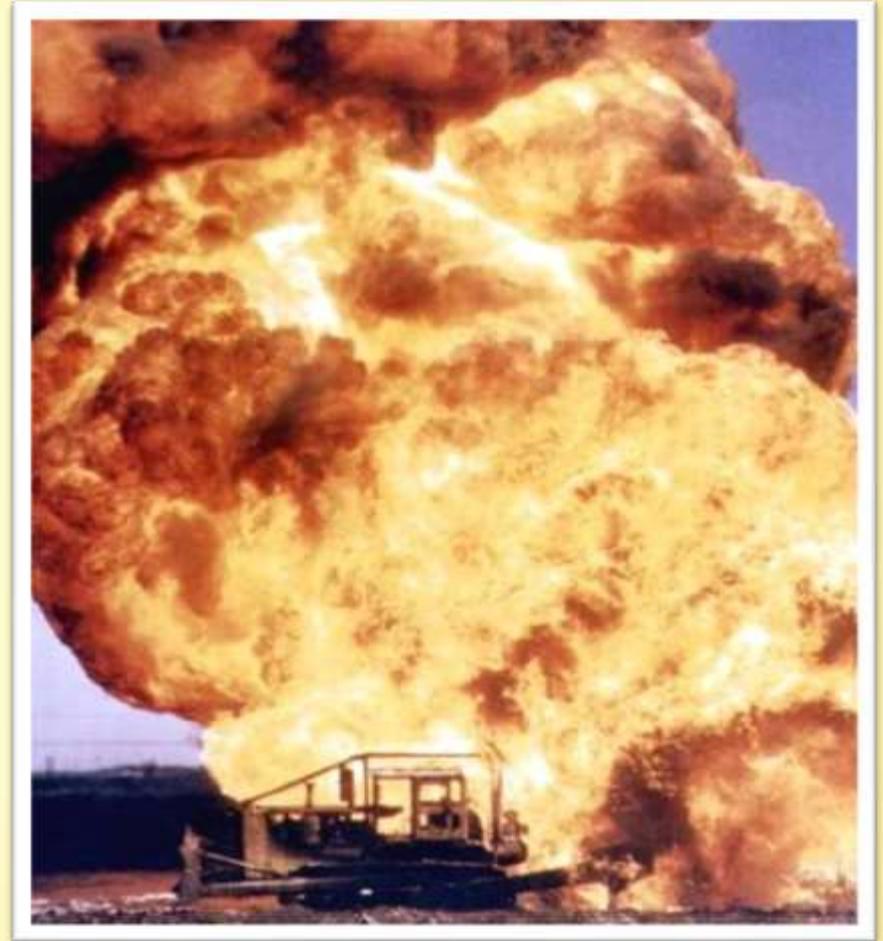
Vehicle accident

**Not all  
failures need  
investigation**



# Who investigates?

- DOT - PHMSA/State regulators
  - Pipeline hazards to public
- EPA
  - Environmental contamination
- OSHA
  - Workplace accidents
- NTSB
  - Any transportation accident



# Role of Pipeline Inspectors

- Ensure Public Safety
- Compliance with regulatory requirements
- Review procedures and emergency response for violations
- Help direct the investigation
- Safe operation of the facility



# Typical Operator

## Response to Leaking Gas

- CORRECT UNSAFE CONDITION;
- RESTORE SERVICE;
- DOCUMENT NEW INSTALLATION;

*Oh, and maybe.....*

–Determine cause of failure.

Failure investigation is often secondary  
to the top three goals.

# Role of Pipeline Operators

- Search for the probable cause
- Repair and restore service
- Prepare for litigation
- Prevent the possibility of a recurrence



# What to Investigate

- The events and actions that lead to the failure
- When did the failure occur
- Why did the failure occur
- How did the failure occur
- Where did the failure occur
- Who was involved/identified the failure
- How much could have been prevented
- What else was affected?

# **Pipeline Scene Investigation (PSI instead of CSI)**

Take a forensic approach to investigating a failure, accident, or incident and follow basic root cause investigation techniques and rules

# Follow the Basic Rules

- Use an investigation form (PHMSA Form 11) to help prompt and remind you what to collect
- Document only the facts and never opinions
  - Don't jump to conclusions
  - Allow the evidence to direct the investigation
- Construct a time line of the events
- Document surface conditions at point of failure
- Document weather and environmental conditions at time of failure, 24 hours before and after as available

# How to Investigate

**ALWAYS MAKE SURE THE**  
**LOCATION IS SAFE**

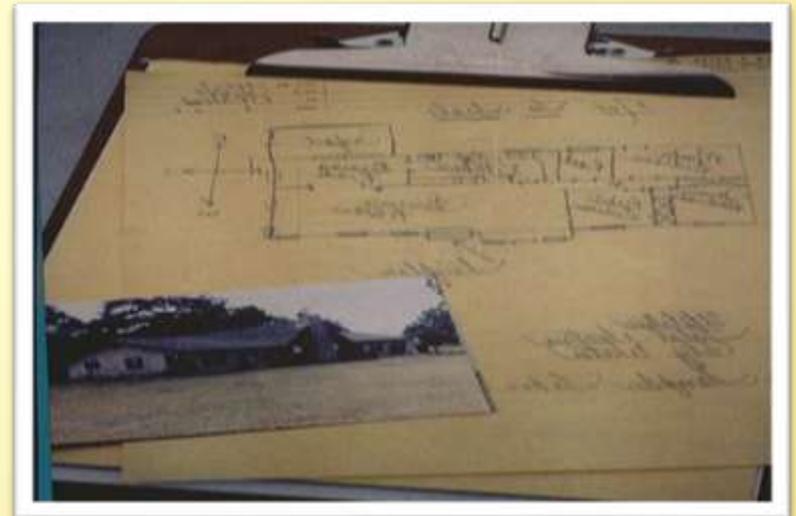
# Pipeline Scene Investigation

1. Photograph and Diagram the Scene
2. Interview Witnesses
3. Conduct a Migration Survey
4. Retrieve or Dig up the Facility, preserving failed equipment
5. Make Repairs
6. Test the Facility in Place
7. Run tests on failed equipment as needed
8. Additional system tests

# Photos and Diagrams of the Scene

Photos are important throughout the procedure

- Used to identify as found conditions
- Location of debris, damage conditions
- Preserve a chronology of actions
- May be needed during repair process or
- as additional conditions
- uncovered
- Identify as left conditions



# Pipeline Rupture

## Appomattox Co, VA 9/28/08





**Harlem 2014**

**Philadelphia, 2011**



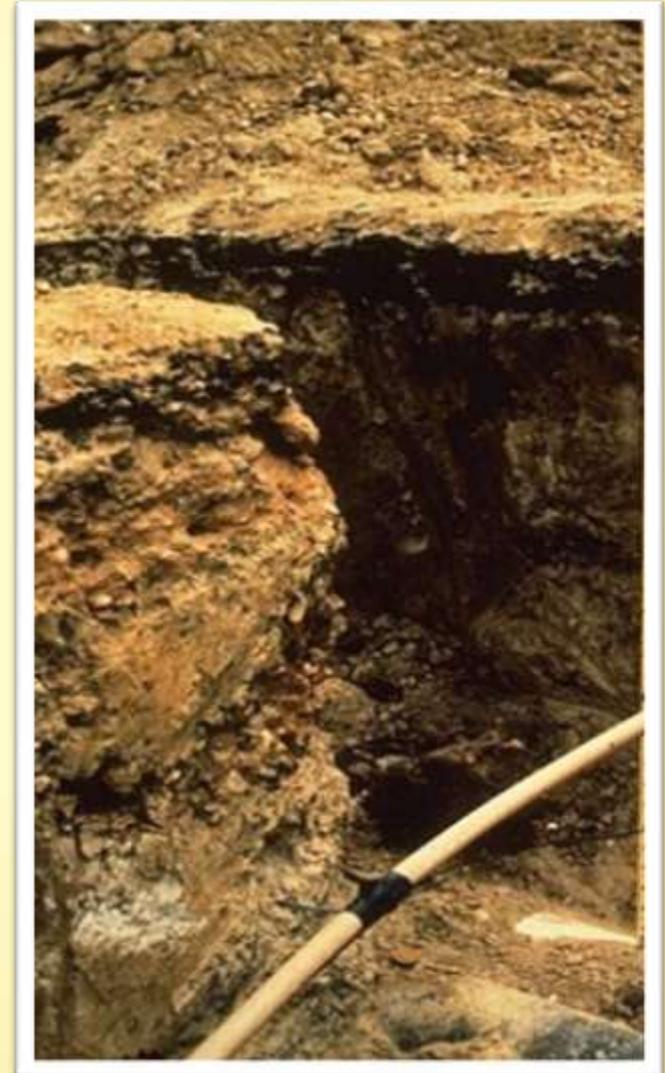
# Photos and Diagrams of the Scene

Photographs from all angles, sides or views of the area

- Keep running list of photographs and locations for future reference
- Establish scale or perspective and dimension

<i>Pipeline Failure Investigation Report</i>			
<i>Photo Documentation <sup>(1)</sup></i>			
Overall Area from best possible view. Pictures from the four points of the compass. Failed Component, Operator Action, Damages in Area, Address Markings, etc.			
Photo No.	Description	Photo No.	Description
1		31	
2		32	
3		33	
4		34	
5		35	
6		36	
7		37	

# Photographs without scale



# Photographs showing scale



# CREATIVE PHOTOGRAPHY



# Photos and Diagrams of the Scene

## Video

- Video may be useful tool
  - Video without the microphone on
- Helps document actions taken by all parties

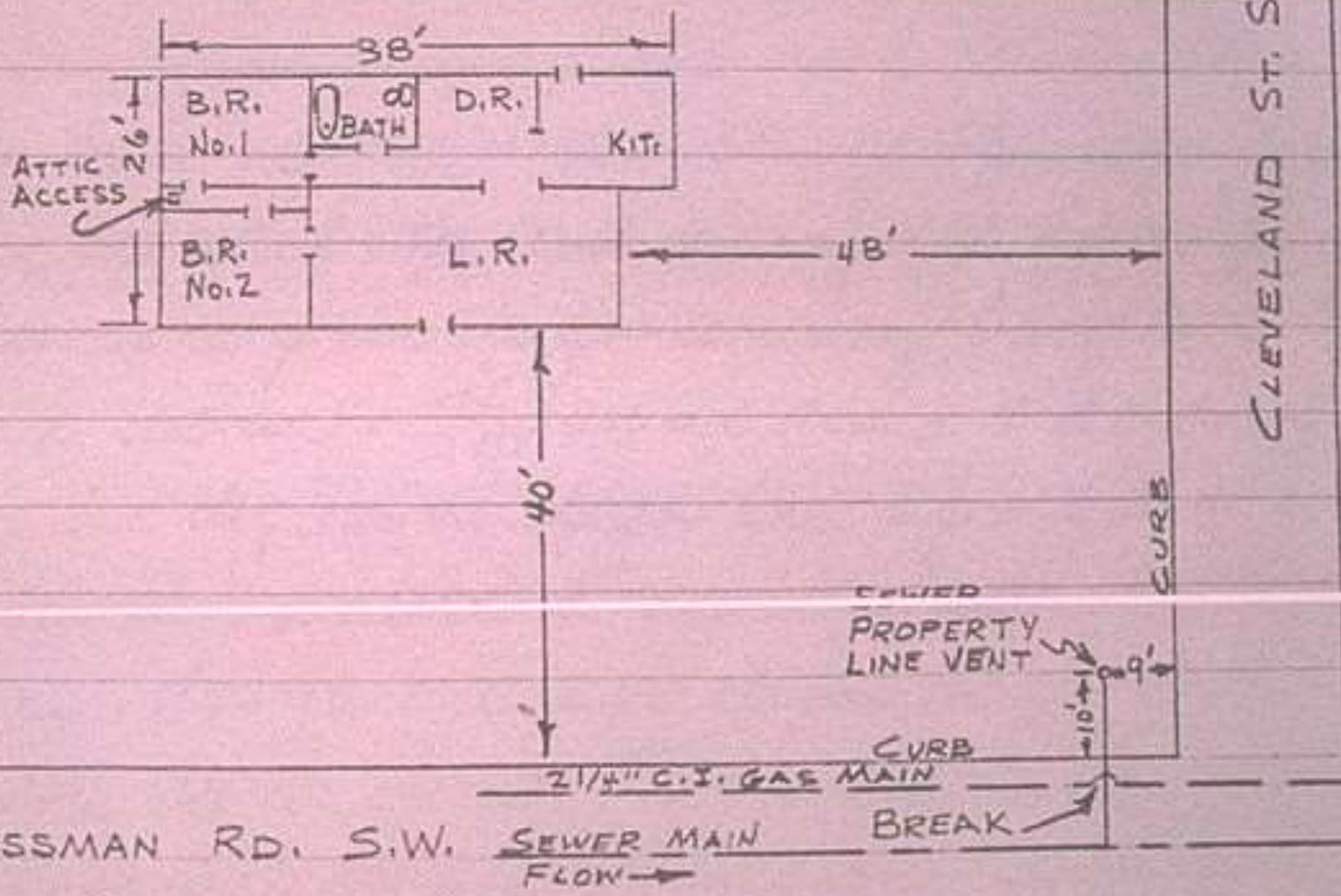


# Photos and Diagrams of the Scene

Diagram location with measurements as possible

- Location of debris may help investigation and timeline of events
- GPS locations instead of measurements still allow mapping
- Witness can use copies of diagrams during interviews

1301 LESSMAN RD.



# Evidence of Material Removed From Site

POINT NUMBER	GPS LOCATION	DESCRIPTION OF MATERIAL
1	32 26.3141 91 28.1300	Casing on north side of service road
2	32 26.3200 91 28.1346	Pipe on south side of I-20 east bound lane next to bridge railings
3	32 26.3143 91 28.1396	Casing removed from I-20 east bound lane. The readings are at the location after casing was removed from I-20 east bound lane.
4	32 26.2712 91 28.1035	Pipe located on west side of slough
5	32 26.2367 91 28.1291	Field joint form
6	32 26.2635 91 28.1305	Field joint form
7	32 26.2635 91 28.1305	Field joint form
8	32 26.2905 91 28.1117	Field joint form
9	32 26.2887 91 28.1071	Field joint form
10	32 26.2933 91 28.1003	Pipe coating
11	32 26.2969 91 28.0994	Pipe coating
12	32 26.2948 91 28.0998	Pipe coating
13	32 26.2992 91 28.1227	Pipe south end of rupture
14	32 26.3086 91 28.1163	Pipe north end of rupture
15	32 26.3555 91 28.1195	Pipe north side of I-20 west bound lane
16	32 26.2898 91 28.1305	Small piece of pipe south of crater approximately 10 ft. west of Line 100
17	32 26.2755 91 28.1221	Metal strap
18	32 26.2473 91 28.1126	Metal strap
19	32 26.2910 91 28.1037	Pipe coating
20	32 26.2815 91 28.1174	Pipe coating
21	32 26.2929 91 28.1279	Metal strap
22	32 26.3086 91 28.1163	Casing on north side of rupture
23	32 26.3150 91 28.1268	Vent piping
24	32 26.3493 91 28.1190	Small piece of pipe located on north side of I-20 west bound lane
25	32 26.2875 91 28.1126	Field joint form

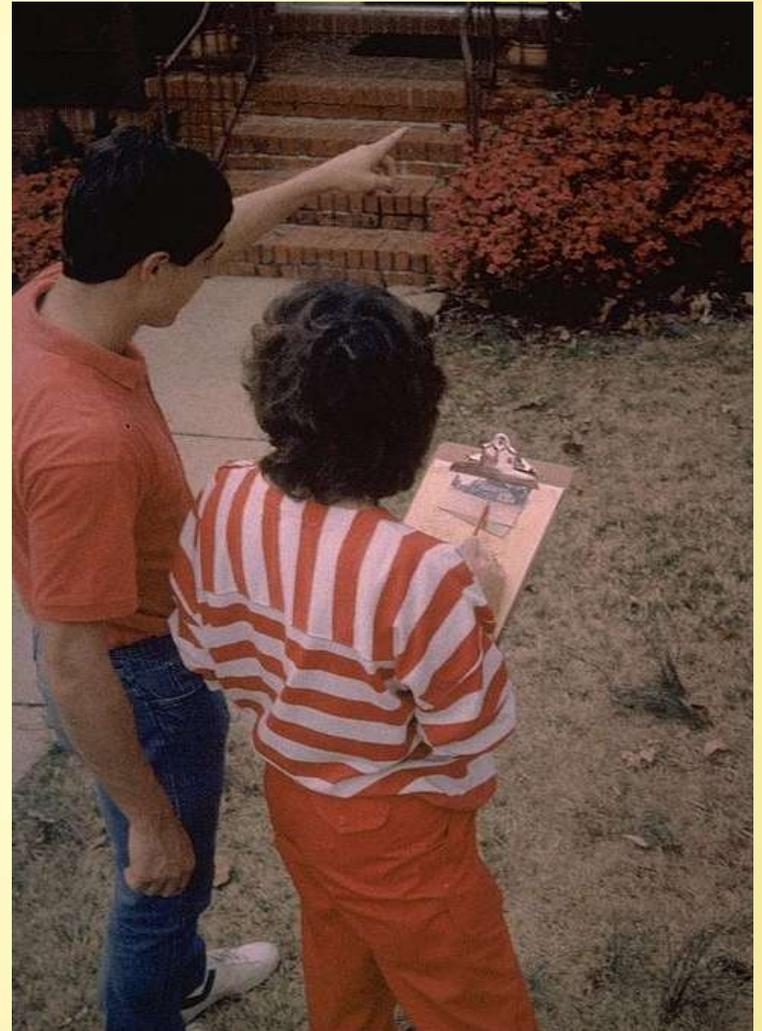
GPS readings were taken with a Trimble Pro XR



# Interviews

## Interview witnesses

- May need multiple interviews
- Use diagrams
- Develop list of question before interview

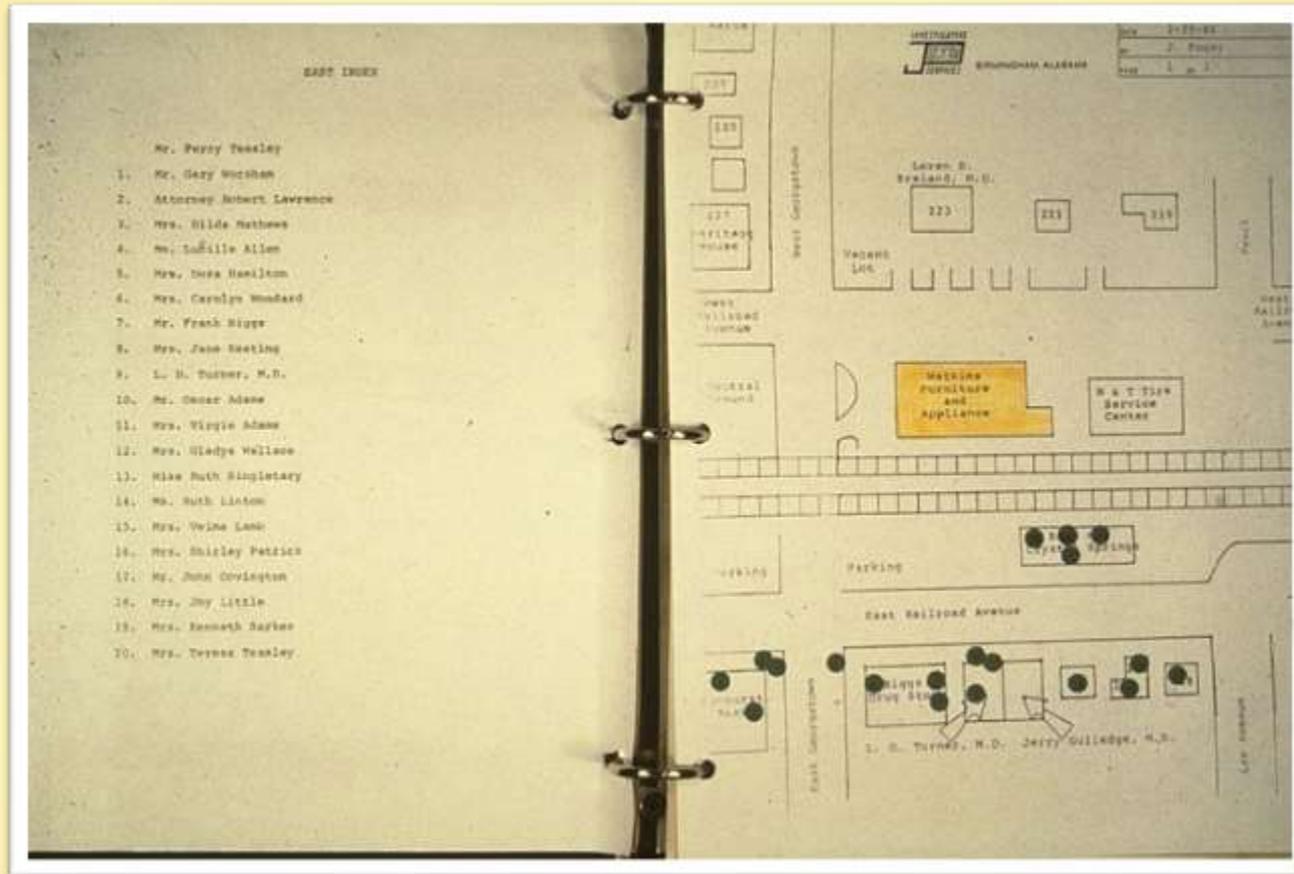


# Witness Interviews

- Company personnel
  - On site personnel
  - First responders
  - Control room
- Contractor personnel
- Public
- Media
- Emergency response personnel



# Plot location of Witnesses

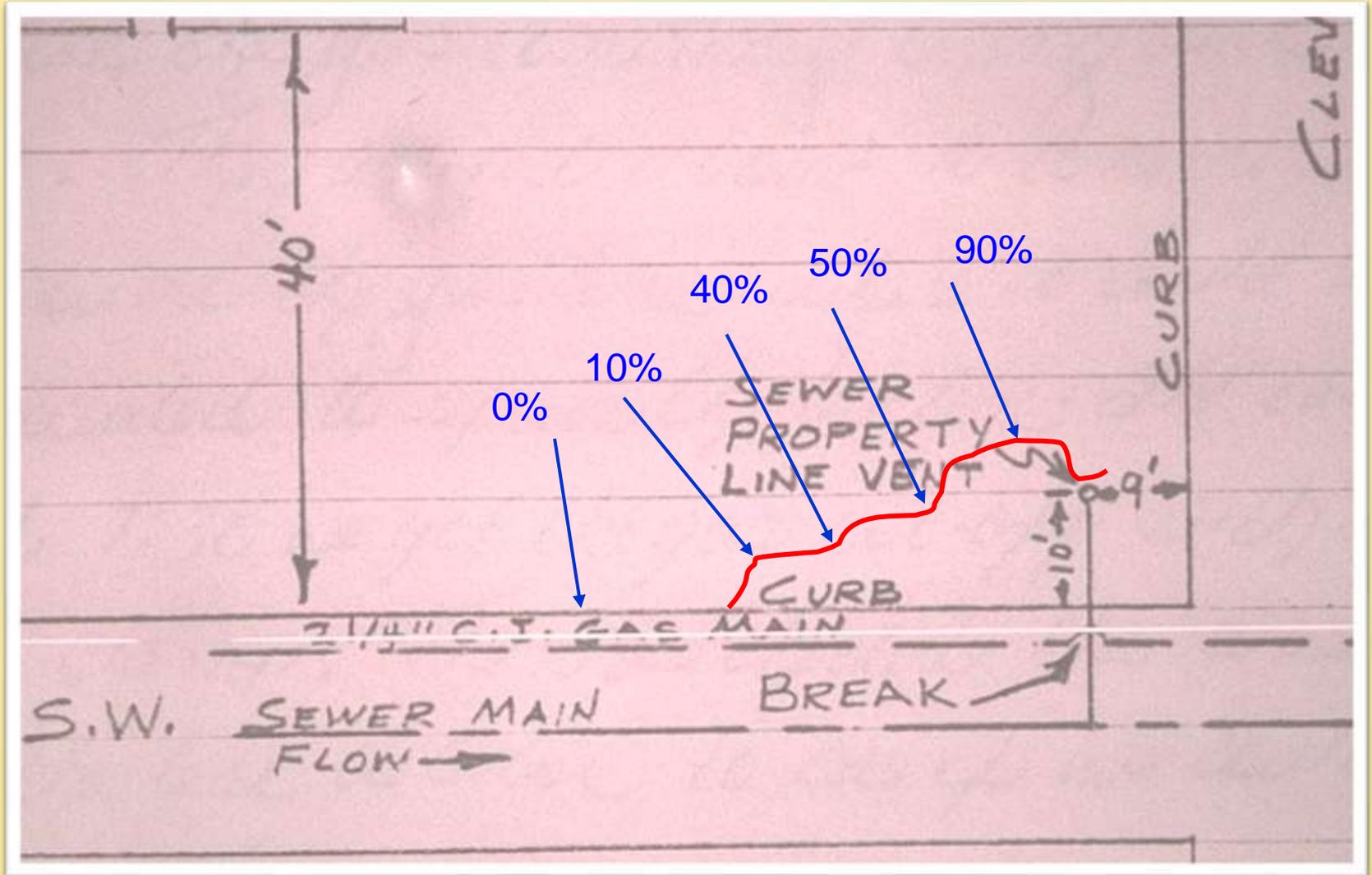


Plotting witnesses locations can help determine if they had line of site of the failure scene

# Migration Survey

- Determines where the gas or product came from and where it went.
- Confirms that there are no additional hazardous areas (i.e. gas up against an adjacent house)
- Checks for collateral damage

# Plot Gas Migration



# Recover Damaged Facility

- Treat digging and recovery of equipment as archeological dig
- Take pictures and make diagrams as needed



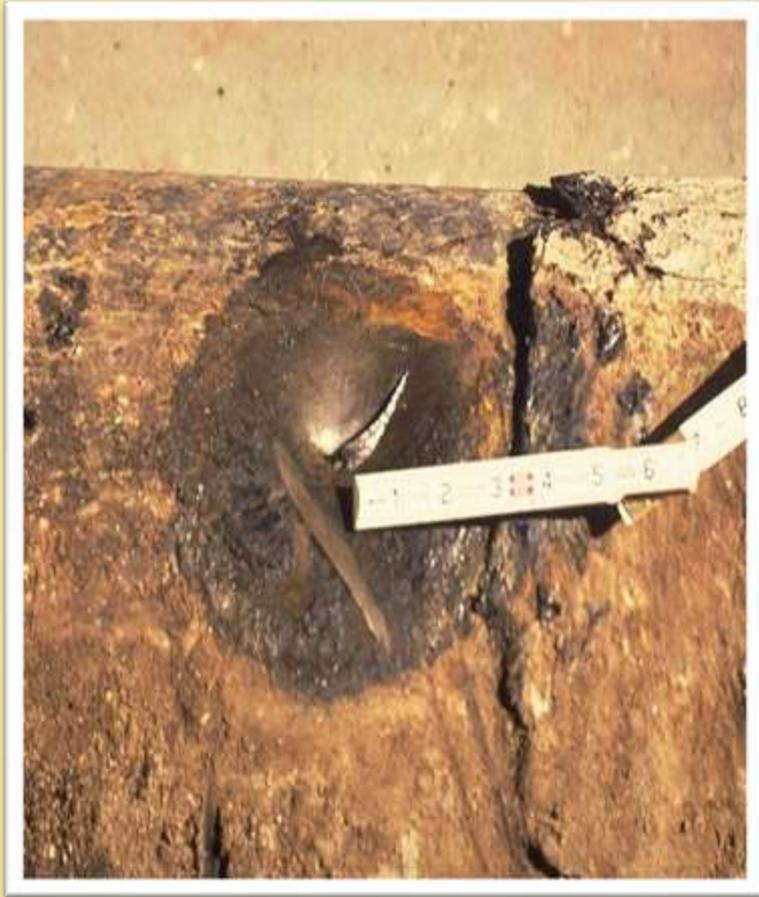
# Recover Damaged Facility

Recover all pieces of failed equipment

- Label all pieces
  - Include equipment orientation
  - Direction of gas flow
- Follow a chain of custody for all pieces.
  - Maintains integrity of evidence
  - Protects company



# Recover Damaged Facility



## **DON'T TOUCH FRACTURE SURFACES**

- Don't clean fracture surfaces or pieces
- Wrap in bubble-wrap or similar product
- Secure in shipping container



# Depending on Material

- Indicate if there is evidence of external corrosion
- Take and record CP readings at grade and at pipe elevation before and after repairs
- Other sampling such as soil pH, water, solid samples
- Visually indicate the type and condition of any coating
- Indicate if the pipe and components are above or below ground/water/surface
- Follow O&M Procedures

# Repairs

## Document repairs

- Why that particular repair was used
- Repairs suitable for MAOP
- Testing was done to ensure the integrity of the system before returning it to service
- Identify other areas of the facilities that may be affected by the conditions of this failure/incident/accident

# Pressure Testing



# Pressure Testing

- Pressure test only to the operating pressure at the time of the failure.
- Ensure that the test equipment is calibrated.
- Ensure test is done in accordance with O&M procedures

# Basic Information

## Historical data

- Pipe or equipment information
- Date of installation and installation method
- Normal operating pressure and test records
- Operating pressure at time of failure
- Copies of photos of excavation
- Soil samples
- Cathodic protection data
- Gas samples
- Pipe inspection information



# Other Information

- Emergency Plan
- O&M Plans and Records
- Operator Qualification
- Integrity Plans
- Maps, diagrams, GIS information
- Pressure data including charts or, SCADA
- Control room information
- Other incidents/abnormal operation information

*Are they correct?  
Were they followed?*

# Additional System Tests

Check System for additional problems or collateral damage

- Pull outs, leaks, and other damage
- May also need investigation



# Additional Considerations

## Don't forget to consider:

Drug and alcohol testing

- ADB - 2012-02, February 23, 2012  
Post Accident Drug and Alcohol  
Testing

Operator Qualification

# Prevent Recurrence

**§192.617** – Investigation of failures  
.....procedures for analyzing accidents  
and failures..... to minimize the possibility  
of a recurrence

# Prevent Recurrence

## §195.402(c)(6)

Minimizing the potential for hazards identified under paragraph (c)(4) of this section and the possibility of recurrence of accidents analyzed under paragraph (c)(5) of this section.

# Prevent Recurrence

Information circulated to appropriate personnel

Procedure Review

Data storage for future reference

- May be months to years before another type failure
- Allows comparisons to previous failures

# Procedure Review

- Emergency response procedures
- O&M Procedures
- Operator Qualification
- Integrity Management
- Construction
- Purchasing
- CRM



# Root Cause Analysis

Proper Investigations take time

Rarely is there only one Root Cause  
to a Failure!!

May be failures where the cause  
cannot be determined

# Additional Information

- PHMSA Form 11 –  
Pipeline Failure Investigation Report

*[www.phmsa.dot.gov/pipeline/library/forms](http://www.phmsa.dot.gov/pipeline/library/forms)*

**QUESTIONS?**