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 $50,000 or more
- Unintentional gas loss of ≥ 3,000,000cf (3,000 mcf)
- Other event that operator deems significant
§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 ≥ $50,000
Incident, Accident, Failure

No reference to magnitude or severity
All have negative connotations
Worst Case situation will:

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

[Image of Photos and Diagrams]
Pipeline Rupture
Appomattox Co, VA 9/28/08

585ft
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

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**Pipeline Failure Investigation Report**

<table>
<thead>
<tr>
<th>Photo Documentation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Area</td>
<td>from best possible view. Pictures from the four points of the compass. Failed Component, Operator Action, Damages in Area, Address Markings, etc.</td>
</tr>
<tr>
<td>Photo No.</td>
<td>Description</td>
</tr>
<tr>
<td>1</td>
<td>31</td>
</tr>
<tr>
<td>2</td>
<td>32</td>
</tr>
<tr>
<td>3</td>
<td>33</td>
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<tr>
<td>4</td>
<td>34</td>
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<tr>
<td>5</td>
<td>35</td>
</tr>
<tr>
<td>6</td>
<td>36</td>
</tr>
<tr>
<td>7</td>
<td>37</td>
</tr>
</tbody>
</table>
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
Evidence of Material Removed From Site

<table>
<thead>
<tr>
<th>POINT NUMBER</th>
<th>GPS LOCATION</th>
<th>DESCRIPTION OF MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>32 28.3141</td>
<td>Casing on north side of service road</td>
</tr>
<tr>
<td>2</td>
<td>32 28.3446</td>
<td>Pipe on south side of I-20 east bound lane near to bridge railing</td>
</tr>
<tr>
<td>3</td>
<td>32 28.3443</td>
<td>Casing removed from I-20 east bound lane. The readings are at the location after casing was removed from I-20 east bound lane.</td>
</tr>
<tr>
<td>4</td>
<td>01 28.1355</td>
<td>Pipe located on west side of slough</td>
</tr>
<tr>
<td>5</td>
<td>01 28.1291</td>
<td>Field joint form</td>
</tr>
<tr>
<td>6</td>
<td>01 28.1305</td>
<td>Field joint form</td>
</tr>
<tr>
<td>7</td>
<td>01 28.1305</td>
<td>Field joint form</td>
</tr>
<tr>
<td>8</td>
<td>01 28.1117</td>
<td>Field joint form</td>
</tr>
<tr>
<td>9</td>
<td>01 28.1971</td>
<td>Field joint form</td>
</tr>
<tr>
<td>10</td>
<td>01 28.1063</td>
<td>Pipe coating</td>
</tr>
<tr>
<td>11</td>
<td>01 28.0994</td>
<td>Pipe coating</td>
</tr>
<tr>
<td>12</td>
<td>01 28.0986</td>
<td>Pipe coating</td>
</tr>
<tr>
<td>13</td>
<td>01 28.1227</td>
<td>Pipe south end of rupture</td>
</tr>
<tr>
<td>14</td>
<td>01 28.1145</td>
<td>Pipe north end of rupture</td>
</tr>
<tr>
<td>15</td>
<td>01 28.1155</td>
<td>Pipe north side of I-20 west bound lane</td>
</tr>
<tr>
<td>16</td>
<td>01 28.1305</td>
<td>Small piece of pipe south of crater approximately 10 ft. west of line 100</td>
</tr>
<tr>
<td>17</td>
<td>01 28.1221</td>
<td>Metal strap</td>
</tr>
<tr>
<td>18</td>
<td>01 28.1126</td>
<td>Metal strap</td>
</tr>
<tr>
<td>19</td>
<td>01 28.1077</td>
<td>Pipe coating</td>
</tr>
<tr>
<td>20</td>
<td>01 28.1174</td>
<td>Pipe coating</td>
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<tr>
<td>21</td>
<td>01 28.2922</td>
<td>Metal strap</td>
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<tr>
<td>22</td>
<td>01 28.1179</td>
<td>Metal strap</td>
</tr>
<tr>
<td>23</td>
<td>01 28.1163</td>
<td>Casing on north side of rupture</td>
</tr>
<tr>
<td>24</td>
<td>01 28.1163</td>
<td>Vent piping</td>
</tr>
<tr>
<td>25</td>
<td>01 28.1136</td>
<td>Field joint form</td>
</tr>
</tbody>
</table>

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 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
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
QUESTIONS?