



Failure Investigations and Root Cause

Regulations

- ▶ § 192.617 & § 195.402(c)(5)
 - ▶ (a) Post-failure and incident procedures
 - ▶ (b) Post-failure and incident lessons learned
 - ▶ (c) Analysis of rupture and valve shut-offs
 - ▶ (d) Rupture post-failure and incident summary

“Investigating and analyzing pipeline incidents / accidents and failures...”

Definitions

Incident (§ 191.3)

- ▶ An event that involves a release of gas from a pipeline, gas from an underground natural gas storage facility (UNGSF), liquefied natural gas, liquefied petroleum gas, refrigerant gas, or gas from an LNG facility, and that results in one or more of the following consequences:
 - ▶ Death or personal injury necessitating in-patient hospitalization
 - ▶ Estimated property damage of \$139,700 (2023)
 - ▶ Unintentional estimate gas loss of 3 million cubic feet or more
 - ▶ Emergency shutdown of LNG facility or UNGSF
 - ▶ Significant event to operator judgement

Definitions

Accident (§ 195.50)

- ▶ Each failure in a pipeline system subject to this part in which there is a release of the hazardous liquid or carbon dioxide transported resulting in any of the following:
 - ▶ Explosions or Fire not intentionally set by the operator
 - ▶ Release of 5 gallons or more of hazardous liquid or carbon dioxide
 - ▶ Death of any person
 - ▶ Personal injury necessitating hospitalization
 - ▶ Estimate property damage exceeding \$50,000



Definitions

Failure

- ▶ Failure is a condition in which a human, structure, component, device, or system fails to adequately perform its intended purpose. (PHMSA Glossary)
- ▶ General term used to imply that a part in service has become completely inoperable; is still operable but is incapable of satisfactorily performing its intended function; or has deteriorated seriously, to the point that it has become unreliable or unsafe for continued use. (ASME B31.8S Managing System Integrity of Gas Pipelines)



Definitions

Root Cause

- ▶ The most basic reason(s) for a failure or condition, which if removed will prevent (or minimize the risk of) recurrence.
- ▶ Near misses, near hits, and close calls stem from the same root causes as major incidents



Definitions

Contributing Factors

- ▶ Action, lack of action, or other condition that influences the failure by increasing its likelihood, accelerating the failure time, or affecting the severity of the consequences
- ▶ Not a direct (root) cause for failure

When do we investigate?

- ▶ Most operators' goals when responding to a failure / incident / accident include:
 - ▶ Correct Unsafe Condition
 - ▶ Restore Service
 - ▶ Document New Installation
- ▶ ...Oh, and maybe determine cause of failure

When do we investigate?

- ▶ Operators need to identify what events will trigger an investigation
 - ▶ Major Incidents / Accidents
 - ▶ Fires / Explosions
 - ▶ Death / Serious Injury
 - ▶ Significant impact to operations

When do we investigate?

- ▶ Operators still need to investigate
 - ▶ Excavation / Outside force damage
 - ▶ Leaks / Corrosion / Maintenance
 - ▶ Equipment / Component Failures
 - ▶ Operations / Procedural Failures
 - ▶ Design / Construction / Materials
 - ▶ Environmental / Biological

What should be in an investigation procedure?

- ▶ Event classifications
- ▶ Assigning the investigation
- ▶ Expectations of investigations
- ▶ Evidence collection and security
- ▶ Post investigation responsibilities
- ▶ Investigation training

How do we conduct a failure investigation?

- ▶ Pre-investigation preparation
 - ▶ Procedures in place before the need?
 - ▶ Do you have the required equipment?
 - Personal Safety Equipment
 - Investigation Forms
 - Camera (Memory Cards, Extra Film, Batteries)
 - Notepads, pens, markers
 - Sample / Evidence collection supplies
 - Measuring equipment, scene markers
 - ▶ Training or other resources?

How do we conduct a failure investigation?

- ▶ Initial Response
 - ▶ Scene size-up
 - ▶ Isolation and Resolution
 - ▶ Collection of perishable evidence
 - ▶ Documentation and Photography
 - ▶ Identification of witnesses



How do we conduct a failure investigation?

- ▶ Collection of data
 - ▶ Witness statements
 - ▶ Operational records
 - ▶ Historical records
 - ▶ Control room data
 - ▶ Environmental data
 - ▶ Manuals, Bulletins, Technical Specs
- ▶ Leak reports
- ▶ Odor calls
- ▶ Locate requests
- ▶ Work orders
- ▶ Purchase History
- ▶ Maintenance Records

How do we conduct a failure investigation?

- ▶ Collection of data
 - ▶ Can you answer the WHO, WHAT, WHEN, WHERE, WHY, and HOW?
 - ▶ Allow evidence to direct the investigation findings
 - ▶ Investigations rely on facts not bias or opinion



How do we conduct a failure investigation?

- ▶ Data Analysis
 - ▶ Lab analysis reports
 - ▶ Subject Matter Experts
 - ▶ Testing / Reconstruction
 - ▶ Simulation
 - ▶ Theory evaluation



How do we conduct a failure investigation?

- ▶ Post Investigation
 - ▶ Identification of cause(s)
 - ▶ Identification of contribution factor(s)
 - ▶ Written failure report
 - ▶ Review (Training, Procedures, Policy)



What about lessons learned?



- ▶ Lessons learned are the documented information that reflects both the positive and negative experiences of a failure.
- ▶ There are times that contributing factors can lead to a positive outcome of a failure.

How are lessons learned utilized?

- ▶ Each operator must develop, implement, and incorporate lessons learned from a post-failure or incident/accident review into its written procedures, including personnel training and qualification programs, and design, construction, testing, maintenance, operations, and emergency procedure manuals and specifications.



What about incidents / accidents due to ruptures?



- ▶ If an incident or accident involves the closure of a rupture mitigation valve (RMV), an analysis must be conducted of all factors to determine impact and consequences.
- ▶ Any incident / accident with a rupture or RMV closure requires 90-day (quarterly) summary reviews until investigation and post summary completed.

Effective use of investigative tools

- ▶ Photography
 - ▶ Ensure photos tell the story
 - ▶ Utilize a Macro – Micro approach
 - ▶ Capture images of items as found
 - ▶ Capture evidence collection activities
 - ▶ Use of scale

Effective use of investigative tools

▶ Evidence Collection

- ▶ Document description, location, orientation, characteristics of item
- ▶ Do not alter or clean
- ▶ Do not minimize recovery size
- ▶ Document Chain-of-Custody
- ▶ Ensure post collection access is limited and documented

Effective use of investigative tools

- ▶ Interviews / Witness Statements
 - ▶ Collect facts not admission of guilt
 - ▶ Do not using leading questions
 - ▶ Remain neutral
 - ▶ Collect written statements

Is there anything I missed that you feel is important for me to know?



Horizontal (Directional) Drilling



Horizontal (Directional) Drilling



Rodent /
Insect
Damage



External Force Damage



External Force / Fire Damage

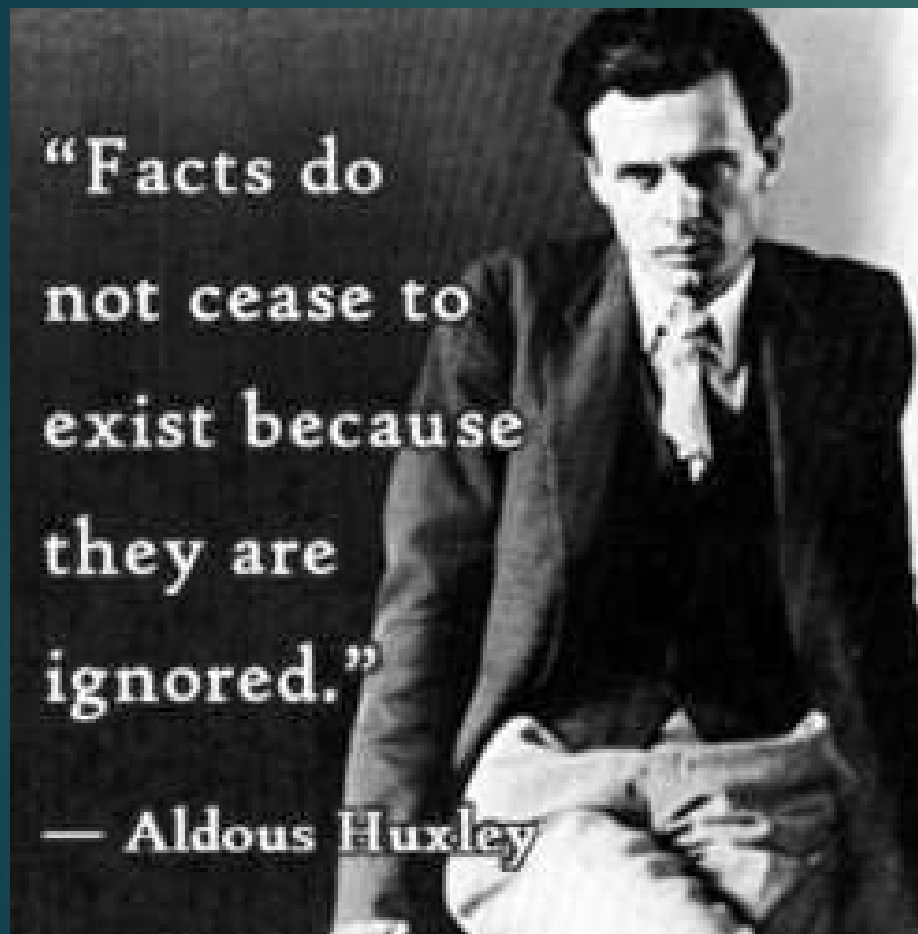


Electrical Arc Damage

Failure Investigations

Anyone can look at a failure and provide a guess as to what happened. Training and experience is necessary for any good investigator to determine the root cause as to WHY and HOW a failure occurred. Without the factual WHY and HOW, developing a plan to minimize or prevent reoccurrence will fail.

Questions



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