Defense Nuclear Facilities Safety Board

Process Safety at U.S. Defense Nuclear Facilities

The Honorable Jessie Hill Roberson
Vice Chairman, DNFSB

American Institute of Chemical Engineers
8th Global Congress on Process Safety
April 3, 2012

Outline of Presentation

- About the Board
- Examples DNFSB Process Safety Issues
- Safety Performance Metrics
- Failing to Learn from Failure
- Summary

Who We Are

Established by Congress in 1988

- Five Safety Board Members – staggered 5-year terms
  - Appointed by the President and confirmed by the Senate
- Statutory staffing up to 150 Full-Time Equivalent (FTE)
  - Currently 109 FTE's with 76 members of the Technical Staff
  - 19 PhD, 49 MS, and 8 BS
  - Broad range of technical expertise
  - Professional Development Program for entry-level staff

Our Approach

- Evaluate DOE's use of safety standards
- Focus oversight on high hazard activities, as well as operations in aging facilities
- Analyze design of new defense nuclear facilities to promote early resolution of safety issues
- Promote stabilization and disposition of legacy wastes and surplus nuclear materials
- Evaluate institutional programs and facility safety analyses
- Recommend to the Secretary of Energy those measures that the Board determines are necessary to ensure the adequate protection of public health and safety

Defense Nuclear Facilities

Site Representatives are stationed full-time at major DOE defense nuclear sites

Why Process Safety Matters to Us

- Some defense nuclear facilities have significant chemical inventories
- Some chemical operations include radioactive materials
- Chemical accidents can drive radiological consequences; nuclear events can drive toxicological consequences
- Collateral damage from nearby facilities could impact defense nuclear facilities
- Many of the evaluation tools and safety strategies used in Process Safety Management are equally useful in nuclear safety management

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LANL's Plutonium Facility

Plutonium Facility at Los Alamos National Laboratory

- Postulated seismic event with ensuing large fire
- Analysis suggests unacceptably large offsite consequences

Y-12 Uranium Processing Facility

- Preliminary design not consistent with DOE expectations for the integration of safety into the design
- Facility is important because it replaces aging facilities with known deficiencies

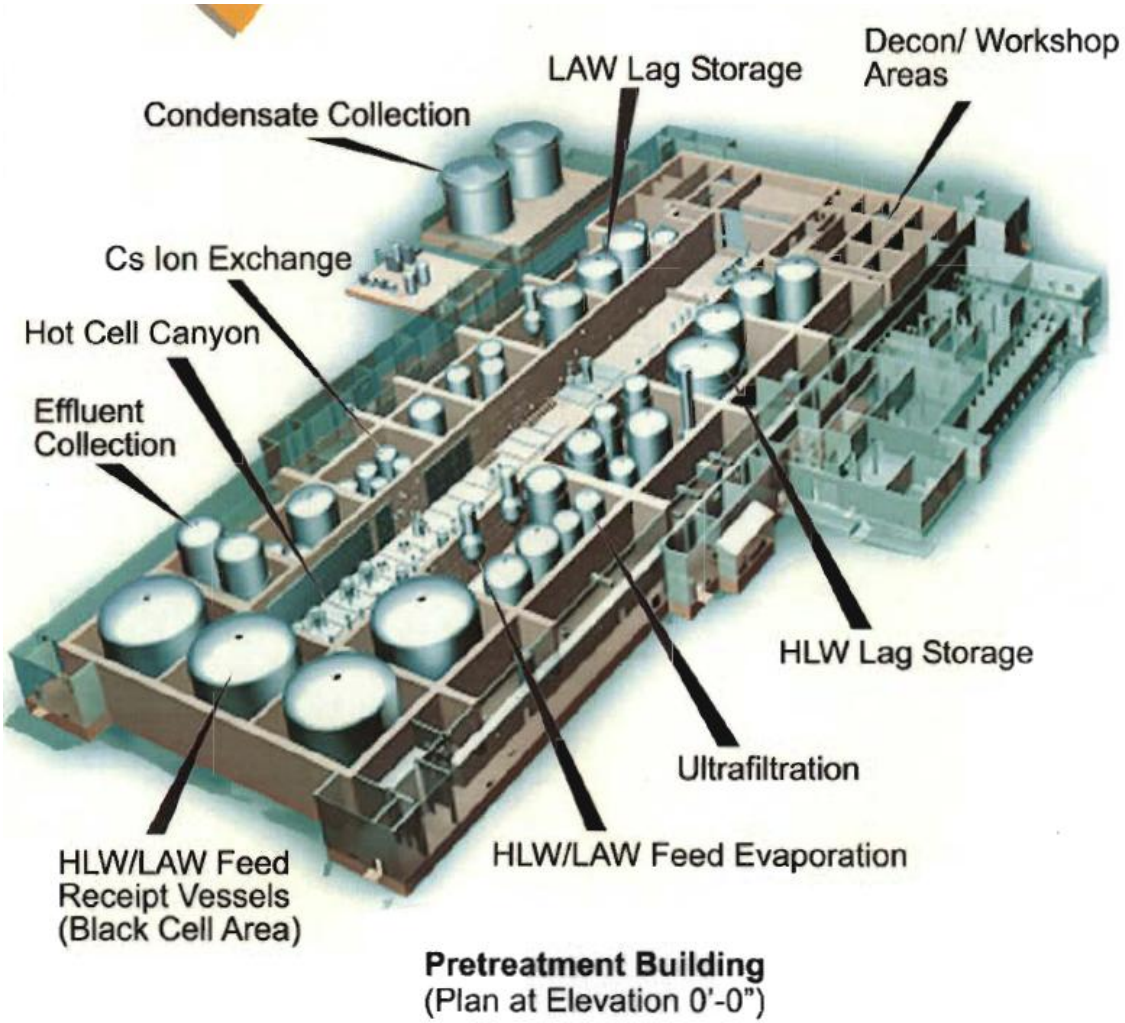
Waste Treatment & Immobilization Plant (WTP)

Design issues that have not been resolved include:

(1) effectiveness of mixing and transfer systems

(2) Generation and control of flammable gas in process systems

(3) characterization of waste destined for WTP's Pretreatment Facility.



WTP (cont.)

Pulse Jet Mixing of High-Level Waste

- Criticality control
- Flammable gas generation
- Erosion of nozzles & piping

Safety Culture

- Open discussion of safety issues is essential

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Safety Metrics

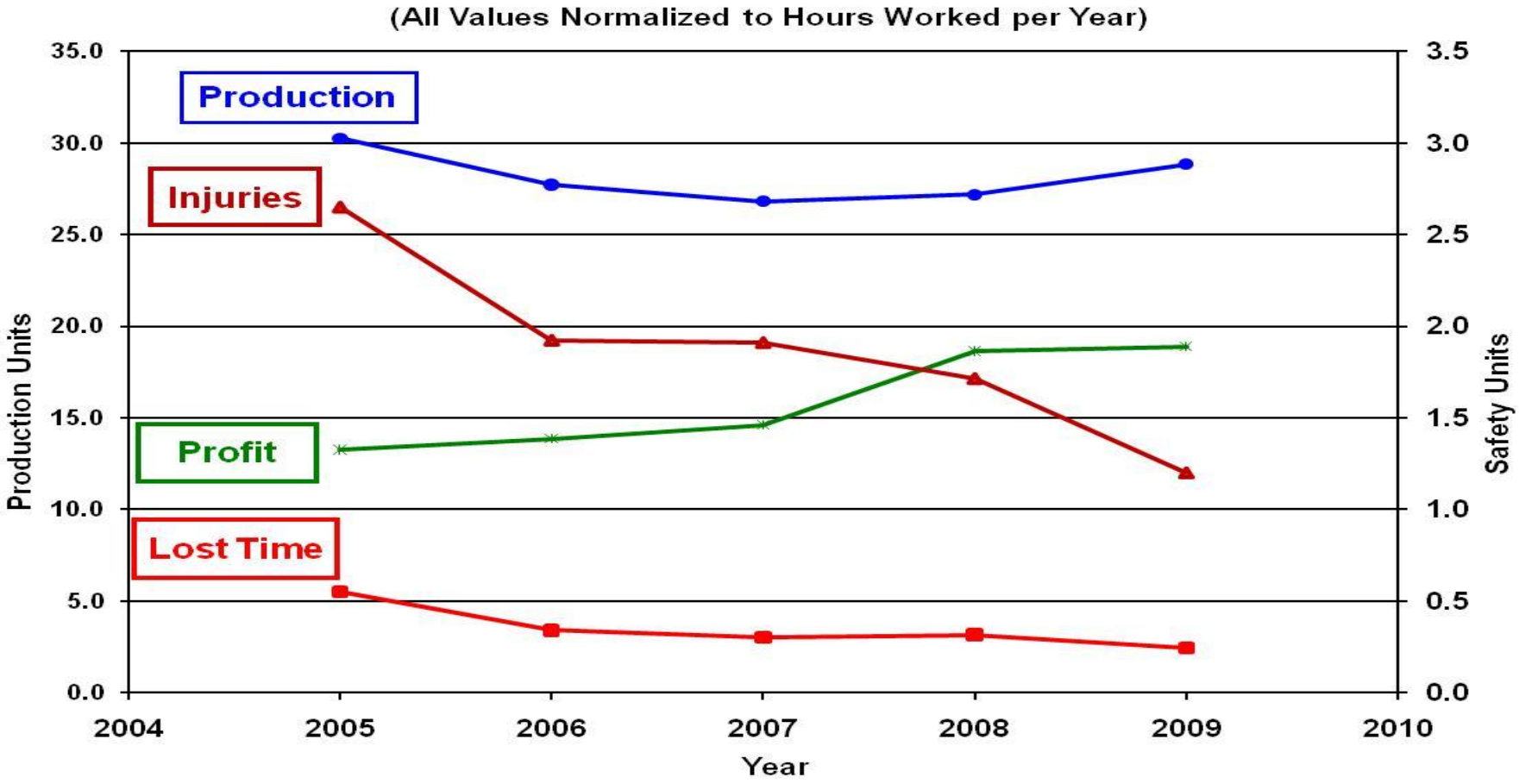
Is this a ***leading*** or ***lagging*** indicator?

- What if the tank is full?
- What if it leaked?
- What if it burst?
- What if it was indoors?
- What if it was for emergency use?
- Did it cause an accident, or will it?

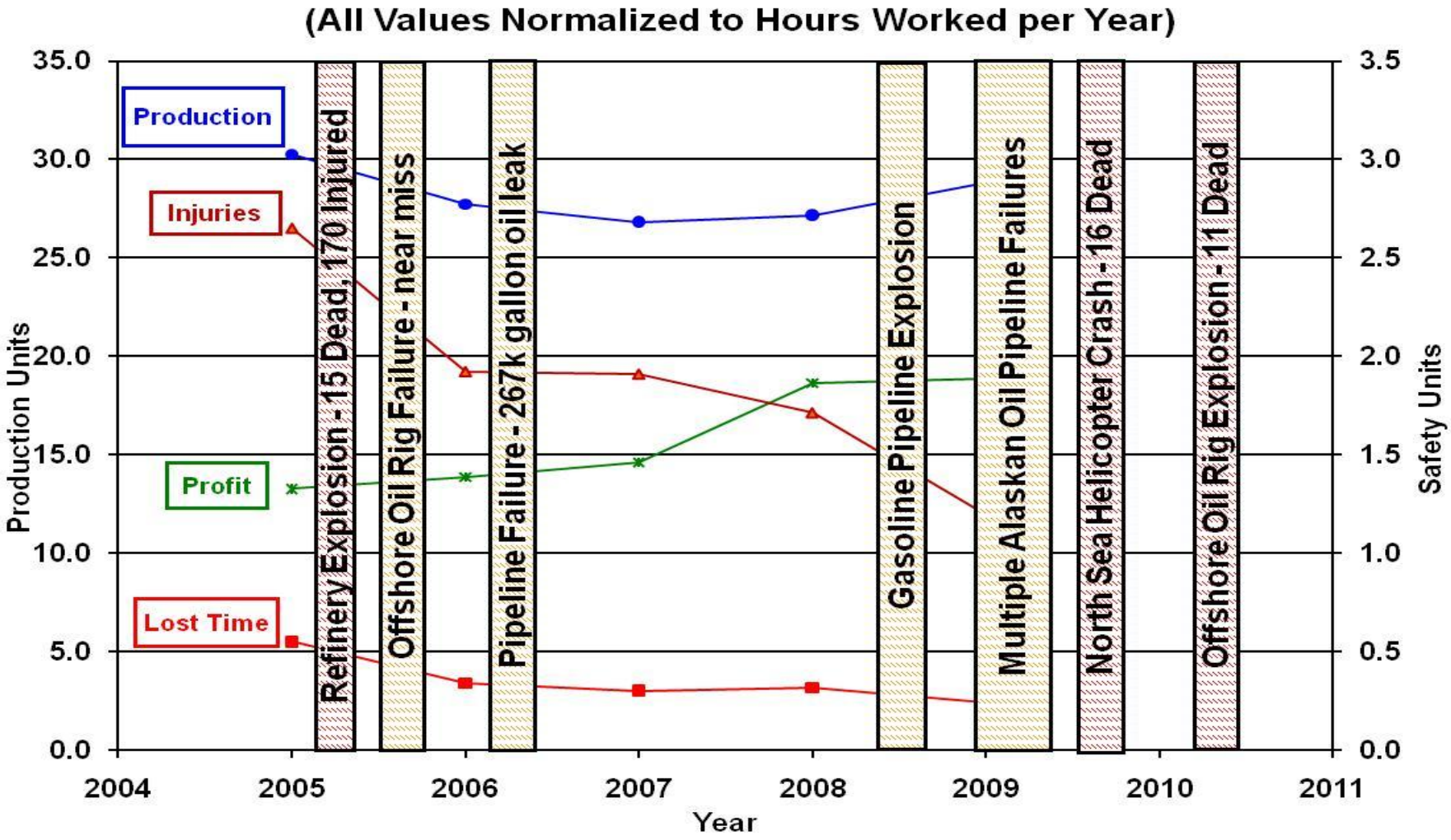
It is the context surrounding a metric that gives it meaning as a leading indicator, not the metric itself!

Pop Quiz

Whose Performance Metrics are these?



A Second Clue



Answer: British Petroleum

"BP focused on safety efforts dealing with slips, trips, falls, and vehicle accidents, even as catastrophic process risks were overlooked or not controlled."

Testimony of Carolyn W. Merritt, Chairman, Chemical Safety Board; House Committee on Energy and Commerce, Subcommittee on Investigations and Oversight, May 16, 2007

"According to BP's Patrick O'Bryan, the Deepwater Horizon was 'one of the top performing rigs in all the BP floater fleets from the standpoint of safety and drilling performance.' Despite all the crew's troubles with this latest well, they had not had a single 'lost-time incident' in seven years of drilling."

Report to the President; National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling; January 2011

(Note: Production and safety data extracted from British Petroleum 2009 Sustainability Report)

Safety Performance Metrics

Picking the right metrics is the key

You have been thinking about this, but is it effective?

This is an element you have in common with the nuclear industry and DOE – we are all struggling to get it right.

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Understanding Accidents

Several agencies have accident investigation responsibilities for activities under their jurisdiction; for example:

- National Transportation Safety Board
- US Chemical Safety Board
- Occupational Safety and Health Administration
- Environmental Protection Agency
- US Department of Energy
- Nuclear Regulatory Commission
- National Aeronautics and Space Administration
- Mine Safety and Health Administration
- US Department of Defense

Ongoing Investigations

What is the Chemical Safety Board currently investigating?

- Explosion during fireworks disassembly, five fatalities
- Explosion during hot work in slurry tank, one fatality
- Explosion during hot work in storage tank, three fatalities
- Explosion of synthetic quartz vessel, one member of public killed
- Explosion of zinc refining column, two fatalities
- Explosions of a vapor cloud and a pipe (both at same plant, same year)
- Explosion of dust at titanium plant, three fatalities
- Explosion of vapor cloud and subsequent fire at fuel storage farm
- Explosion and fire at calcium carbide plant, two fatalities
- Explosion and fire at oil refinery, seven fatalities
- Explosion and fire at oil refinery, one fatality
- Explosion and fire on offshore oil rig, eleven fatalities
- Release of hydrofluoric acid (second in three years at plant)
- Release of anhydrous ammonia, 130 members of public exposed

Failing to Learn from Failure

Why do we fail to learn from failure?

- Short organizational memory (changing members)
- Normalization of deviation (redefining acceptance)
- Fine-tuning the odds (redefining failure)
- Reluctance to be self-critical (denying vulnerability)
- Belief in one's own mythology (avowing superiority)
- Presentation of information (understating significance)
- Self-deception (denying applicability)
- Acceptance of failure as norm (denying causality)
- Blissful ignorance (rejecting similarities)

Failing to Learn from Failure

What can we do better?

- Ensure that lessons are quickly, explicitly, and clearly incorporated into applicable standards
- Ensure that the story of the accident and the lessons learned from it are captured in the organizational lore
- Leaders should demonstrate strong interest and emotional commitment to avoiding similar accidents
- Regulators should review requirements for adequacy and effectiveness based on lessons learned and update as necessary.

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Summary

- Nuclear and chemical safety have similar issues and tools
- Safety metrics need to be aligned with the safety goals of the organization
- Different approaches to incorporating lessons learned need to be developed

Information Available on DNFSB's Public Website

http://www.dnfsb.gov/board-activities/recommendations

All Board Recommendations

http://www.dnfsb.gov/board-activities/letters-and-correspondence

Letters and Correspondence Between the Board, DOE, and Other Entities

http://www.dnfsb.gov/board-activities/reports

Site Representative Weekly Reports

Technical Reports

Staff Issue Reports

Reports to Congress

Backup Slides

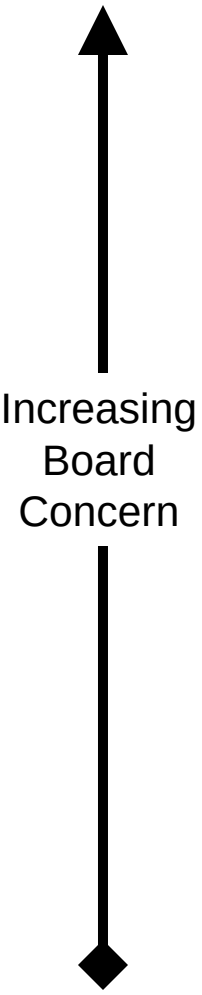
Interactions with DOE

BOARD

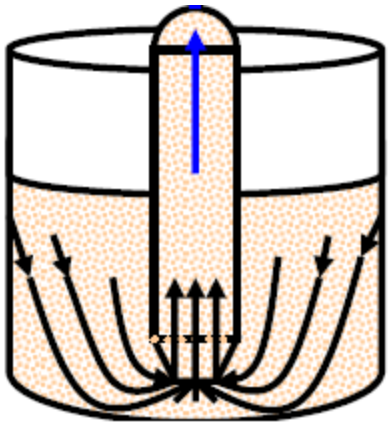
- Formal Recommendations
- Formal Reporting Requirements
- Board Letters Requesting Action
- Board Letters Providing Suggestions
- Board Letters Providing Information
- Public Hearings/Meetings

BOARD'S STAFF

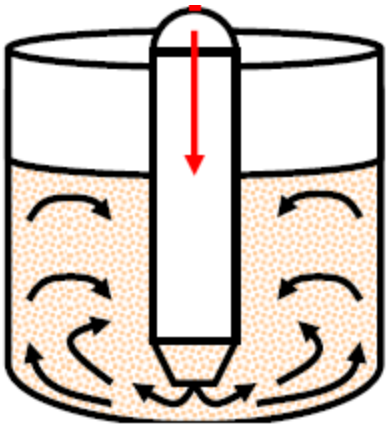
- Letters/Reports Providing Information
- Focused Safety Studies
- Letters on Evaluations of Directives
- Requests for Information
- Field Reviews/Meetings



Pulse Jet Mixing Issues at WTP



SUCTION PHASE

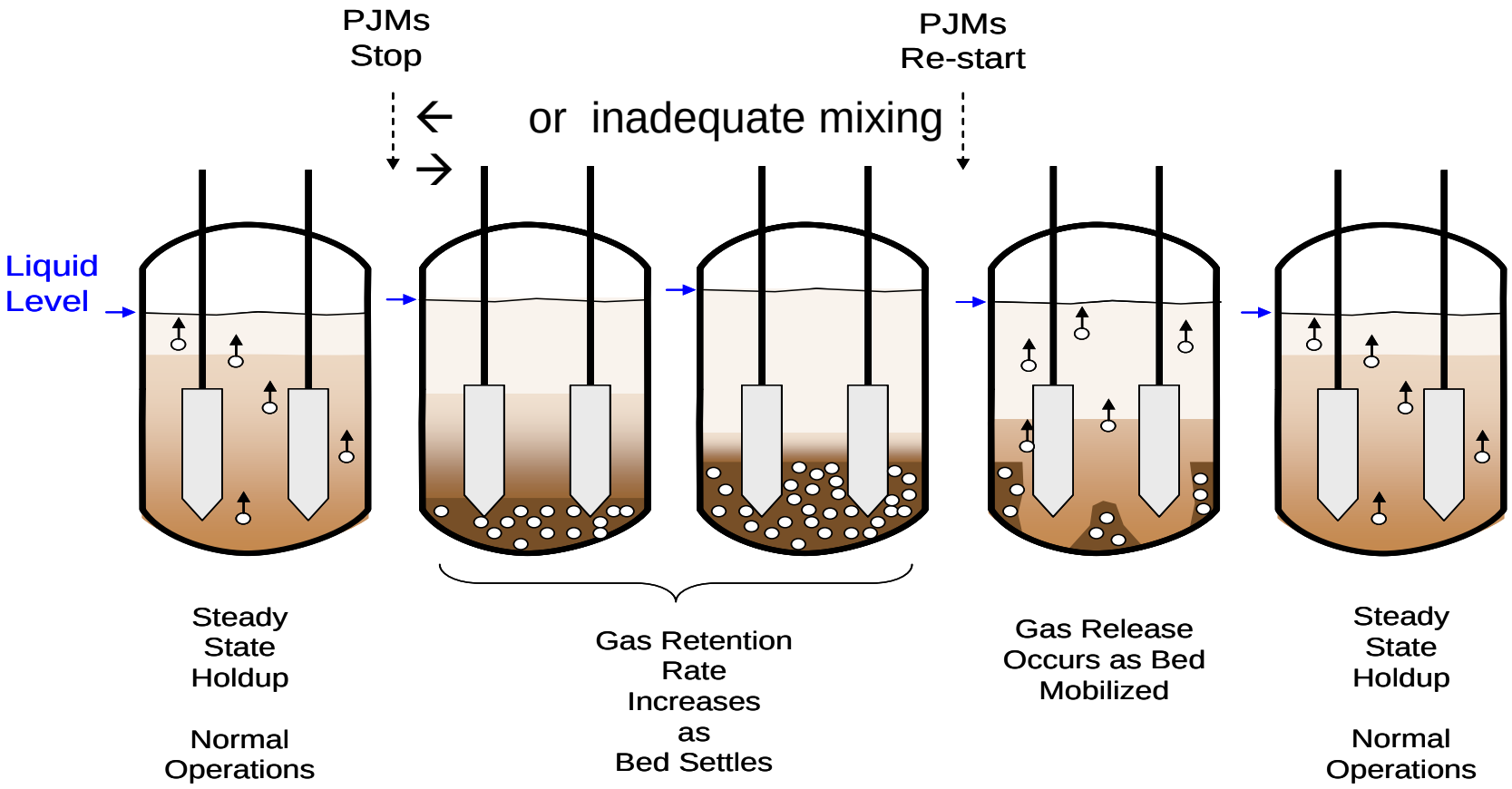


DRIVE PHASE

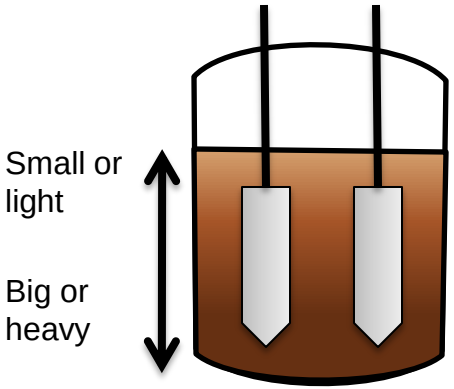
Typical arrangement of multiple pulse jet mixers in a WTP pretreatment vessel

- Charge vessel with a nozzle near the bottom of a vessel
  - Suction phase - vacuum is applied to fill the charge vessel
  - Drive phase – applied compressed air causes a jet at the tank bottom to mobilize solids
- When the charge tube is close to empty the cycle is repeated

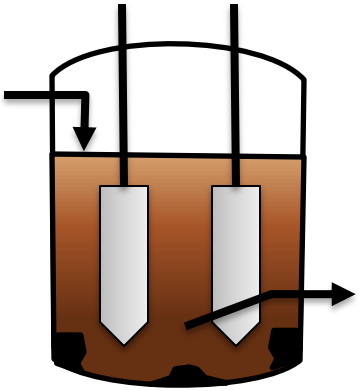
Safety Concerns Associated with Inadequate Mixing - Flammable Gas



Safety Concerns - Inadequate Mixing Solids Accumulation (Criticality)

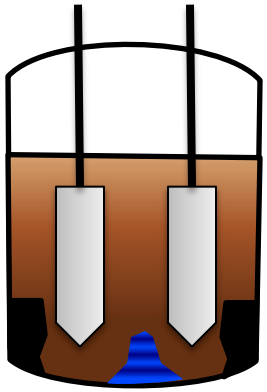


During operation, pulse jet mixers segregate particles by size and density.



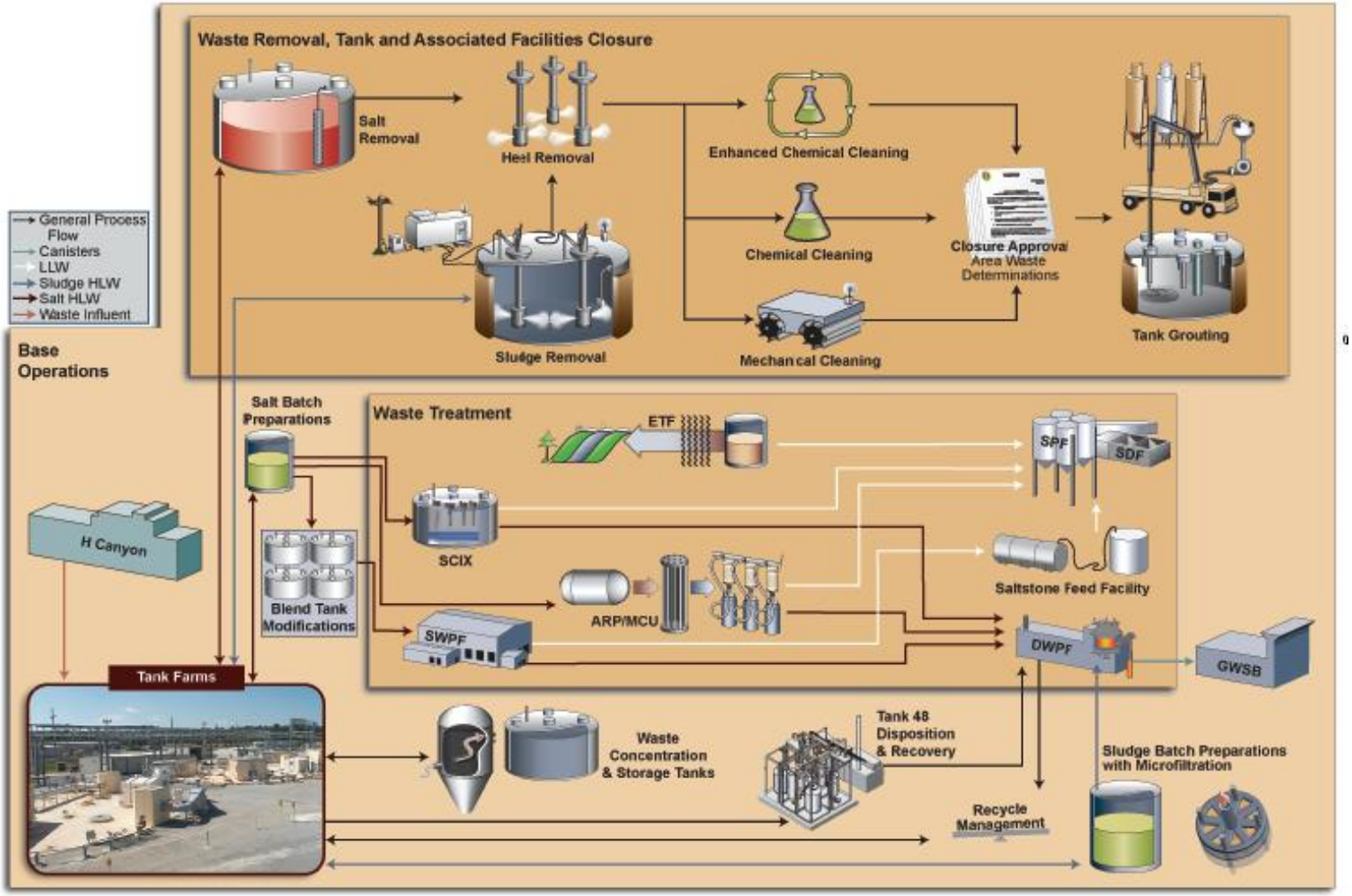
Big and heavy particles that are not suspended accumulate as each batch of waste is processed.

Uranium and plutonium are examples of heavy particles in the waste.



If the accumulated solids consist of enough plutonium in the correct geometry a criticality hazard is posed, these solids can also retain flammable gas.

High-Level Waste Processing (SRS)



Salt Waste Processing Facility (SRS)

- Air pulse agitators mixing in process vessels.
  - Safety Board reviewed the design, testing, and controls
  - The Board is now reviewing the selected safety controls and operating parameters.