



---

# Under Pressure:

## Sonat\* Separation Vessel Pressure Rupture

**Leadership ViTS Meeting**  
December 2008

**Bryan O'Connor**  
*Chief, Safety and Mission Assurance*

**Jim Lloyd**  
*Deputy Chief, Safety and Mission Assurance*

**This and previous presentations are archived at:**  
[http://pbma.nasa.gov/pbma\\_main\\_cid\\_584](http://pbma.nasa.gov/pbma_main_cid_584)

*\* Houston-based Sonat Exploration Company, a wholly owned subsidiary of energy company Sonat Inc., involved in energy exploration and production.*

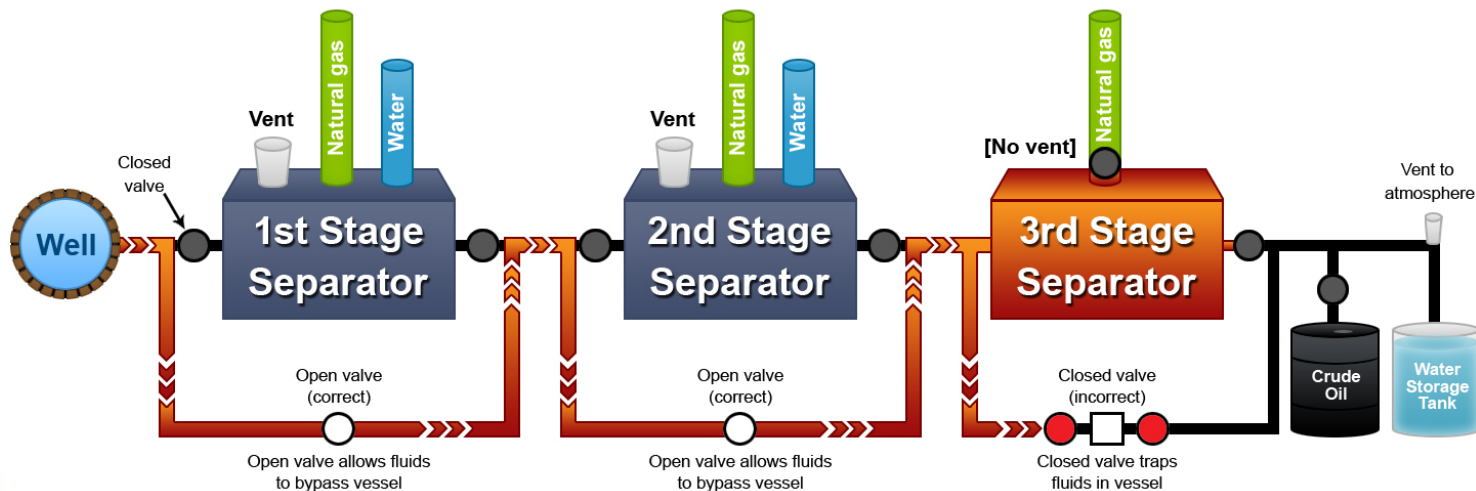


National Aeronautics  
and Space Administration



# The Mishap: Purging the Pipeline

- On March 4, 1998, Sonat Exploration Company was preparing to begin production from a new oil well.
- High pressure fluid from the well traveled a two-mile, 8 inch pipeline to a new “separator train,” which would separate the crude oil from water and natural gas.
- In order to purge the air in the line before starting operations, three separator vessels or tanks were to be isolated by aligning valves to direct water and gas through bypass lines around the tanks.
- Tanks 1 & 2 (both pressure vessels) could be isolated from the line pressure by valves; they also had pressure relief valves.
- Tank 3, designed and constructed for atmospheric pressure, could not be isolated from flow and had no pressure relief system.
- Tank 3 had two manual valves and one pneumatic valve in its bypass line in addition to downstream valves.
- These Tank 3 valves were opened during an earlier operation, but at an unknown time they were incorrectly moved to the closed position. Tank 3 now had no means for relieving any pressure increase internal to the vessel.



***Without an outlet to vent the gas, the third stage separator vessel ruptured at approximately 6:15pm, releasing a fireball that killed four workers and ignited surrounding materials. The facility sustained over \$200K damage.***



# Critical Design Process Deficiencies



- The third separation vessel was designed to operate at atmospheric pressure, had no provision for relief of excess pressure, and could not be isolated from an adjacent bypass line.
- The first and second separation vessels operated above atmospheric pressure but well below maximum operating pressure. They were also equipped with pressure relief valves.
- There was no piping and instrumentation diagram (P&ID) for the system.
- There were no written operating instructions or checklists.

Two valves in the bypass of the third separator vessel and the valve on the outlet side of the vessel were closed, preventing flow out of the vessel and allowing pressure to build (in this instance, possibly as high as 800 PSI).



# Proximate Cause

---

- Two closed valves prevented purged gases from escaping the separation train. Pressure increased to well above the design limits, finally causing the tank to rupture.

# Root Cause/Underlying Issues

---

- **No formal design review or hazard analysis**
  - The design and construction of the facility, pipeline, tanks, and valves did not undergo formal design reviews.
  - Sonat constructed the facility without producing engineering drawings of the process equipment.
  - The ruptured tank did not meet ANSI and API specifications for separator vessels because Sonat classified it as a “storage tank.” The investigation report later stated that this classification was incorrect.
  - The investigating board found that a formal design review and hazard analysis would likely have identified the facility’s shortcomings and prevented the mishap.
- **No written operating procedures for start-up and operation of the facility**
  - Sonat made the active decision to use oral instructions to train and direct facility operations, increasing the risk of catastrophic consequences.
  - Personnel had to manually manage 12 valves during the non-routine purging and start-up procedure.
- **Inadequate employee training**
  - Sonat employees received predominantly on-the-job training.
  - Monthly internal safety meetings and external coursework focused on broad subjects such as Hazardous Waste Relations or Emergency Response and did not provide formal site-specific or process-specific training.
  - Contracted workers received even less training than Sonat employees.



# NASA Applicability

---

- Design Review must be pursued aggressively and include adequate hazard analysis to ensure mission safety and mitigation of all potential risks.
- While experience and mentoring are important to successful operations, they cannot be depended on to take the place of documented, systematic process controls. Written procedures should address emergency or 'off-nominal' as well as normal operations.
- Hazard analysis should be considered key feedback into design excellence.
- Specifications are based on lessons learned and knowledge management strategies; designs and hazard analysis must use specifications as a guide for design efforts and as a basis for measurement of design compliance.

*“Provide consistent information to all users...remove guesswork...provide the tools for an effective program.” - AIChE Center for Chemical Process Safety*