Steam Locomotive Firebox Explosion on the Gettysburg Railroad near Gardners, Pennsylvania

Leadership ViTS Meeting
6 September 2005

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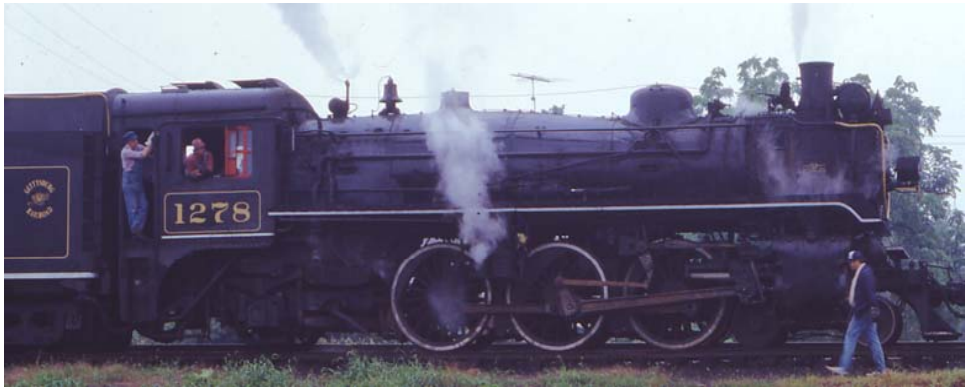
Office of Safety and Mission Assurance

Accident Timeline

Place: Gettysburg Railroad
near Gardners, PA

Accident Date: June 16, 1995



Gettysburg 1278 @ Gettysburg Oct 1988

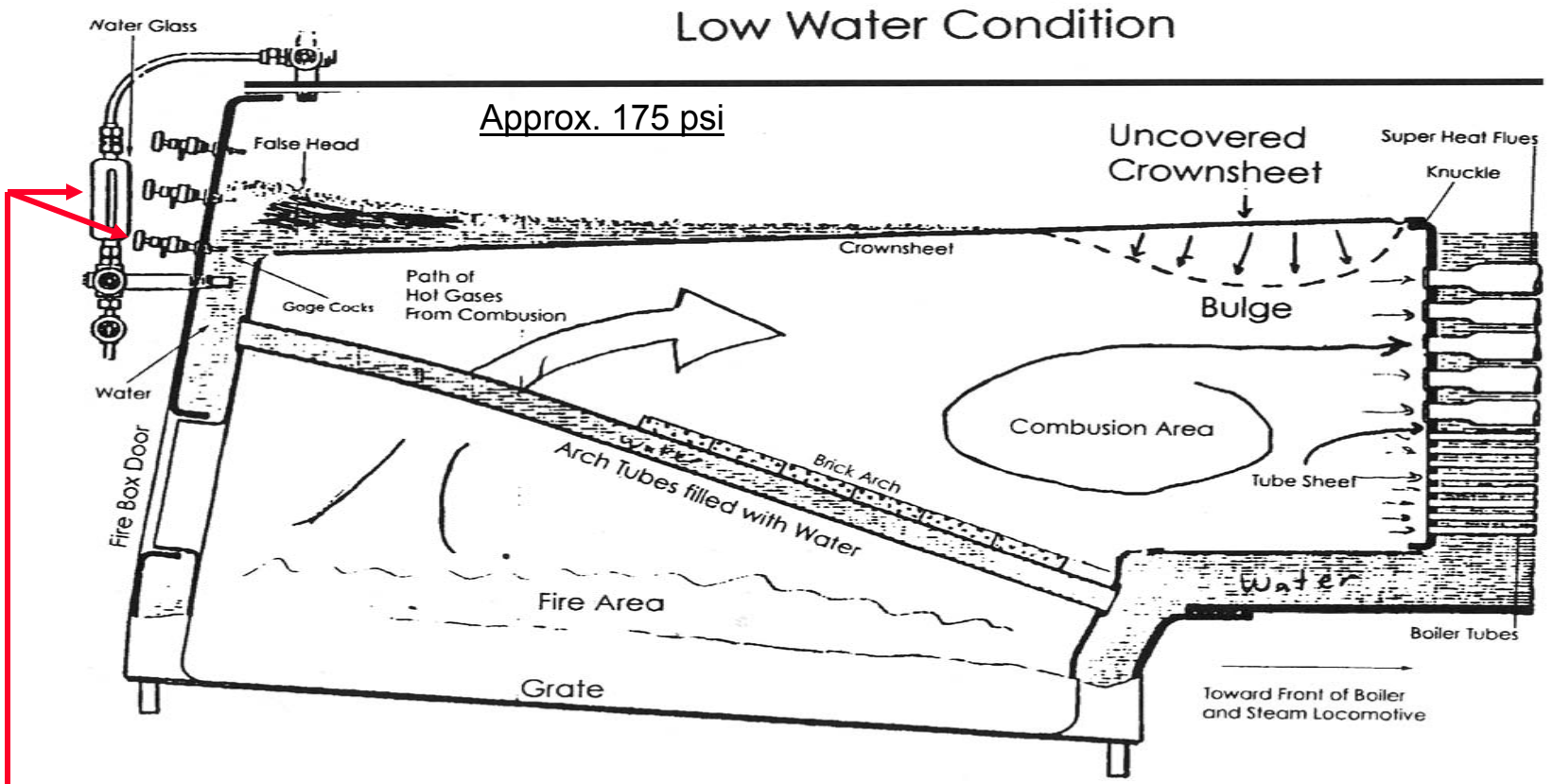
The Accident:

- **Steam locomotive 1278 with six passenger cars had completed two excursions and was preparing for a third and final excursion for the day.**
- **During slow climb up moderate grade, the boiler exploded, seriously burning the engineer and two firemen.**

Events Associated with Proximate Cause

- Operators began climb with too little water in boiler
- Water-level continued to drop and by the time the locomotive had crested the grade the crownsheet of boiler was not covered by water and failed due to thermal overstress.
- Failure of crownsheet opened boiler to the firebox (atmosphere) and the water in boiler flashed into high pressure steam.
- Steam exploded through firebox door into the locomotive cab, seriously burning the engineer (third degree burns over 65% of body) and two firemen.

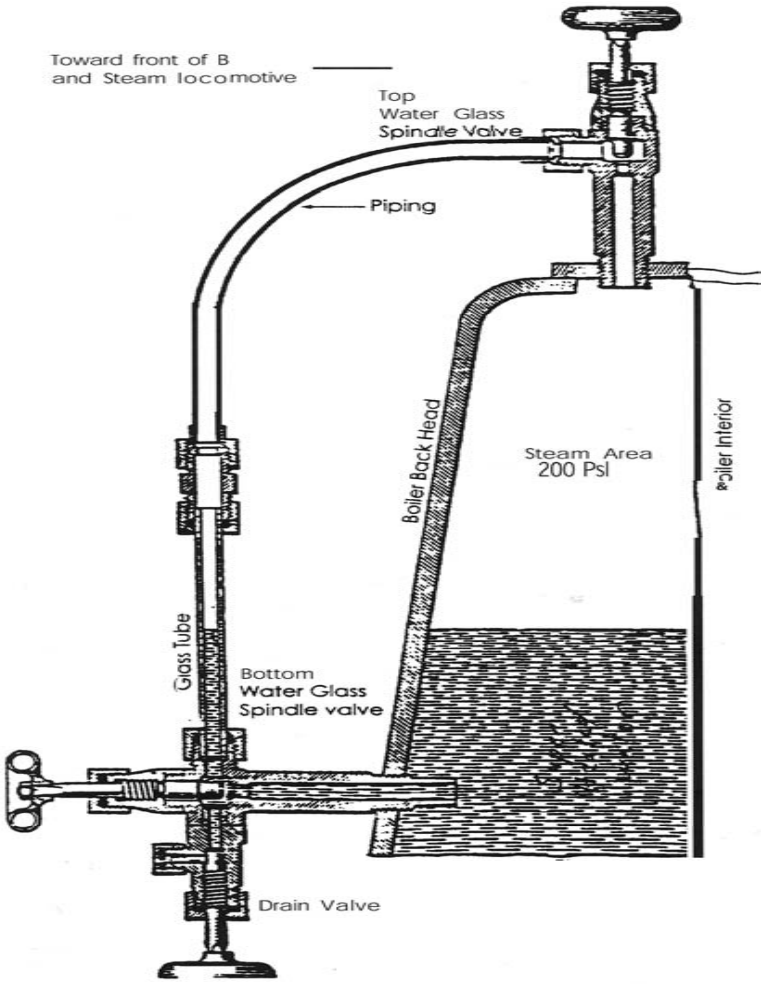
Events Associated with Proximate Cause



This figure is exaggerated to show low water conditions, in locomotive 1278 the lowest gage cock was 3.25 inches above the highest point of the crownsheet and the water glass was 3.125 inches above the highest point of the crownsheet

Contributing Factors

- Prior to operation the feed pump gauge had been removed.
- Preparing to ascend grade first fireman shut off the feed pump to the boiler because a leaking check valve between the feed-pump and the boiler could potentially cause slippage on driving wheels.
- On climbing grade at approximately 15 mph the boiler pressure dropped from 230 psi to 175 psi. Firemen did not add water but did monitor water glass to make sure water level didn't become dangerously low.
- Water-level in water-glass is expected to fluctuate in response to grade, vibrations, and starting and stopping the train.
- Firemen observed fluctuations of approximately ½ inch when 4 inches is the norm (indicative of clogged gauge line).



Water Glass Arrangement

Root Causes and Lessons Learned for NASA

- Maintenance: The boiler water-level indicators and boiler had not been cleaned as indicated and when they had been cleaned they hadn't been cleaned properly. Both the water-glass and the lower two gage cocks were restricted and could not represent the water level in the boiler. In addition the water glass was not properly illuminated.

  Lesson: Are your maintenance practices documented? Are they followed? Are they adequate? Are you keeping up with required maintenance and avoiding deferred maintenance?

- Operational checks: The water-glass and the gage cocks were not properly blown-out or tested before the trip.

  Lesson: Are your operational procedures current, complete and accurate? Are your operational checks rigorously followed?

- Minimum Equipment: Because the feed-pump gage was missing, the engine crew had no reliable way to determine whether feed-pump pressure was overcoming boiler pressure and delivering water to the boiler.

  Lesson: Is operator adhering to minimum equipment requirements? (are hazard controls in place?)

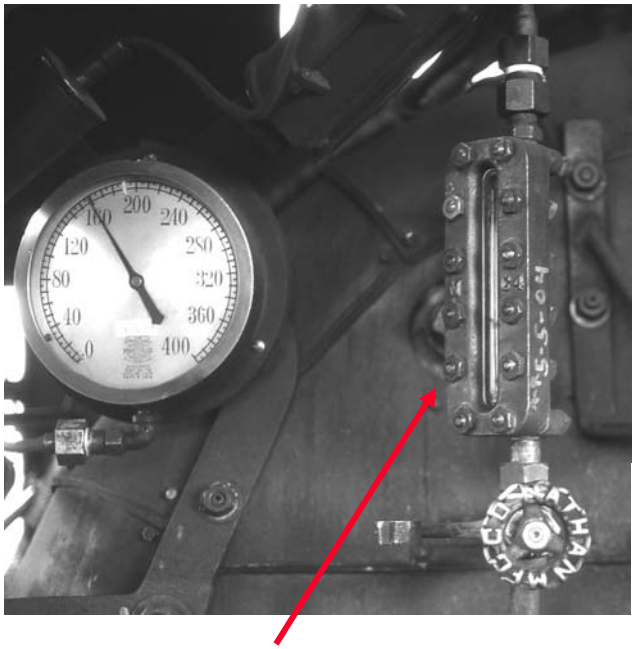
- Operator Training: Engineer and firemen were not formally trained in steam-locomotive operation but were only trained via informal On-the-Job Training.

  Lesson: Particularly as we operate older equipment, are operators adequately trained to operate and maintain equipment? Recognize and deal with hazards? Recognize off-nominal conditions? Is On-the-Job training systematic to assure full coverage? Are the results of that training documented and is proficiency demonstrated to a known standard?

Backup - Accident Preconditions

- Boiler water-level indicators (water-glass and gage cocks) must be blown out and tested before each trip. (49 CFR 230.40)
- Boiler water-level indicators must be removed and thoroughly cleaned of scale and sediment at least once a month.
- Boiler must be washed at least once a month to minimize scale build-up.
- Records indicate that boiler wash and boiler water-level indicators had been cleaned. (NTSB Investigation later revealed that cleaning had not occurred as recorded and that testing and blow-out of water-level indicators had not been performed properly).
- Feed-pump gage that indicates if pump is effectively pumping water into the boiler was removed.
- The check-valve between the feed-water pump and the boiler had been leaking on earlier trips.
- Water-glass light inoperative.

- For more information see the National Transportation Safety Board Special Investigation Report at http://www.ntsb.gov/Publictn/R_Stu.htm



Typical Water Glass