BARNHART

Minds Over Matter

Lessons Learned from Puget Sound –
How a hydrotreater made Barnhart a better company

NWCCC

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Outline

1. Scope of work
2. The Plan
3. The Incident
   i. Failure Mechanism and Mode of Failure
   ii. Root Cause and Contributing Factors
4. Lessons Learned
5. Recurrence Controls: 6 years later

Scope of Work

Develop engineered plans, and provide equipment and crew to:

1. Receive 970,000 pound hydrotreater from ships gear at the Port of Seattle.
2. Barge from Seattle to Cherry Point.
3. Roll-off from barge and haul to BP site.
4. Lift and set onto anchor bolts after vessel was dressed out.

Details of the Plan that Increased Risk

- Permit from the Department of Fish and Wildlife required that barge roll-off be completed during a high tide greater than 9.1 feet to avoid prop scouring of bed. For December 9, 2011 this required a roll-off at 06:02 with a tide of 9.48 feet.
  - Required working in early morning dark environment.
  - Tidal requirements could increase risk of rushing

- Hauling route to plant had a limitation of 20' road width.
  - Required use of 1.5 File (16'-1" wide trailer). Lower stability than 2 File (20'-10" wide trailer)

Changes to the Plan…

- **Equipment Change**
  - Logistic decision to change 66’ barge ramps for 38’.
  - Consequence:
    i. required barge to get closer to ramp by 28’
    ii. required trailer to be moved 10’ aft and fully ballast the aft rake tank
    iii. There was a 14-day delay in communication between Barnhart engineering and the 3rd party navel architect stating this change. Final ballast plan was not provided until early on 9-Dec-2011.

Changes to the Plan…

- **Operations in Open Water**
  - Decision was made to move the trailer 10’ aft while in tow. [Jr. Engineer was asked, but did not seek approval from Sr. Engineer who sealed drawing]
  - Ballasting operations were also being performed in rear ballast tank
  - Tug was in a left hand turn during incident, increasing inertia loads to starboard.
  - Consequences:
    i. Barnhart Project Team did not follow common practice to ground or moor barge if at all possible before releasing load.
    ii. After the load was unchained from the barge, the barge’s angle of list was now a major factor in diminishing trailer stability.
    iii. Rear and forward ballast tanks had free surface ability of water to pass from port to starboard or vice-versa.
    iv. Small wave action like movement of the barge was reported by operator at the time of incident.
    v. Free surface effect, turn, wave action and trailer side to side operations greatly reduced margin of safety in trailer operations as the deck of barge leaned to starboard.

Failure Mechanism

1. Operator induced movements of the load while removing cribbing between saddles and bolsters. This created the initial movement of the load that led to the leaning of barge. [By removing chains, the load and trailer were decoupled from the barge]
2. Barge movements were exacerbated by free surface water in ballast tanks – water both already in the bow and water being added to the stern.
3. The left hand turn of the barge contributed to the starboard lean of the barge.
4. Vessel CG moved beyond hydraulic stability of trailer.
5. Trailer deck tipped due to instability thereby allowing further roll of load/barge.
6. Load eventually exceeded the bolster's and tie down chain's structural capacities.
7. The barge deck list angle reduced the trailer's stability window such that the load became unstable on the trailer. When the load's CG passed beyond the trailer's stability limit, the trailer deck rolled in the direction of the load which further rolled the barge. The bolster and tie down chains broke when the angle of the load reached the bolster/chain structural limit allowing the load to roll into the water

Mode of Failure

Vessel and barge tipped until the combined list angle of the barge and trailer caused the load's center-of-gravity to move outside the hydraulic stability of the trailer until the chains and rear bolster failed allowing the vessel to slide off the Goldhofer.

Causal Analysis

1. Engineering did not inform the operator of the restrictive nature of the cross fall limit.
2. Changing the barge roll-off ramps from 66’ to 38’ set into motion the need to move the trailer back 10’ to raise the bow to get sufficiently close to the shore.
3. Project Engineer did not notify the Senior Engineer of the change to the ballast plan.
4. The Project Team did not assess the increased risk of moving the trailer to the rear of the barge while the barge was underway.
5. No combined analysis of trailer and barge stability was conducted after the ballast plan was changed.
6. Performing simultaneous functions, i.e, barge movement with tug, ballasting tanks, removing load securements, without studying the impact of these activities being performed in parallel.

Root Cause

Failure to properly assess and mitigate the combined risks of the job. This was demonstrated in insufficient management of changes that occurred the day of and the days leading to the incident.

Contributing Factors

1. Barnhart Project Team did not follow common practice to ground or moor barge if at all possible before releasing load, nor did they evaluate the increased risk involved in moving the trailer while underway.

2. Ballasting operations were simultaneously being performed in rear ballast tank.

3. Rear and forward ballast tanks had free surface ability of water to build up and then suddenly pass from port to starboard or vice-versa through openings in bulkheads that were not able to be properly identified or considered during the planning stages of the job.

4. During the removal of the cribbing from under the vessel's saddles, the operator had to move the load side-to-side using the hydraulics of the platform trailer. Vessel's load shifting side-to-side on trailers had a negative cumulative effect on the barge's list or side-to-side tilt.

5. Small cross fall angle of the trailers in the bolstered configuration (i.e. the narrow hydraulic stability width) was not effectively communicated to operator. [Operator had no way of monitoring cross fall at night]

Lessons Not Needed to be Learned

1. Barnhart took immediate and full responsibility for the incident.
2. All needed resources were immediately dispatched.
3. Open and continuous communication with BP throughout investigation and recovery.
4. Full release of our findings.
5. Use the incident to Continuously Improve [4th Core Value]

Lessons Learned

1. Do not rely on 3rd parties for operational schedule.
2. Effective MOC is crucial to operational success. Requires training and continual use of the process.
3. Assessing and mitigating the risks on a job (managing the risks) must be done at all stages of work: Sales, engineering, PM, and operations.
4. The value of a readiness review to ensure high risk aspects of a job are assessed by multiple people (superintendent, PM, engineering, operators).
5. Having effective (experienced and trained) Risk Manager on high risks jobs is crucial.

Recurrence Controls

1. Modified Platform Trailer and Roll-on/Roll-off SOPs to include revised cross fall limits for transporters on floating barges and sections were added to more effectively address bolster operations. Use in Goldhofer Operator training.

2. Conducted a review of Barnhart Process Manual and related procedures to identify sufficiency of change management controls. MOC has now become part of our operational vernacular.

3. Risk Management qualification and Project Management training regarding assessment of risk and management of change has been instituted.

Recurrence Controls

4. Established a review process by senior management
   i. Initial and Final Project Plans reviews [Daily call as needed]
   ii. Risk factor analysis done by sales person and PM.
   iii. Weekly, company wide resource allocation meeting.
   iv. Readiness Review calls on all higher risk jobs.

5. Developed inhouse skill and tools for barge stability calculations and ballasting procedures.