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Messages for Manufacturing Personnel

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Incident Investigation of a Steam Pipe Failure

June 2017

In November 1998 a 12 in. (30.5 cm), 600 psig (~ 41 bar[g]) steam pipe in a large chemical plant failed catastrophically. A 36 in. (~ 1 m) long section of pipe just upstream of a decommissioned venturi flow meter suddenly ruptured causing major damage in the area (Fig. 1). Steam supply throughout the plant was lost, the steam generation equipment shut down, and there was no production in most of the plant for more than 5 days. Fortunately there were no injuries or fatalities.

Figure 1: Damage

An investigation team was immediately formed to understand the cause of the failure of the 30 year old pipe (Fig. 2). There was concern about other steam piping which might be in danger of a similar failure. The team consisted of utility operating and management personnel, materials and mechanical engineers (piping, reliability, and failure analysis experts), and chemical engineers. The initial suspected cause was erosion of the pipe wall immediately upstream of the venturi caused by poor quality (wet) steam, resulting in thinning of the pipe wall. Observed lines on the pipe (Fig. 3) were believed to be created by erosion.

Figure 2: Failed pipe

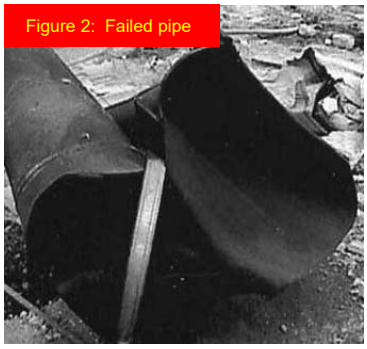
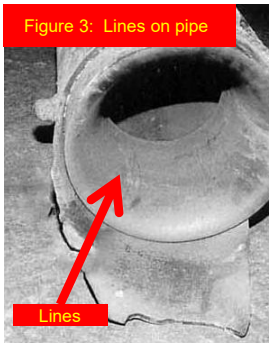


Figure 3: Lines on pipe



In the course of the investigation it was determined that the pipe which failed had been designed to have a slight taper (about 10º) to smooth flow to the venturi. This taper was produced by boring a thicker piece of pipe to the designed profile. The investigation team asked an experienced machinist to inspect the failed pipe. The machinist immediately recognized that the lines were not signs of erosion, but actually tool marks from a boring tool. When the pipe was bored, the tool had not been inserted properly, but off-center. This resulted in the pipe being only about 25% of the intended thickness at the top, and consequently weakened.

Did you know?

There is a reason for including a team of people with different expertise in an incident investigation, or any other process safety management activity (process hazard analysis, management of change, pre-startup safety review, etc.). Everybody involved has a unique expertise to bring to the discussion, based on their education, training, and most importantly, their work experience. In this incident, the engineers and other experts did not recognize the machine tool marks on the failed pipe, and yet it was immediately obvious to the expert, experienced machinist. His knowledge completely changed the conclusions of the investigation, and was essential for understanding the cause of the incident.

Reference: Lodal, P. N., *Process Safety Progress* **19** (3), pp. 154-159 (2000).

What can you do?

- If you are asked to participate in an incident investigation, be a full participant and share your knowledge and expertise with the rest of the team. Your experience in operating or maintaining the plant is important for understanding the incident. Share that knowledge and ask questions. If something in the discussion doesn't sound consistent with your experience, make sure that it is resolved to your satisfaction.
- You may be involved in other process safety management activities as an operations or maintenance representative – for example, management of change, process hazard analysis, writing procedures, developing training material, pre-startup safety reviews, and others. Be an active participant in these activities, and share your knowledge with other participants.

Everybody has something to contribute when investigating an incident!

The Beacon is usually available in Afrikaans, Arabic, Catalan, Chinese, Czech, Danish, Dutch, English, Filipino, French, German, Greek, Gujarati, Hebrew, Hindi, Hungarian, Indonesian, Italian, Japanese, Korean, Malay, Marathi, Mongolian, Persian (Farsi), Polish, Portuguese, Romanian, Russian, Spanish, Swedish, Telugu, Thai, Turkish, and Vietnamese.

Questions:

1. ***(20-30 min)** In 4-6 sentences, discuss the steps this facility should take to prevent this type of incident from recurring. (*Hint:* Consider what should have been done before the pipe was initially installed. This article may be helpful.)

2. **(5 min)** *What did you learn?*
   Besides involving machinists and others in the safety analysis process, what other lessons did you learn from this article that can be used to educate others in the workplace about piping properties and machining procedures?