

U.S. CHEMICAL SAFETY AND HAZARD INVESTIGATION BOARD

Recommendation

Key Findings

1. On March 23, 2005, the BP Texas City refinery experienced severe explosions and fires that resulted in 15 deaths, 180 injuries, and significant economic losses; the accident was one of the most serious U.S. workplace disasters of the past two decades.
2. During the isomerization (ISOM) unit startup, a distillation tower was overfilled with liquid, triggering the opening of three emergency relief valves that protect the tower from high pressure; the liquid discharged into a disposal blowdown drum with a stack open to the atmosphere. The drum rapidly overfilled with flammable liquid leading to a geyser-like release out of the stack and subsequent explosion and fire.
3. The ISOM blowdown drum was connected to 58 emergency relief valves. BP had not completed a relief valve and disposal collection piping study for the ISOM which was necessary to determine if the drum was adequately sized. At the time of the incident, many BP Texas City refinery process units did not have up-to-date relief studies. In addition, information on the original design basis and capacity of the ISOM blowdown drum was missing. CSB determined that liquid was released out the top of the ISOM blowdown stack during the incident because the drum was undersized.
4. From 1994 to 2004, there were eight serious ISOM blowdown incidents; in two of these incidents the blowdown stack caught fire. The other six incidents were serious near misses where flammable hydrocarbon vapors that were released from the blowdown system could have had catastrophic consequences if the resulting ground level vapor clouds had found sources of ignition.
5. The BP Texas City refinery safety standards, in effect since 1977, stated that new blowdown stacks were not permitted and blowdown drums should be connected to a closed system or a flare when the existing facility was outgrown or major modifications were made to the unit. Since 1986 the blowdown drum was replaced and major capacity changes were made but the blowdown drum was not connected to a safe disposal system such as a flare. In 2002, BP engineers proposed connecting the discharge from the ISOM relief valves to a flare as part of an environmental project, but this work was not performed. A properly designed flare system would safely contain discharged liquid in a disposal drum and burn flammable vapor preventing a hazardous release to atmosphere. Flares are the most frequently used disposal control equipment in the oil refining industry.

6. As a result of mergers and acquisitions with Amoco and Arco, BP owns five North American refineries. Prior to the incident, the five refineries operated 22 blowdown systems with stacks open to atmosphere; 17 handled flammables. Since the March 23, 2005 accident, BP has stated it will eliminate all atmospheric blowdown systems in flammable service at all five of its U.S. refineries including Texas City.
7. OSHA's Process Safety Management (PSM) standard establishes requirements for the prevention of catastrophic releases of highly hazardous chemicals such as flammables. The standard requires employers of covered processes to compile written process safety information including information pertaining to relief system design and design basis that complies with "recognized and generally accepted good engineering practices." OSHA publishes PSM Compliance Guidelines that establish procedures for the enforcement of the standard. These guidelines call for inspections to ensure that "destruct systems such as flares are in place and operating" and "pressure relief valves and rupture disks are properly designed and discharge to a safe area."
8. In 1992, the Occupational Safety and Health Administration (OSHA) cited and proposed fines to Amoco on the hazardous design of a similar blowdown drum and stack at the Texas City refinery. OSHA determined that the drum and stack were not constructed in accordance with the American Society of Mechanical Engineers' (ASME) *Boiler and Pressure Vessel Code*. The code requires relief valve piping to discharge to a safe location. As an abatement method OSHA suggested connecting the blowdown drum to a closed system such as a flare. Amoco asserted that the blowdown system was constructed in accordance with industry standards citing the American Petroleum Institute's (API) Recommended Practice 521 *Guide for Pressure-Relieving and Depressuring Systems*. As part of a settlement agreement, OSHA withdrew the citation and the fine. The refinery continued to use blowdown drums without flares at the Texas City site. As a result of the March 23, 2005 incident, OSHA cited BP's ISOM blowdown system for a willful violation of the same regulation. In the settlement agreement, BP agreed to permanently remove the ISOM blowdown system from service.
9. API 521 is the generally accepted practice for the design and operation of pressure relieving and disposal systems. CSB found that for flammables API 521:
 - a. Does not consider liquid overflow of a vessel as a potential hazard which can result in large liquid releases to pressure relief and disposal systems;
 - b. Lacks adequate drum sizing guidance for large releases of liquid to disposal systems;
 - c. Does not address the hazard posed by relief flows less than design causing flammable concentrations of vapor at ground level due to low stack exit velocity and ineffective dispersion;

- d. Does not recommend the use of inherently safer options such as a flare system in lieu of a blowdown drum and stack vented to the atmosphere.

Therefore, the Board makes the following safety recommendations:

American Petroleum Institute

Revise API Recommended Practice 521, *Guide for Pressure Relieving and Depressuring Systems* to ensure that the guidance:

- Identifies overfilling vessels as a potential hazard for evaluation in selecting and designing pressure relief and disposal systems;
- Addresses the need to adequately size disposal drums for credible worst-case liquid relief scenarios, based on accurate relief valve and disposal collection piping studies;
- Warns against the use of atmospheric blowdown drums and stacks attached to collection piping systems that receive flammable discharges from multiple relief valves and urges the use of appropriate inherently safer alternatives such as a flare system.

Occupational Safety and Health Administration (OSHA)

1. Implement a national emphasis program for all oil refineries that focuses on:
 - The hazards of blowdown drums and stacks that release flammables to the atmosphere instead of to an inherently safer disposal system such as a flare. Particular attention should be paid to blowdown drums attached to collection piping systems servicing multiple relief valves;
 - The need for adequately sized disposal knockout drums to safely contain discharged flammable liquid based on accurate relief valve and disposal collection piping studies.
2. Urge States that administer their own OSHA plan to implement comparable emphasis programs within their respective jurisdictions.