Lessons Learned Database
Individual Incident Summary Report

IChemE
Safety & Loss Prevention
Special Interest Group

Incident Title	**Spray Drier Feed Tank Catastrophic Failure**		
Incident Type	Explosion		
Date	11th April 2003		
Country	USA		
Location	Louisville, KY		
Fatalities	**Injuries**	**Cost**	
1	0	Unknown	

Incident Description

Credit: US Chemical Safety Board

A spray drier feed mixing tank exploded on a plant manufacturing food-grade caramel colouring. The top head of the tank separated at the weld seam and was propelled approximately 91 m (100 yds) before landing on a railway line used by third parties for freight transportation. The explosion toppled the spray drier structure and pushed an aqueous ammonia (NH_3) storage tank off its foundation causing escalation of the incident due to release of 11.8 tonnes (26,000 lb) of the 29.4 vol% strength NH_3 solution. The resulting toxic NH_3 vapour cloud necessitated evacuation of 26 neighbouring residents and execution of a shelter-in-place order for a further 1500 residents.

The ruptured feed tank was the larger of two in the same service. Both tanks were fabricated from 316 stainless steel and contained an agitator and a dual-purpose internal stainless steel coil for heating with steam or cooling with water. Neither was rated for vacuum. Both could be pressurised with compressed air (when their respective vent valves were closed) to assist transfer of the highly viscous product to the spray drier feed pump. The air supply header operated at 8.6 barg (125 psig) and the tank pressures in each were modulated to approximately 1.5 barg (22 psig) by self-contained pressure regulators. The tanks were manually operated on an alternating basis to maintain a continuous feed flow to the drier (one tank in service while the second was prepared, then switched over when the first tank ran empty).

Incident Analysis

Basic cause was overpressure and rupture of the feed tank due to extended heating of the tank contents with the vent line plugged.

Critical factors included: 1) The feed tanks had not been designed to the relevant code (ASME VIII), 2) Both tanks had been relocated from plants in other States and installed without the pressure relief device provided in their previous service, 3) The ruptured tank had been weakened by misapplication of vacuum in service twice at another location, 4) The Louisville plant relied on operator vigilance for safe operation (the tanks had local temperature and pressure indication but no automatic process controls), 5) Operators were distracted by other duties (re-labelling mislabelled product boxes), 6) The vent pipe on the ruptured tank was subsequently found to be plugged.

Root causes included: 1) Inadequate design (not compliant with ASME VIII), 2) Inadequate communication (failure to register tanks with State authority), 3) Absence of fitness for service inspection, 4) Inadequate process hazard analysis, 5) Failure to learn (misapplication of vacuum), 6) Inadequate instrumentation (no alarms), 7) Inadequate operator training (response to abnormal operating conditions), 8) Inadequate operating procedures (failure to highlight importance of keeping vent valve open while heating and inherent risk of overpressure), 9) Inadequate maintenance (vent pipe plugged).

Lessons Learned

1) All pressure systems should be subjected to a process hazard analysis (PHA) to ensure appropriate control systems, alarms, trips and pressure relief systems are provided to prevent catastrophic failure due to overpressure.
2) Re-purposed equipment should always undergo a full fitness for service (FFS) inspection and pre-startup safety review (PSSR).
3) Relocated pressure vessels may need re-registration with a new authority.

More Information

1) "Catastrophic Vessel Failure", US Chemical Safety and Hazard Investigation Board, Report No. 2003-11-I-KY (2004).

Industry Sector	Process Type	Incident Type
Food & Drink	Food Processing	Explosion
Equipment Category	**Equipment Class**	**Equipment Type**
Mechanical	Vessel	Pressurised Mixing Tank

Peter Marsh
Director – XBP Refining Consultants Ltd.