


Incident Title		Acid Storage Tank Explosion During Maintenance	
Incident Type		Explosion and Fire	
Date		17 th July 2001	
Country		USA	
Location		Delaware City, DE	
Fatalities		Injuries	Cost
1		8	Unknown
Incident Description  <small>Credit: US Chemical Safety Board</small>		<p>A contract maintenance crew had been working for several days to repair a corroded catwalk above six 1571 m³ (415,000 gallon) carbon steel tanks (Tk 391-396) in a common bunded area of the sulphuric acid (H₂SO₄) storage tank farm. Tk 391-393 and Tk 396 had been converted from low-volatility fresh H₂SO₄ to spent H₂SO₄ acid service by adding a carbon dioxide (CO₂) inerting system, a conservation vent and a flame arrestor. [Spent H₂SO₄ acid contains up to 5 vol% water (hence more corrosive) and flammable light hydrocarbons.]</p> <p>On the morning of the incident, a gas test was carried out and a hot work permit (HWP) was issued allowing boilermakers to burn, weld and grind the catwalk grating at Tk 393, and instructing them to stop work immediately if hydrocarbons were detected. Other precautions included specification of appropriate personnel protective equipment (PPE) and provision of a fire watch and warning signs. Provision for spark containment was not specified.</p> <p>The boilermakers, without consulting the permit signatory, switched from using oxy-acetylene torches to air carbon arc gouging (more effective but ejects large amounts of molten metal over a wide area). As soon as cutting of the grating at Tk 393 began, a deflagration occurred inside the tank. The shell separated from its floor, instantly releasing its contents and causing the catwalk to collapse. Other tanks in the tank farm also released their contents. As spilled acid inundated the bunded area, flammable material burned on top of it for 30 mins. The combined volume of acid spilled and firewater used to fight the fire overwhelmed the bund's spill diversion and treatment systems and reached the Delaware River, causing significant damage to aquatic life.</p>	
Incident Analysis		<p>Basic cause of the explosion in Tk 393 was ignition of flammable vapours by sparks from a carbon arc gouging tool used for repairing the catwalk.</p> <p>Critical factors included: 1) Tk 393 had corrosion holes in its roof and shell, 2) Tk 393 inerting system inadequate (undersized hose, shared with Tk 396), 3) Spark containment not specified for hot work above/around tank containing flammables, 4) Tk 393 did not have a frangible roof (designed for fresh H₂SO₄).</p> <p>Root causes included: 1) Inadequate design (tank inerting and bund spill diversion systems), 2) Inadequate management of change (MoC) review (tank conversion from fresh to spent acid service), 3) Inadequate mechanical integrity programme (tank defects not repaired promptly, internal inspections deferred), 4) Inadequate control of work (absence of contractor supervision, spark containment and continuous flammables monitoring), 5) Inadequate communication (contractors not aware of flammables and holes in tanks), 6) Inadequate process safety management (failure to enforce MoC review requirement, failure to act on Tk 393 unsafe condition report 3 weeks prior).</p>	
Lessons Learned		<p>1) MoC reviews should be conducted whenever changes are made to tank service and contents or tank peripherals (e.g. inerting and venting systems). 2) Hazardous material storage tanks which are holed/corroded beyond min. acceptable thickness should be taken out of service or repaired immediately.</p>	
More Information		<p>1) "Refinery Incident", US Chemical Safety and Hazard Investigation Board, Report No. 2001-05-I-DE (2002): US CSB Investigation Report. 2) INDG 370: "Controlling Fire and Explosion Risks in the Workplace", UK Health & Safety Executive (2013): https://www.hse.gov.uk/pubns/indg370.pdf.</p>	
Industry Sector		Process Type	Incident Type
Oil & Gas		Alkylolation (H ₂ SO ₄)	Explosion & Fire
Equipment Category		Equipment Class	Equipment Type
Mechanical		Vessel	Atmospheric Storage Tank