


<b>Incident Title</b>		<b>Organic Peroxide Thermal Decomposition</b>	
<b>Incident Type</b>		Fire	
<b>Date</b>		31 <sup>st</sup> August 2017	
<b>Country</b>		USA	
<b>Location</b>		Crosby, TX	
<b>Fatalities</b>		<b>Injuries</b>	<b>Cost</b>
0		21	Unknown
<b>Incident Description</b>		<p>The Crosby plant manufactures and stores a range of organic peroxides. These are powerful oxidising agents used to initiate polymerisation reactions in the manufacture of materials such as polyvinyl chloride and polystyrene. On 25-Aug-17, the manufacturing plant was proactively shut down to prepare for arrival of a Category 4 hurricane (“Harvey”). However, by 27-Aug-17, unexpectedly high and rising water levels threatened the electrical power, backup power and refrigeration systems in the low temperature warehouses where thermally unstable organic peroxides were stored. So the electrical equipment in the warehouses was turned off. On 28-Aug-17, the rising water level reached a transformer and all electrical power to the site was lost. The low temperature organic peroxide products were transferred to 9 standby refrigerated trailers, but flooding prevented 3 of the trailers being moved to high ground. On 29-Aug-17, all employees at the plant and neighbouring residents in a 2.5 km (1½ mile) exclusion zone had to be evacuated.</p> <p>On 31-Aug-17, organic peroxide products in one of the refrigerated trailers decomposed, causing the peroxides and trailer to combust. On 01-Sep-17, 2 more trailers caught fire. On 03-Sep-17, a controlled burn was carried out by emergency responders on the remaining 6 trailers. Fumes generated by decomposing organic peroxides drifted across a public road, causing 21 people to seek medical attention. A total of ~ 159 tonnes of organic products were burned and ~ 200 evacuated residents could not return home for a week.</p>	
 <p>Credit: US Chemical Safety Board</p>			
<b>Incident Analysis</b>		<p><b>Basic cause</b> was thermal decomposition of organic peroxide products due to refrigeration systems becoming inoperable because of rising floodwater.</p> <p><b>Critical factors</b> included: 1) Organic peroxides are reactive and inherently unstable, 2) Staff were not aware that a flood insurance map revision in 2007 designated part of the site a 500-year flood plain, 3) Hurricane Harvey flood levels greatly exceeded the 500-year flood level design basis, 4) A public highway passing through the exclusion zone was kept open for hurricane relief and rescue resource transportation (hazardous fumes exposure risk).</p> <p><b>Root causes</b> included: 1) Inadequate hazard identification (common mode failure of multiple layers of protection due to rising floodwater), 2) Inadequate process hazard analysis (risk of flood), 3) Creeping change (frequency and severity of extreme weather events appear to be increasing), 4) Inadequate federal process safety regulations (flood insurance maps not explicitly specified as required input for process safety hazard assessment).</p>	
<b>Lessons Learned</b>		<p>1) The interaction of natural hazards and technological systems such as chemical manufacturing plant can lead to major accidents (“Natech events”).</p> <p>2) Worst case scenarios (e.g. extreme flooding) should be considered for land use planning, hazardous facility siting, hazard analysis and plant layout.</p> <p>3) Multiple independent layers of protection may be needed to prevent common mode failure of safety-critical systems to maintain thermally unstable chemicals below their self-accelerating decomposition temperature (SADT).</p>	
<b>More Information</b>		<p>1) “Organic Peroxide Decomposition, Release, and Fire at Arkema Crosby Following Hurricane Harvey Flooding”, US Chemical Safety and Hazard Investigation Board, Report No. 2017-08-I-TX (2018).</p> <p>2) “Rain Starts Fire”, P. Carson &amp; R. Abhari, IChemE Loss Prevention Bulletin 277 (Feb 2021) <a href="https://www.icheme.org/media/15306/lpb277_pg29.pdf">https://www.icheme.org/media/15306/lpb277_pg29.pdf</a>.</p>	
<b>Industry Sector</b>		<b>Process Type</b>	<b>Incident Type</b>
Petrochemicals		Organic Peroxides	Fire
<b>Equipment Category</b>		<b>Equipment Class</b>	<b>Equipment Type</b>
Electrical		Switchgear	Miscellaneous