


Incident Title		Confined Space Hydrogen Explosion	
Incident Type		Explosion and Fire	
Date		8 th April 1999	
Country		USA	
Location		Gannon, FL	
Fatalities		Injuries	Cost
3		48	Unknown
Incident Description		<p>A routine maintenance outage was in progress on a 375 MW turbine and generator set (Unit 6) at a coal-fired power station. Some 13 days into the shutdown, with the turbine and generator already partially dis-assembled, mechanics removed an access cover from the Unit 6 generator's gaseous hydrogen cooling system. A release of pressurised hydrogen occurred and resulted in multiple explosions and fires. Three workers were killed by injuries sustained in the blast. Two were employees working near the generator (one died at the scene, the other died in hospital a few hours later). The third was a contractor working outside the turbine hall who was killed by a Transite siding panel blown off the turbine hall enclosure by the explosion.</p> <p>The fires were brought under control after 15 minutes. Only 1 of the 6 turbo-generator sets in the turbine hall was damaged, but the remaining 5 were taken off-line for precautionary safety inspections. The cost of replacement fuel and purchased power associated with this accident was \$5 m.</p> <p>Gaseous hydrogen is used as a coolant in large electric power generators because it has high heat capacity (14 times higher than air which is typically used for smaller generators), high thermal conductivity, high specific heat, low viscosity and low(est) molecular weight (minimises windage losses).</p>	
			
Incident Analysis		<p>Basic cause was a confined space hydrogen explosion due to ignition of gaseous hydrogen accidentally released from the closed-circuit generator cooling system.</p> <p>Critical factors included: 1) Purging (displacing with carbon dioxide then air) and depressuring of the gaseous hydrogen cooling system had not been carried out before disassembly of the turbine and generator set commenced, 2) The experienced mechanics working on the machine assumed hydrogen had already been purged from the system (common practice was for this to be done before disassembly begins, usually by day 2 or 3 of the shutdown).</p> <p>Root causes are believed to include: 1) Inadequate control of work (violation of lock out-tag out procedures, failure to use lock out devices and tags), 2) Inadequate communication between maintenance and operations personnel (work scope and equipment preparation status), 3) Failure to comply with energy isolation procedures (purging and depressuring hydrogen cooling system), 4) Inadequate process safety management (failure to enforce procedures), 5) Inadequate regulatory oversight (failure to visit the plant to audit control of work despite several leaks, fires and explosions since 1992).</p>	
Lessons Learned		<p>1) Shutdown and lock out/tag out (LOTO) procedures for maintenance of machinery should specify all measures required to verify a safe energy state for all its associated process, hydraulic, pneumatic, mechanical, electrical and other utilities before maintenance is permitted to begin.</p> <p>2) Shutdown/LOTO procedures should be rigorously enforced and energy isolation status should be clearly communicated to maintenance crews.</p>	
More Information		<p>1) US Dept. of Labour Occupational Safety and Health Administration (OSHA) Region 4 News Release USDOL 99-197 (7th October 1999).</p> <p>2) US Dept. of Labour Occupational Safety and Health Administration (OSHA) Inspection Report Nr. 109212571 (13th February 2001).</p>	
Industry Sector		Process Type	Incident Type
Power Generation		Coal-Fired	Explosion & Fire
Equipment Category		Equipment Class	Equipment Type
Not equipment related		Not applicable	Not applicable