

SafeGuard PSM

CSB Case Study Series | Executive Summary

www.safeguardpsm.com

EXPLOSION AND FIRE

U.S. Steel Clairton Coke Works Fatal Explosion

EXECUTIVE SUMMARY

CSB-CS-132 | U.S. Chemical Safety Board Investigation

Incident Quick Facts		
Company		U.S. Steel Corporation / MPW Industrial Services
Location		Clairton, PA
Incident Date		August 11, 2025
CSB Report Released		August 10, 2026
Fatalities		2
Injuries / Affected		11 (5 serious)
Chemical / Hazard		Coke Oven Gas (Hydrogen, Methane, CO -- Highly Flammable, Toxic) -- Double Disc Gate Valve Catastrophic Failure
CSB Recommendations		7 Total
PSM Elements Involved		
SOP	Operating Procedures	29 CFR §1910.119(f)
MI	Mechanical Integrity	29 CFR §1910.119(j)
SITING	Facility Siting	29 CFR §1910.119
CS	Contractor Safety	29 CFR §1910.119
PSM	PSM System	29 CFR §1910.119

1. EXECUTIVE SUMMARY

On August 11, 2025, two workers were killed and eleven others injured -- five seriously -- when coke oven gas exploded at the U.S. Steel Clairton Coke Works in Clairton, Pennsylvania. The Clairton facility is the largest coke manufacturing facility in the Western Hemisphere, in continuous operation since 1901. Property damage totaled \$52.5 million.

The explosion originated at a double disc gate valve on a coke oven gas supply line. MPW Industrial Services contract workers were cleaning the valve using an ad hoc water-washing technique that had been practiced informally at the facility for more than three years, with no written procedure governing it. Workers injected pressurized water between the two discs of the gate valve -- a configuration that traps water under pressure between the valve seats. The pressure exerted by the trapped water exceeded the structural capacity of the 70-plus-year-old cast iron valve body, which fractured catastrophically, releasing coke oven gas. The gas ignited within minutes and exploded.

Coke oven gas is a complex, highly flammable and toxic mixture -- primarily hydrogen and methane, with significant concentrations of carbon monoxide. The CSB investigation identified the absence of a written valve-washing procedure, the use of a cast iron valve prohibited by industry standards in flammable gas service, and inadequate facility siting as the primary failure chain. Buildings occupied by workers were located within twenty feet of active coke gas piping and were not designed to withstand an explosion.

2. KEY FINDINGS

	Finding	Detail
F-1	No Written Procedure for Water-Washing Valves	MPW workers had been injecting pressurized water into double disc gate valves on coke gas piping for more than three years. No written procedure existed governing this practice, and it was never formally evaluated for the pressure hazards it created.
F-2	Cast Iron Valve in Flammable Gas Service -- Prohibited by Standards	The failed valve was a 70-plus-year-old cast iron double disc gate valve. Cast iron is prohibited for flammable gas service by ASME B31.3, API 6D, and NFPA standards due to brittleness and susceptibility to catastrophic fracture under pressure or thermal shock.
F-3	Water Trapped Between Valve Discs Created Overpressure	The double disc gate valve design creates an enclosed cavity between the two disc faces when closed. Injecting pressurized water into this cavity trapped water under pressure. The hydraulic pressure exceeded the structural limits of the aged cast iron valve body.
F-4	Occupied Buildings Within 20 Feet of Coke Gas Piping -- Not Explosion-Rated	A facility siting evaluation had not been performed for buildings adjacent to active coke oven gas piping. Occupied structures were located within 20 feet of the piping without being designed or evaluated for explosion overpressure resistance.
F-5	No Formal PSM System at the Clairton Facility	The Clairton Coke Works did not operate under a comprehensive Process Safety Management system. The absence of PSM elements allowed hazardous ad hoc practices to persist for years without review.
F-6	Contractor MPW Had No Written Procedures for Cleaning Flammable Gas Piping	MPW Industrial Services had no written procedures for cleaning or servicing valves and piping in flammable or toxic gas service. Workers developed and passed on the water-washing technique informally with no hazard analysis.
F-7	Nippon Steel North America -- No Corporate PSM Governance	Nippon Steel North America had no corporate-level PSM governance program requiring U.S. Steel operations to implement PSM systems or audit compliance with process safety standards.
F-8	Coke Gas Released and Ignited Within Minutes of Valve Failure	The time between catastrophic valve fracture and ignition of the released coke oven gas was estimated at less than three minutes. Workers had no opportunity to detect the release and evacuate before the explosion.

3. ROOT CAUSES

	Root Cause	Analysis
RC-1	Ad Hoc Valve-Washing Practice Without Written Procedure or Hazard Evaluation	The root cause was the performance of a pressurized water injection technique on a double disc gate valve in coke oven gas service with no written procedure and no prior evaluation of the pressure hazard created by trapping water in the valve cavity. The practice had been performed informally for over three years -- long enough to normalize a technique inherently capable of catastrophic valve failure.
RC-2	Continued Use of Cast Iron Valve Prohibited by Industry Standards	The valve that failed was cast iron, a material prohibited for flammable gas service by multiple industry standards due to brittleness and susceptibility to sudden fracture. A mechanical integrity program would have identified this valve for replacement.
RC-3	Absence of a Comprehensive PSM System	The Clairton Coke Works operated without the PSM program elements that would have prevented this incident: written operating procedures for non-routine maintenance tasks, mechanical integrity program, contractor safety management, and a facility siting program for buildings adjacent to high-consequence piping.
RC-4	Facility Siting -- Occupied Buildings Adjacent to High-Consequence Piping	No facility siting evaluation had established safe separation distances or structural requirements for buildings adjacent to coke oven gas piping. Workers occupying buildings within 20 feet of the gas piping were exposed to lethal blast overpressure when the explosion occurred.

4. CSB RECOMMENDATIONS (7 Total)

	Recipient	Recommendation
R-1	U.S. Steel Corporation	Conduct a comprehensive facility siting evaluation for all occupied structures at the Clairton Coke Works to determine whether buildings are within explosion overpressure zones of coke oven gas or other hazardous piping. Implement required mitigation before resuming normal operations in affected areas.
R-2	U.S. Steel Corporation	Develop and implement a written procedure for all valve cleaning, washing, and maintenance activities on coke oven gas and other hazardous gas piping systems. Require a hazard review of each non-routine maintenance task. Prohibit water injection into double disc gate valves without an engineering evaluation.
R-3	U.S. Steel Corporation	Implement a comprehensive PSM system at the Clairton Coke Works including written operating and maintenance procedures, mechanical integrity program with identification and replacement of all cast iron valves in flammable/toxic gas service, contractor safety management, management of change, and pre-startup safety review.
R-4	Nippon Steel North America	Establish a corporate-level PSM governance program requiring all U.S. Steel and affiliated operating facilities to implement site-level PSM systems consistent with OSHA 1910.119 and recognized industry standards, with periodic corporate PSM audits.
R-5	Nippon Steel North America	Require all U.S. operating facilities under corporate control to conduct facility siting evaluations and provide results to corporate leadership on a defined schedule. Make facility siting compliance a tracked corporate safety metric.
R-6	MPW Industrial Services	Develop written procedures for all cleaning, washing, and maintenance activities performed on piping, valves, and equipment in flammable or toxic gas service. Require hazard analyses before any non-routine task in hazardous gas environments.
R-7	MPW Industrial Services	Train all workers who perform maintenance on piping and valves in flammable or toxic gas service on the hazards of those systems, including coke oven gas properties, valve cavity pressure hazards, and emergency response requirements for a gas release.

5. LESSONS LEARNED

	Key Lesson
1	A maintenance practice performed informally for years without incident is not safe -- it is unreviewed. The valve-washing technique at Clairton had been used for more than three years without a near-miss. Every non-routine task on hazardous energy systems requires a written procedure and hazard review before workers perform it.
2	Cast iron does not belong in flammable or toxic gas service. Multiple standards have prohibited it for decades. A mechanical integrity program that inventories valve materials and requires replacement of non-compliant equipment would have removed this valve from service long before the explosion.
3	Facility siting is not optional. OSHA 1910.119 requires it. Buildings near high-consequence piping must be evaluated, and if they cannot be made safe, workers must not occupy them.
4	Contractors must have written procedures for hazardous work before they start. A contractor whose workers perform valve cleaning in coke oven gas service without written procedures is a contractor operating without safety controls at the most critical point of risk.
5	PSM is the barrier between normal operations and catastrophe. Mechanical integrity would have flagged the cast iron valve; written procedures would have required a review of the water-washing task; contractor safety management would have required MPWs written procedures; facility siting would have identified the occupied building exposure. Any one of these barriers could have prevented this incident.

PSM Elements Referenced: SOP §1910.119(f) | MI §1910.119(j) | SITING §1910.119 | CS §1910.119 | PSM §1910.119 | 29 CFR 1910.119

6. SAFETY MEETING TOOLBOX TALK

Topic: Toxic Chemical Release Prevention and Emergency Response

Discussion Questions

	Question for Your Team
?	For any maintenance task performed on valves or piping in flammable or toxic gas service, do we have a written procedure reviewed for pressure hazards and energy isolation requirements before the work starts?
?	Has our facility identified and inventoried all valves in coke oven gas, hydrogen, methane, or other flammable gas service? Do any contain cast iron components -- and if so, what is our replacement plan and timeline?
?	When contractors perform maintenance on our process piping and valves, do we require written procedures from the contractor for every task in hazardous service -- and do we review those procedures before work begins?
?	Has a facility siting evaluation been conducted for occupied buildings, control rooms, and contractor work areas at our facility relative to potential explosion or toxic release zones?
?	Is there a process at our facility to identify and review informal maintenance practices that have developed over time but have never been written down or formally evaluated?

Team Action Items

	Action
[x]	Identify all non-routine maintenance tasks performed on valves and piping in flammable or toxic gas service -- including

	any informal practices -- and confirm each has a written procedure with a documented hazard review
[x]	Review your valve inventory in flammable and toxic gas service for cast iron valve bodies or components and initiate a replacement tracking program for any non-compliant valves identified
[x]	Confirm all contractors performing work on hazardous gas systems are required to submit written procedures and hazard analyses before work begins -- verify compliance for current active contractors
[x]	Review the facility siting evaluation status for your site, with particular attention to occupied buildings and contractor staging areas within consequence zones of high-consequence process piping
[x]	Brief your team on the Clairton incident -- ask each member: what informal practices at our facility have never been written down or reviewed?

PSM Partners Consulting | www.safeguardpsm.com | Helping facilities build compliant, effective PSM programs.