

Incident Summary #II-1520328-2023 (#33311) (FINAL)

SUPPORTING INFORMATION	Incident Date	March 9, 2023	
	Location	Hixon	
	Regulated industry sector	Gas - Natural gas system	
	Impact	Qty injuries	3
		Injury description	Three individuals within an industrial building were taken to hospital for possible carbon monoxide poisoning. One individual collapsed on site, one individual suffered dizziness and nausea, and one was examined for precautionary measures.
		Injury rating	Moderate
	Damage	Damage description	N/A
		Damage rating	None
Incident rating	Moderate		
Incident overview	A newly built, gas-fired dry kiln produced a high concentration of carbon monoxide which led to carbon monoxide exposure to multiple individuals.		
INVESTIGATION CONCLUSIONS	Site, system and components	<p>Industrial Sawmill:</p> <ul style="list-style-type: none"> A sawmill, or lumber mill is a facility where logs are cut into lumber. Modern sawmills use a motorized saw to cut logs lengthwise to make long pieces, and crosswise to length depending on standard or custom sizes then the lumber is dried inside a kiln. <p>Lumber Dry Kiln:</p> <ul style="list-style-type: none"> Fresh-cut raw lumber is loaded onto open rail cars, and the cars are then pushed into the kiln main drying section with front end loaders. Doors are manually closed, and the drying process is started. Burners can be started from the onsite control room or remotely from the mill's operation centre. The drying process can take anywhere from 18 hours to 26 hours depending on the moisture content of the lumber and is then followed by an approximately 6-hour cool down period before the lumber is removed from the drying section. <p>Direct-fired natural gas systems circulate the products of combustion throughout the main drying section of the kiln. The gases are directed through overhead supply ductwork into the main drying section and distributed throughout using down-comers along its length. The gases are directed and controlled in the downcomers utilizing a series of adjustable dampers. Excess gases are directed through the return ducting into the recirculating fan back through the burner. Vents installed in the roof of the kiln are computer controlled to maintain the required temperature and humidity to properly dry the lumber. These vents are open at approximately 5% for the first six hours of operation to allow the main drying section to reach the required room temperature.</p> <p>Natural gas requires a correct ratio of air to fuel to burn completely. When this ratio is incorrect and there is either not enough air or too much fuel, the result can be incomplete combustion. One of the by-products of incomplete combustion is carbon monoxide (CO). Carbon monoxide is a colourless, odourless, tasteless gas that is toxic to humans and animals. Exposure to carbon monoxide interferes with the</p>	

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	<p>body's ability to absorb oxygen, which can result in serious illness or death. CO concentrations above 1200 parts per million (ppm) are considered immediately dangerous to life or health (IDLH) by the Centers for Disease Control and Prevention.</p>
<p>Failure scenario(s)</p>	<p>Lumber was placed in the kiln and the drying process was started. The kiln vents were set to open at approximately 5% for the first six hours of operation. During this time the lumber in the kiln began to dry and produce steam, the vent opening did not allow sufficient venting of the steam and combustion products and they began to displace the oxygen inside the main drying section causing incomplete gas combustion and dangerous levels of carbon monoxide. The high concentration of carbon monoxide entered the control, burner, and motor control center (MCC) rooms through unsealed openings, and fresh air grill openings, affecting the individuals inside.</p>
<p>Facts and evidence</p>	<p>The gas contractor tested equipment over multiple days and multiple loads of lumber and found:</p> <ul style="list-style-type: none"> • Operating conditions for kilns 7 and 8 produced high CO levels. • Air and gas pressures for the burners were typical for proper combustion. • With the kiln vents closed, O₂ and CO levels were normal at startup but as the drying cycle proceeded the oxygen was displaced leading to low O₂ levels and CO levels in excess of 8000 ppm. • Opening the vents to 15 or 20% seems to allow enough air into the kilns to reduce the CO to acceptable levels. • There were no mechanical stops preventing the vents from fully closing. • There were no O₂ or CO sensors in the kilns to monitor for safe operation. • There were no O₂ sensors or CO alarms in the occupied workspaces to protect the personnel. • If the kilns are operated with the vents fully closed CO will climb above acceptable levels and hazardous conditions could occur again.
<p>Causes and contributing factors</p>	<p>The incident was caused by the dangerous levels of carbon monoxide being produced by incomplete combustion and entering occupied spaces through unsealed openings throughout the space.</p> <p>Contributing factors to the incident include:</p> <ul style="list-style-type: none"> • The operation of the kilns with the vents not allowing for sufficient venting of steam and products of combustion. • No O₂ or CO sensors in the kiln to monitor for safe operation. • No O₂ or CO sensors installed in the occupied workspaces to monitor for personal safety.



Image 1 – Industrial lumber kiln and attached control building.



Image 2 – Red arrow showing adjustable vent dampers on the roof of the kiln.



Image 3 – Kiln burner, control room and motor control room adjacent to lumber kiln.



Image 4 – Electrical motor control room two of the workers were in when they were exposed to CO.



Image 5 – Openings in occupied space CO may have entered through that were sealed after the incident.