Bureau of Safety and Environmental Enforcement

SAFETY ALERT

Safety Alert No. 475

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Flash Fire from Oxygen Regulator Leads to Burn Injury

Figure 1: Burn injury to wrist of operator.

Figure 2: Damage to aluminum fitting on regulator.

During the process of decommissioning a platform, a derrick barge crew member sustained first- and second-degree burns on his left wrist when he reached out to grab an oxygen bottle valve, even though he was wearing rigging gloves and a fire-retardant shirt (Figure 1). This happened because an oxygen bottle regulator (refer to Figure 2) suddenly burst, starting a flash fire while the crew member was turning the valve to supply oxygen for welding. The crewmember's wounds were treated with burn gel.

When dealing with oxygen systems, it is crucial to understand the interconnection of the three elements of the fire triangle[1]: the oxidizing agent (oxygen); system components (valves, regulators, fittings, cylinders etc.) serving as the fuel source; and the interaction among system components to create the potential ignition source.

[1] The fire triangle or combustion triangle is a simple model for understanding the necessary ingredients for most fires. The triangle illustrates the three elements a fire needs to ignite: heat, fuel, and an oxidizing agent. A fire naturally occurs when the elements are present and combined in the right mixture.

During the incident, the aluminum regulator attached to the oxygen bottle was directly exposed to the high-pressure environment and a flow of oxygen-rich gas, creating a susceptible chain for potential ignition. Ignition sources in an oxygen system can include:

1.) **Heat:** produced at a point of a striking blow.
2.) **Impact**: from high velocity particle flow.
3.) **Friction**: from two solid materials rubbing together.
4.) **Compression – Expansion Heating:**[2] Rapid pressure changes, such as the quick opening of a valve, can lead to compression-expansion heating of gas, potentially causing ignition.

Therefore, BSEE recommends that operators and their contractors, where appropriate, consider the following:

- Ensuring proper training and awareness of oxygen system safety among all personnel.
- Exercising caution to prevent exposure of skin when handling oxygen bottles and equipment.
- Regularly inspecting and maintaining oxygen system components to identify and address potential issues.
- Following manufacturer guidelines and industry best practices for the safe handling and use of oxygen equipment.
- Maintaining a safe distance from oxygen systems during operations to reduce the risk of exposure to potential ignition sources.
- Using oxygen bottle regulators constructed with brass fittings rather than aluminum. Aluminum easily ignites in high-pressure oxygen, burns rapidly, and has very high heats of combustion.
- Adhering to the following guidelines to ensure safety during valve operations:
    - **Opening valves slowly:** When operating valves, particularly those connected to oxygen systems, always open them slowly. Rapid valve

[2]Compression– Expansion Heating: also called **"adiabatic heating"** refers to an increase in temperature that happens when air or gas is compressed (squeezed) and then expands without any heat being added or taken away from the surroundings. It's the result of changes in pressure and volume without heat exchange with the environment.

opening can subject passageways to a rapid compression, leading to a rise in temperature and the possibility of ignition.

  - **Positioning valves away from the operator:** Ensuring that valves are positioned away from the operator's body. This positioning minimizes the risk of exposure to any unexpected release of gases or potential ignition sources.
  - **Preventing particle introduction:** Fast valve opening can introduce particles into the flow path of the regulator. These particles, when released, could ignite large materials within the system. To mitigate this risk, open valves in a controlled manner.

- Ensuring warning labels are in adequate condition and clearly legible on valve regulators as applicable.

- Ensuring oxygen refilling stations, and maintenance areas where oxygen equipment is serviced, are clean and free of dirt, oils, and grease to prevent valves from collecting any residual contaminants.

- Ensuring proper Personnel Protective Equipment (PPE)[3] is always worn during the operation or maintenance of an oxygen regulator, including well-fitting shirt sleeves that will not ride up upon movement.

– BSEE –

A **Safety Alert** is a tool used by BSEE to inform the offshore oil and gas industry of the circumstances surrounding a potential safety issue. It also contains recommendations that could assist avoiding potential incidents on the Outer Continental Shelf.

Category: Fire; Personnel Safety

[3] Personal protective equipment, commonly referred to as "PPE", is equipment worn to minimize exposure to hazards that cause serious workplace injuries and illnesses. These injuries and illnesses may result from contact with chemical, radiological, physical, electrical, mechanical, or other workplace hazards.