

Safe Oxygen Servicing



Oxygen is a vital gas, but when combined with a source of heat and flammable material, it can cause a significant fire hazard. This risk increases in an oxygen-enriched environment and can even lead to an explosion. Oxygen servicing requires specific safety precautions to avoid any hazardous situations. This article explains how a fire can start in the presence of oxygen and highlights the safety precautions that must always be followed whenever working on oxygen systems.

This article is also available on safetyfirst.airbus.com and on the Safety first app for iOS and Android devices.



CASE STUDY

Event Description

During the daily check of an A319, the maintenance crew checked the DOOR/OXY system page and noticed that the flight crew oxygen pressure was 1 450 psi instead of 1 500 psi, as per the Operator's own requirement. They decided to perform an oxygen servicing task before the aircraft was dispatched.

During the servicing task, the Pressure Regulator Transmitter (PRT) between the oxygen servicing cart and the crew oxygen cylinder exploded and started a fire that propagated towards the oxygen cylinder. The fire at the PRT melted the inlet hose of the cylinder valve, which caused it to separate from the PRT. Pressurized oxygen gas rapidly discharged and injured a maintenance crew member's face, causing skin and eye irritation. The second maintenance crew member managed to shut off the oxygen supply at the oxygen servicing cart. Other around the aircraft who heard the explosion reacted by shutting off the discharging flight crew oxygen cylinder, cutting power to the aircraft, and calling the emergency services. The maintenance crew member only suffered minor injuries.

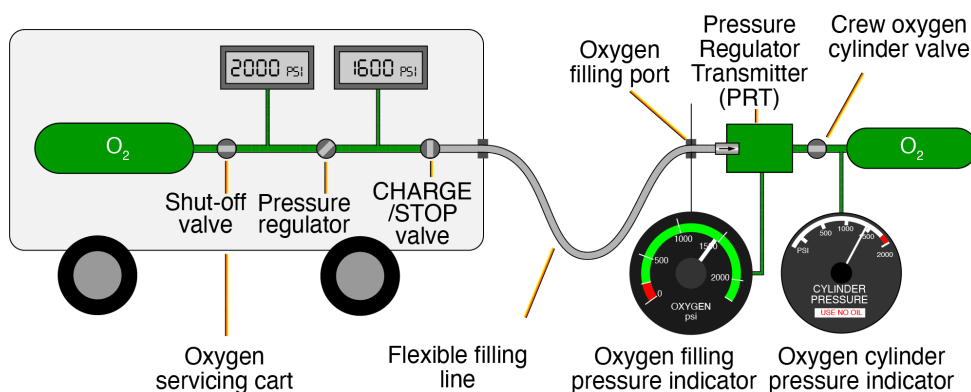
Event Analysis

Investigation revealed that the most probable sequence of actions that led to the fire was the following:

The crew oxygen cylinder valve was open and the pressure inside the PRT was around 1 450 psi.

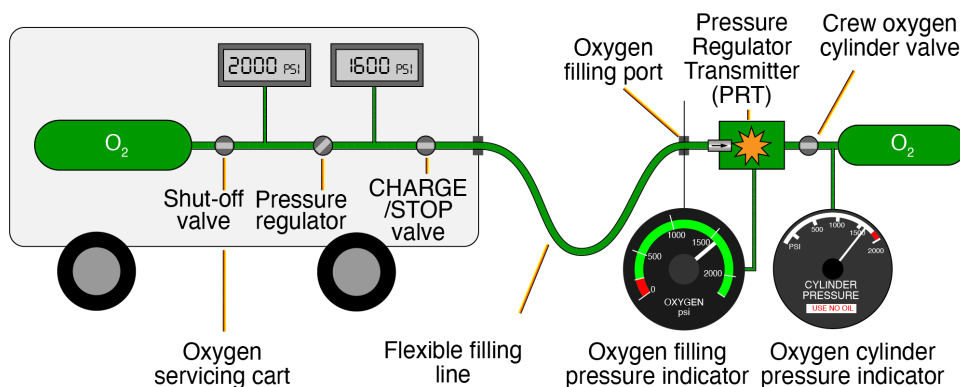
The maintenance crew opened the shut-off valve of the oxygen bottle on the servicing cart, which provided a pressure of 2 000 psi upstream of the cart pressure regulator.

The cart regulator was then opened and set to a regulated pressure of 1 600 psi. At this stage, the flexible filling line was not pressurized, because the CHARGE/STOP valve was in a closed position (**fig.1**).



(fig.1) Initial setup of the oxygen servicing cart during the event

The maintenance crew then opened the CHARGE/STOP valve (set to the CHARGE position). This created a rapid pressurization inside the flexible filling line up to 1 600 psi, which caused the oxygen temperature to increase to approximately 800°C at the entry of the PRT. This phenomenon is called adiabatic compression. An O-ring located at the PRT inlet ignited at this temperature. The resulting fire propagated to the other PRT components and to the cylinder valve inlet, which separated from the PRT and released the oxygen from the cylinder (**fig.2**).



(fig.2) The sudden pressure build-up in the filling line led to a rapid increase of the oxygen temperature to 800°C. It triggered the ignition of an O-ring inside the PRT and the fire propagated to the cylinder valve.

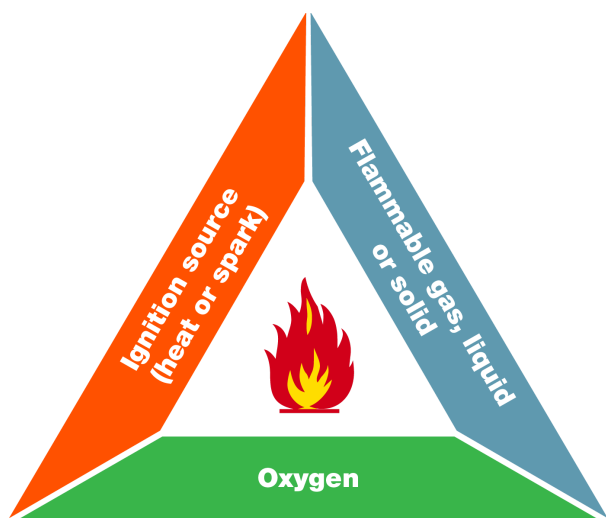
Importance of following oxygen servicing instructions

The instructions for use of the servicing cart states that the CHARGE/STOP valve must be open before opening the cart pressure regulator. The risk of rapid pressurization was specifically mentioned and carefully following the instructions would have prevented the incident. When pressurizing an oxygen system or device, it is essential to always slowly open the valves and to control the slow pressurization of the system. ■

OXYGEN AND THE RISK OF FIRE

Oxygen is not a flammable gas but an excellent oxidizer, which is present at a concentration of approximately 21% in the ambient air. It is odorless, invisible, and difficult to detect.

When an oxidizer comes into contact with flammable materials in gas, liquid, or solid form, and if energy from a heat source or a spark is present, this starts a fire that burns until one of the three components of this fire triangle is removed **(fig.3)**.



(fig.3) The fire triangle

Some flammable material such as grease or oil can self-ignite in a pure oxygen atmosphere, but only at fairly high temperatures above 200°C. In an oxygen-enriched environment, those same materials can self-ignite at much lower temperatures depending on the level of oxygen concentration present. In that case, the fire will be of higher intensity and temperature. Even without sparks or an ignition source, large fires and explosions can occur. ■



KEYPOINT

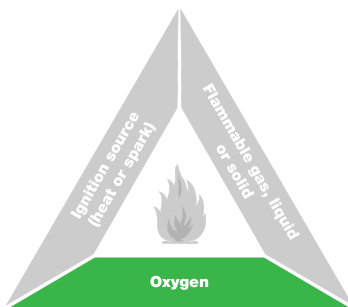
Even a small increase in the oxygen concentration level from 21% (standard air environment) to 24% can create a dangerous situation with rapid and explosive combustion.

SAFETY PRECAUTIONS DURING OXYGEN SERVICING

Oxygen cylinders need regular servicing and they can either be refilled or replaced. There are specific precautions to follow for these tasks. They can only be performed by qualified personnel who are trained to work on oxygen systems and aware of the associated risks, especially fire risks. Only approved tools, materials, and procedures should be used.

The general precautions to take are available in the Airbus AMM/MP/AMP maintenance procedures dealing with oxygen systems.

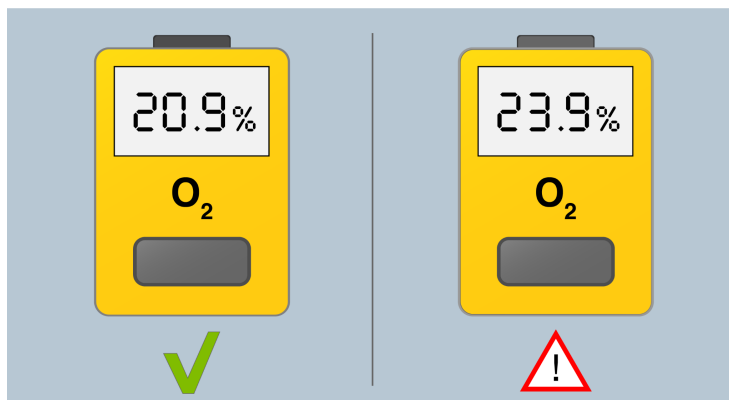
Prevent an oxygen enriched atmosphere



Use an oxygen detector and ventilate confined areas, when necessary

Any oxygen leak can create an oxygen-enriched environment, which could lead to dangerous situations especially when oxygen cylinders are placed in confined spaces. During flight, these areas are ventilated by the aircraft air conditioning system. However, when on the ground there is no ventilation. Therefore, maintenance crews should be aware of the oxygen level before entering those confined areas.

The use of an oxygen detector is recommended (fig.4). If high levels of oxygen concentration is detected, the area must be ventilated before performing any maintenance actions.



(fig.4) An oxygen detector enables a check of the oxygen concentration in a confined area before starting any maintenance task

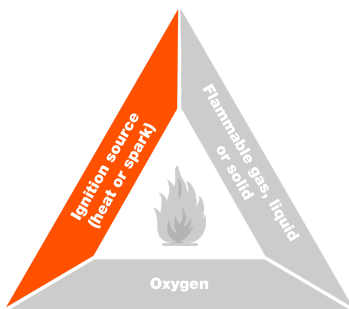
Follow maintenance procedures and instructions of use

To prevent any oxygen leak during servicing, it is crucial to follow the AMM/AMP/MP procedures. It is also crucial to follow the operating instructions for the oxygen servicing cart and the instructions of use for the filling port adapter provided by the ground equipment manufacturer.

Keep track of your oxygen servicing

It is recommended to keep track of the frequency of the oxygen servicing especially if it often occurs before the scheduled maintenance as this could indicate a leak in the oxygen system.

Prevent any ignition source



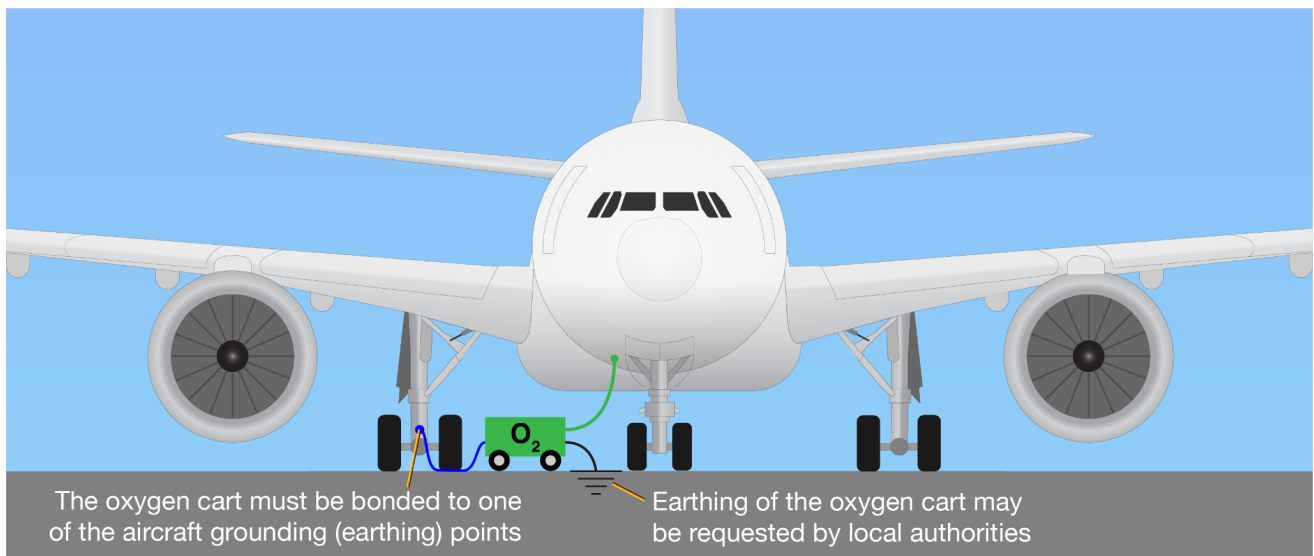
During oxygen servicing, all possible heat sources should be removed to avoid any fire risk.

Prevent heat coming from sparks or flames

It is forbidden to smoke during oxygen servicing. Oxygen servicing must not be performed in the proximity of other maintenance activities that could create flames, heat, or sparks such as grinding or drilling.

Prevent heat coming from electrical discharge or electrical overheating

It is forbidden to use mobile phones during servicing and to perform oxygen servicing during thunderstorms. When refilling oxygen, it is mandatory to bond the aircraft to the oxygen servicing cart before connecting the refill valve (**fig.5**). This will ensure electrical continuity between the aircraft and the oxygen servicing cart and prevent the likelihood of sparks due to a potential difference between the aircraft and the cart. Airbus AMM/MP/AMP maintenance procedures do not require grounding (earthing) of the aircraft or of the oxygen servicing cart, but local authority regulations may request this.



(fig.5) Mandatory bonding during oxygen servicing operations using an oxygen cart

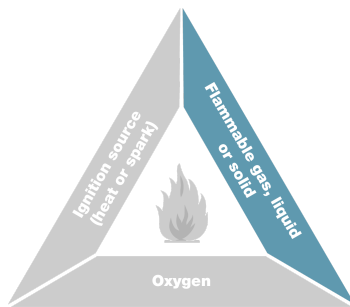
Prevent rapid oxygen pressure build-up

The event described earlier highlights the need to handle oxygen valves with care to prevent rapid oxygen pressure build-up and ignition of flammable materials. Also if dust or debris are present in the system, for example, due to contaminated tooling, a fast oxygen flow could create sparks as a result of particle impact.

Respect a safety zone

As an industry standard, a 5-meter safety zone must be maintained around the oxygen filling port during refilling.

Prevent presence of flammable gas, liquid or solid



Restrict other maintenance activities

Oxygen servicing must not be performed during refueling, cleaning, deicing, when working on fuel and hydraulics, or any systems using flammable materials. Oil, grease, lubricant, fuel, cleaning and deicing materials are flammable and can self-ignite the presence of concentrated levels of oxygen.

Only use approved lubricant/cleaner

The maintenance crew should only use approved lubricant and cleaner products on oxygen system components.

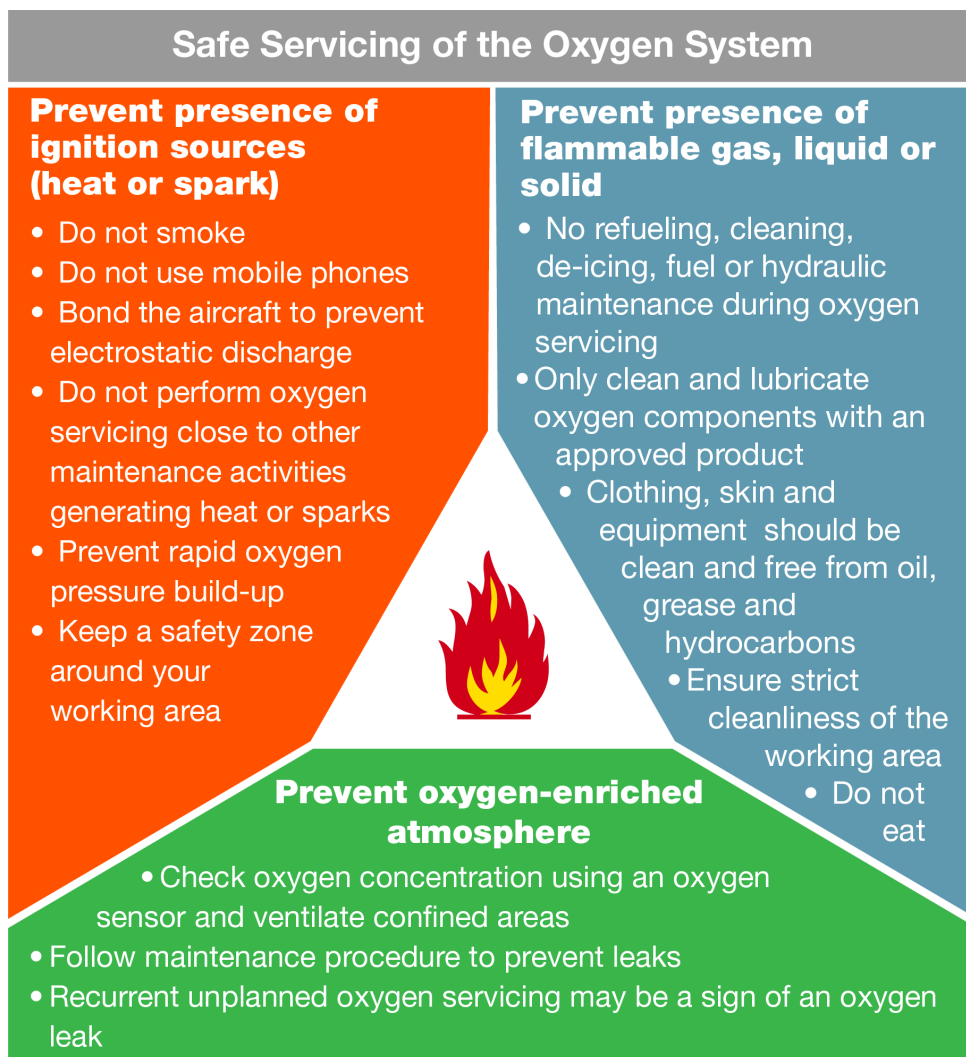
The importance of a clean work area, tools and servicing equipment

A clean work area, tools and servicing equipment should be ensured to prevent dust or debris entering into the oxygen system from the reception and storage of oxygen system components through to the final installation on the aircraft. Check that each person working on the oxygen systems, or performing oxygen servicing tasks, has clean hands, clean clothes, clean tools, and clean working areas. This will avoid oil or grease stains from coming into contact with oxygen gas. This will also avoid the presence of particles or other contaminants that could lead to a fire if combined with a heat source and oxygen. ■



KEYPOINT

In an oxygen-enriched environment, even a rag with grease on it used during previous maintenance tasks can lead to a fire. Therefore, the maintenance crew must always use clean equipment during servicing to prevent any risk of fire or combustion.



(fig.6) Summary of the safety precautions for oxygen servicing

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Oxygen in the presence of a source of heat and flammable material can lead to significant fire events. Oxygen-enriched environments can create even more intense fires and explosions. When working on oxygen systems such as during oxygen servicing, specific safety precautions need to be followed to avoid these hazardous situations.

There are safety precautions to reduce the risk of an oxygen-enriched environment due to oxygen leaks. The use of an oxygen detector and the ventilation of confined areas is recommended.

Other safety precautions are intended to remove any source of heat coming from either flames or sparks, from electrical discharge or electrical overheating. It is the reason why it is mandatory to bond the aircraft to the oxygen filling cart when performing oxygen servicing. Grounding the aircraft may also be required by local authorities. In all cases, a safety zone around the filling port must be maintained.

It is essential to remove any flammable material near the oxygen systems during servicing. A clean work area, tools, and servicing equipment must be ensured. Performing maintenance tasks on systems with flammable materials such as fuel, hydraulic fluid, or deicing products must be avoided during servicing of oxygen systems.

Following Airbus maintenance procedures and all procedures and instructions for use provided by the manufacturers of all ground equipment and products used is essential to ensure safe oxygen servicing.

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Safety first

The Airbus Safety magazine

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