Case Study

Monitoring of oxygen at Cranfield airfield

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Introduction

For personnel safety, monitoring of oxygen (O_2) levels was required as part of an experimental field campaign based at Cranfield airfield. This experiment was undertaken by researchers in the atmospheric physics group at Imperial College London.

The researchers are interested in measuring Far-infrared radiance fields in the atmosphere in order to better understand atmospheric heating/cooling effects of high level cirrus clouds and water vapour.

To help with their research the group designed and built the Tropospheric Airborne Fourier Transform Spectrometer (TAFTS), which is a high resolution Far infrared spectro-radiometer covering the range 16 µm -120 µm. This instrument employs liquid cryogen cooling for the detectors, enabling rapid sampling of the atmosphere.

TAFTS is a unique instrument and is currently the only aircraft based instrument covering this wavelength region.

These measurements are being used to improve the data set in various studies of the Earth's climate and climate change.

Context

Field deployment of TAFTS can be within the UK or abroad and it has previously been deployed on several aircraft for research campaigns, including the UK Met Office C130 research aircraft, the ARA Egrett and the FAAM Bae-146.

It was most recently based at Cranfield airfield with a ground preparation station situated in a large aircraft hangar where engineers were working.

The spectro-radiometer houses detectors, which are two pairs of highly sensitive photoconductors that must operate at liquid helium temperature (-269 °C).

The detectors and associated optics are attached to a tank of liquid helium which is in turn surrounded by a liquid nitrogen cooled radiation shield and vacuum enclosure.

The cryogen dewars employed and housed in the aircraft hangar were 230 litres of liquid nitrogen and 120 litres of liquid helium.

Following a risk assessment it was identified that oxygen monitoring was required to ensure the safety of those in the aircraft hangar.

Nitrogen and helium are not toxic but they are inert gases that do not support human breathing.

In the air a normal concentration of oxygen is 21%, while the rest of the atmosphere is made up of 78% nitrogen and trace gases.

If an inert gas is leaked this can displace oxygen in the atmosphere causing oxygen depletion.

Depending on the concentration of oxygen, the effects and symptoms of oxygen depletion on the human body will vary. At 19% people may suffer some physiological effects, but it may not be noticeable; while a drop to 12-15% is enough to cause poor judgement, faulty coordination, abnormal fatigue and emotional upset.

If the oxygen level reaches less than 10% this can cause immediate fainting, an inability to move, loss of consciousness, asphyxiation or death.

Objectives

A rapid release from the contained cryogens would cause oxygen depletion and affect the health of those working in the hangar. After this risk was identified, our O2NE+ was installed in the aircraft hangar to ensure the area was fully monitored. The atmosphere monitoring experiment lasted three months, and the main objective was to keep all personnel safe during this time period, while measurements were being obtained.

Methodology

The O2NE+ is an ambient oxygen deficiency monitor and sensor. It is a fixed instrument comprising of a wall mounted main sensor unit and a repeater.

The main sensor unit is usually wall mounted at normal working head height in the area recommended as a result of a risk assessment. This may be an area that is using multiple gases or a gas storage area where there is a potential leak of an inert gas.

The repeater unit (which takes its power from the main unit) is then sited at the entrance to the area to provide an early warning to personnel before entering an oxygen depleted room.

For the purpose of the experiment in the hangar, the repeater did not need to be outside the room, and both the main unit and repeater were mounted on the same housing.

The unit was placed within 1- 2 metres of the cryogenic dewars throughout the three month period.

The oxygen range the O2NE+ measures is 0 to 25% and it has two low audio/visual alarms. The first alarm is pre-set to when the levels of oxygen reach 19.5% and the second is set at 18%. However these set points can be adjusted by the user.

It also has a sensor life of up to 10 years meaning it has very low maintenance costs.

Figure 1: The O2NE+ installed in the aircraft hangar

Results

The O2NE+ is a continuous monitor so there is no need to analyse results unless there is an incident. In the three month period when it was based in the hangar the levels of oxygen remained at a safe level.

Conclusion

The Cranfield airfield hangar was fitted with one O2NE+ in order to safely monitor the area. The requirement for this monitor came from the conclusion of a risk assessment carried out before the experiment began.

Dr. Jonathan Murray, Research Fellow, Space and Atmospheric Physics, Imperial College London, said: “Local volume oxygen depletion in the case of a rapid release of the contained cryogens was flagged as a risk and in order to give warning to those working nearby it was decided that a portable oxygen monitor would be required.

“I searched online and found the O2NE+ which looked like an ideal unit, so I contacted Analox and arranged for us to loan a unit for three months.

“The O2NE+ was simple to setup, requiring mains input, the loan unit came with a repeater in the event that an external alarm is required to prevent personnel entering an oxygen depleted room, although for our purposes this was not required and both the main unit and repeater were mounted on the same housing. We were able to test the unit and demonstrate the alarm system to those working in the vicinity quite easily. In total we made use of this unit for three months and found that it fulfilled our requirements well, keeping the unit within 1 – 2 metres of the dewars throughout this period. I was particularly happy with the ease of use. In our case no sudden release of cryogens occurred and the experiment went ahead without issue.”

For more information on Imperial College London visit www.imperial.ac.uk

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