Personnel Safety Systems

ESS ACCELERATOR OXYGEN DEPLETION HAZARD DETECTION SYSTEM

EUROPEAN SPALLATION SOURCE

Abstract

At the European Spallation Source ERIC (ESS), cryogenic cooling is essential for various equipment of the facility. The ESS Superconducting LINAC and the ESS Cryomodule Test Stand, will require major cryogenic services in order to be supplied with liquid nitrogen and helium. Since the use of cryogenic fluids can be associated with Oxygen Depletion Hazard (ODH), the ESS Protection and Safety Systems group will install an ODH Detection System which is a PLC-based alarm system. This system will monitor real time Oxygen concentration levels in designated areas, with the aim to alarm personnel if the oxygen level is detected below certain thresholds. This poster gives an overview about the requirements, system architecture, hardware and software of the ODH Detection System in ESS Accelerator buildings.

1. Introduction

In ESS Accelerator buildings, through an ODH assessment five areas have been identified where ODH Detection System is required, the Helium Compressor Building (HCB), the Cryogenic Transfer Line Gallery (CTLG), the Cold Box Hall (CXH), the Cryomodule Test Stand and the Accelerator tunnel.

The following are the sources of ODH in the areas already mentioned:

- Warm Helium in the HCB, the CTLG and the CXH.
- Nitrogen in HCB.
- Nitrogen in the CXH.
- Liquid helium in the CXH, CTLG and Accelerator tunnel.

If the Oxygen concentration is detected to be between 19.5% and 18%, the ODH detection system will send a warning signal to the Main Control Room and the Cryogenic Control Room where operators will be notified. The ODH evacuation alarm (red beacon lights + siren sounders) will be activated upon detection of low level of oxygen (≤18%) from at least one of the ODH monitors. The alarms will remain active as long as the digital signal from the ODH monitor is active.

2. Architecture

The Accelerator ODH Detection System consists of a single-train system using Siemens S7 1500 series safety PLC's. At ESS, the ODH Detection Systems will be completely independent from Personnel Safety Systems. The system will use fibre connections from the main PLC rack to the distributed I/O (ET200SP) by means of a ring topology over PROFINET protocol, as shown in figure 1. All signal paths are hardwired from equipment (sensors and actuators) to the peripheral modules, which are: analog input (AI), digital input (DI) and digital output (DQ).

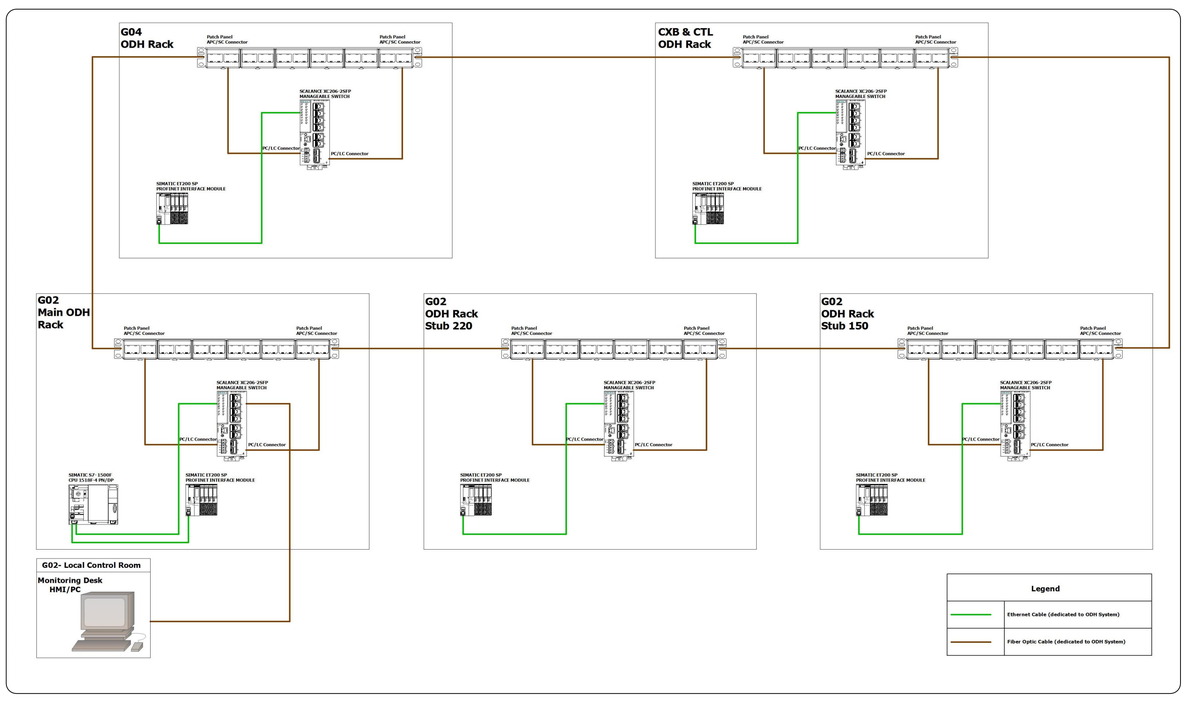

Figure 1: Accelerator ODH Detection System Physical Topology

3. Controlled devices

ODH monitors:

The ODH monitors measure and display the oxygen concentration in a gas sample drawn through the instrument, (figure 2). Gas is pumped sequentially from up to four input sample ports, through the oxygen sample cell, and out the exhaust port. An internal filter in the input line prevents contamination of the sensor.

Oxigraf O2iM single port and multiport are used in the implementation of the ODH Detection System. Single port will provide a faster sampling of oxygen while the multiport will provide a wider area-coverage.

Figure 2: O2iM 4-port mounted in a pillar at the HCB

Figure 3: Alarm plate installed in the facade of the HCB

Alarm devices:

The alarm devices are comprised of red beacon lights and siren sounders, (figure 3). These devices are used to alert the personnel in the hazardous areas in order to facilitate their safe and fast evacuation in case of oxygen depletion. Flashing lights are installed in the lateral walls of the rooms while rotating lights are installed in the central areas of the rooms in order to reach a good visibility from every point.

4. Software

The ODH Detection System software will be developed using Siemens TIA Portal SIMATIC S7. The software is following an activation matrix which summarize the requirements of ODH system.

Two modes of operation can be configured in the ODH monitors; normal mode and channel relay mode. For ESS application, normal mode is chosen to show more detail information in each relay. The individual relay is connected to the Digital Input of PLC and the PLC software will determine the action needed upon activation / deactivation of the relays

5. Conclusion

The Accelerator ODH Detection System installation is being carried out in two phases. Phase one is nearly finished and comprises of HCB, CTLG and CXH buildings. The second phase comprises of the Cryomodule Test Stand and the Accelerator tunnel. In addition, Target and Neutron Instrument(s) ODH Detection Systems will be developed in future.

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