

# HYDROGEN DELIVERY SYSTEM CRITICAL SAFETY FUNCTIONS

- I. Operation of the ventilation system on detection of a hydrogen leak
- II. A shut-off facility for the Hydride Bed Heater/Chiller on detection of bed overpressure (this would require an additional pressure transmitter) – really a safety function?
- III. Shut-off PV20 if there is pressure rise in the cryostat during operation (detected by VG3?).
- IV. Cryocooler shut-off if temperature drops below hydrogen freezing point (14K) – is this a safety function?
- V. Interlock the Gas Panel Enclosure with system returning to 'safe state' on breaking of interlock – RAL to confirm this requirement. (AI#21)

**All safety functions are intended to be hardwired and separate from the control system PLC**

## OPERATION OF THE VENTILATION SYSTEM ON DETECTION OF A HYDROGEN LEAK

Ventilation System to consist of two fans (?? 4Kw ??) Each - Each with its own UPS

One Fan on its own to be capable of providing required flow rate (100% Speed)

Fans can run at reduced speed if:-

The other Fan is running (50% Speed) – Loss of one fan will cause the other to speed up

A signal is present from the Hydrogen Detection System (HDS) saying No hydrogen has been detected (20% Speed) -

Detection of hydrogen or failure of the Hydrogen Detection System will cause the fans to speed up

Hydrogen Detection System to be Dual Redundant each system will need 4 Outputs:- 1 to each fan, 1 to the control PLC & 1 Spare

## A SHUT-OFF FACILITY FOR THE HYDRIDE BED HEATER/CHILLER ON DETECTION OF BED OVERPRESSURE

Failure of the control system may cause excessive heating of the Hydride Bed / Production Hydrogen causing over pressure of the system and hydrogen release (HA-RV23 will operate)

This Safety Function is intended to prevent this by removing the power to the Heater/Chillier Unit if over pressure is detected by a pressure transducer independent of the control system

This would require separate pressure transducer in the hydrogen pipe work interlocked to a contactor in the Heater/Chillier Unit electrical supply

## SHUT-OFF PV20 IF THERE IS PRESSURE RISE IN THE CRYOSTAT DURING OPERATION

This Safety Function is intended to prevent hydrogen being pumped by the Vacuum System if there is a leak from the absorber vessel

A relay circuit driven by a set point output from Vac Gauge HA-VG3 could be used to remove the power from HA-PV20 causing it to close. If a pressure rise is detected once a stable vacuum has been established.

**NOTE:-** If the Safety Functions are to be separate consideration should be given as to whether HA-VG3 & HA-PV20 should be Duplicated

## CRYOCOOLER SHUT-OFF IF TEMPERATURE DROPS BELOW HYDROGEN FREEZING POINT (14K)

Failure of the Heaters HA-HTR1 & HA-HTR2 may cause excessive cooling of the Hydrogen causing it to freeze creating trapped volumes and over pressure problems

Can we let the control system look after the temperature & the Safety System prove the heaters are working (Maybe current monitoring) and remove the electrical supply to the Cryocooler (Contactor) if heaters OK Signal is not present

## INTERLOCK THE GAS PANEL ENCLOSURE WITH SYSTEM RETURNING TO 'SAFE STATE' ON BREAKING OF INTERLOCK

Would be better to Prevent in gas Panel Enclosure from being Opened unless to system is in a safe state – using a Trapped Key system (Would be better than causing the system to operate when access has been gained)