Cryogenics Plans and Interface with FSCF BMS – DRAFT

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LBNF/DUNE FS Interface Meeting

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Detector Cavern ODH Safety System Local Inputs – 1/2

- **Oxygen level at 19.5%:**
  - Local cavern horn/strobes.
    - Minimizing in series control components (i.e. non-safety PLC, etc.).
  - ODH alarm to SURF PLC?
  - ODH alarm to Ventilation PLC?
- **Oxygen level at 18.0%:**
  - Cryo isolation valves will close.
  - LBNF Facility horn/strobes:
    - This means CUC horn/strobes go off.
    - Drift between detector/CUC?
    - Other drifts?
  - ODH emergency alarm to SURF PLC?
  - ODH emergency alarm to Ventilation PLC?

Detector Cavern ODH Safety System General Inputs – 2/2

- **Low air temperature:**
  - Cryo isolation valves will close.
  - Low air T alarm to SURF PLC?
- **Seismic activity** (above some acceleration value):
  - Cryo isolation valves will close.
  - Seismic alarm to SURF PLC?
- **Local Emergency stop:**
  - Anything significant here??

Detector Cavern ODH Safety System Input from other systems

- **From Ventilation system:**
  - Low Exhaust flow:
    - Sensor installed after beneficial occupancy?
    - Same response as ODH 19.5%.
  - Ventilation trouble alarm?
    - Cryo isolation valves will close.
  - Fire alarm:
    - Cryo isolation valves will close.
- **From SURF:**
  - SURF facility alarm?
  - Site alarm?
- **From DUNE:**
  - Anything that should trigger an ODH alarm?

CUC ODH Safety System Local Inputs

- **Oxygen 19.5%:**
  - Local cavern horn/strobes.
    - Minimizing in series control components (i.e. non-safety PLC, etc).
  - ODH alarm to SURF PLC?
  - ODH alarm to Ventilation PLC?
- **Oxygen 18.0%:**
  - Cryo isolation valves will close.
  - LBNF Facility horn/strobes?
    - Smaller cryogen inventory compared to cryostat.
    - Drifts?
  - ODH emergency alarm to SURF PLC?
  - ODH emergency alarm to Ventilation PLC?

CUC ODH Safety System General Inputs

- **Seismic activity** (above some acceleration value):
  - Cryo isolation valves will close
  - N2 refrig safe shutdown?
  - Seismic alarm to SURF PLC?
- **Local Emergency stop:**
  - Anything significant here??

CUC ODH Safety System Input from other systems

- **From Ventilation system:**
  - Low Exhaust flow:
    - Sensor installed after beneficial occupancy?
    - Same response as ODH 19.5%
  - Ventilation trouble alarm?
    - Cryo isolation valves will close
  - Fire alarm
    - Cryo isolation valves will close
- **From SURF:**
  - SURF facility alarm?
  - Site alarm?
  - Power outage:
    - Nitrogen system shuts down and start flowing LN2 from temporary storage.
    - Controls system goes into safe mode.
- **From DUNE:**
  - Anything that should trigger an ODH alarm?

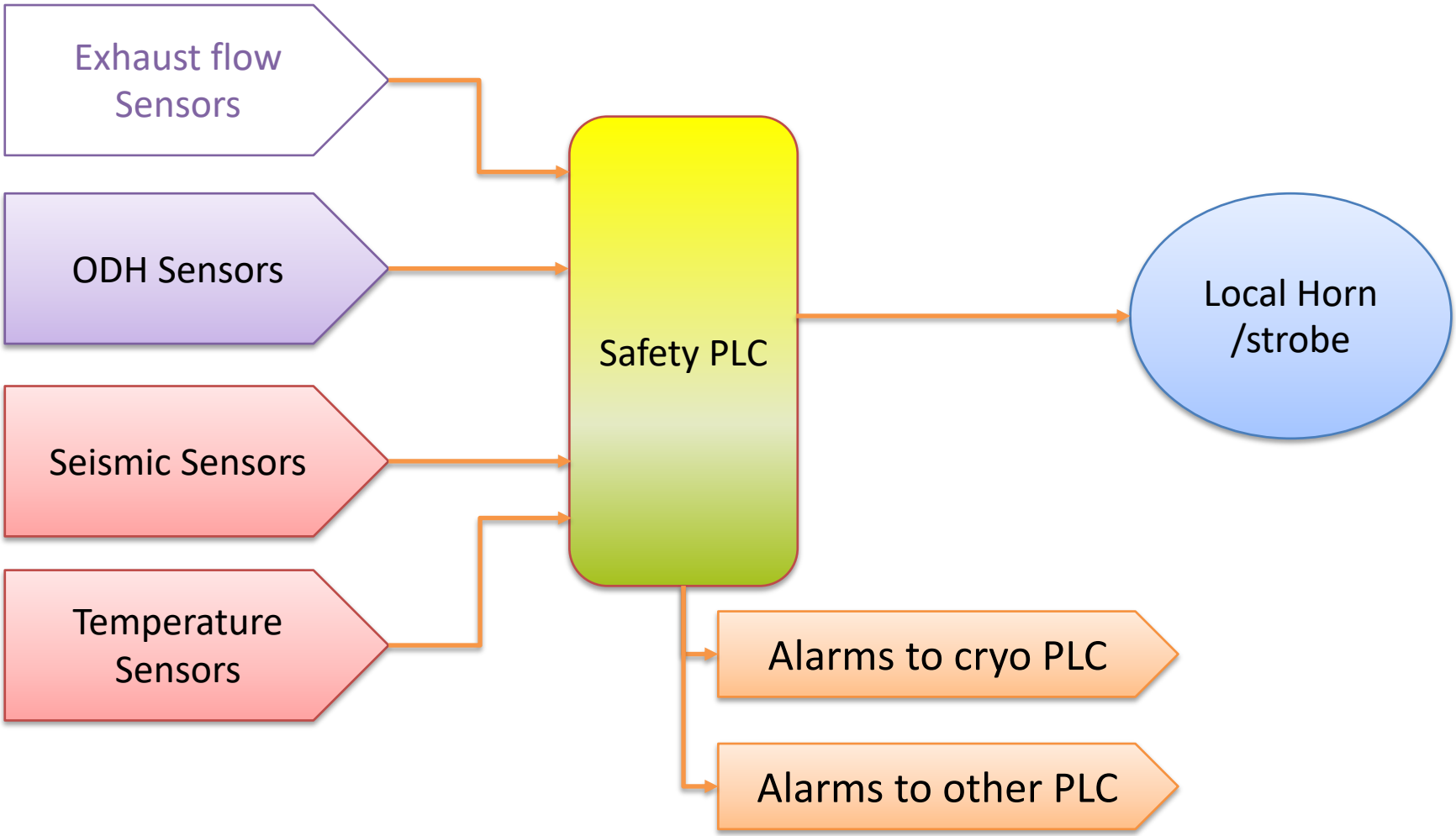
Ross cage ODH Safety System

- Concept battery powered ODH monitor/alarm
  - Oxygen 19.5% - Alerts cage operator
    - Operator returns cage to surface
    - Safety/cryo investigates.
      - Possible actions to mitigate
        - Stop GAr transfer for filling
        - N2 refrig to safe shutdown

ODH sensors in drifts

- ODH sensors planned for drifts containing liquid or gas cryogen piping.
  - These are ODH 0 spaces. (ODH 0 status must be reevaluated with drift air flow from CF design.)
  - These sensors inform LBNF safety PLC, SURF PLC, Ventilation PLC?

Detector cavern safety PLC



Other alarms

- Pressure increase in cryostat:
  - Automatic vent will act automatically to release overpressure. If pressure reaches PSV set point, PSVs will release overpressure.
  - Triggers alarm to cryo ops team or cryo expert on call for investigation.
- Low vacuum level in vacuum insulation (> 10 mBar):
  - Triggers alarm to cryo ops team or cryo expert on call for investigation.
- High level of Oxygen/Water in GAr purges from chimneys.
  - Triggers alarm to cryo ops team or cryo expert on call for investigation.
- Argon in GN2 purge within insulation.
  - Triggers alarm for investigation.
- Nitrogen System malfunctioning:
  - Triggers alarm to cryo ops team or cryo expert on call for investigation.
  - If ODH alarm, same response as ODH alarm.
  - Will start usage of LN2 storage to maintain Argon inventory.
- Need to continue to identify data that needs to be exchanged with DUNE and FSCF/BMS.

Thanks

Backup

Preliminary Control System Architecture