

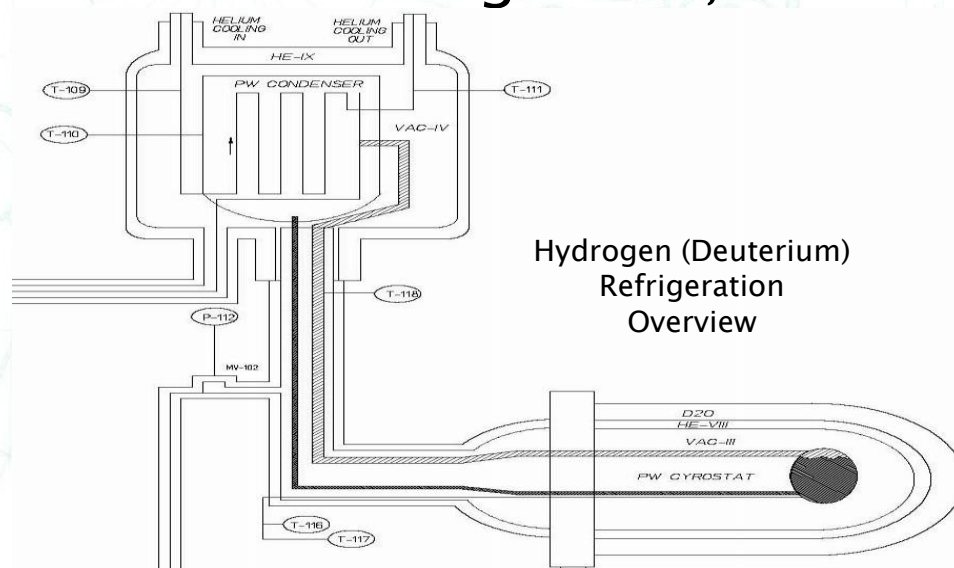


Oxygen Deficiency Hazard

Ryan Fangmeyer

Awareness

- ▶ Deuterium Cold Source project brought awareness to the hazard
- ▶ Project requires a larger refrigerator in C200
- ▶ Existing nitrogen tank is 6000 gallons, future is even larger



Oxygen Deficiency Hazard Sub-Committee

- ▶ Hazard Review Committee created ODH Sub-Committee
- ▶ Representatives from NCNR engineers and operators created analysis of ODH
- ▶ Sub-committee reviewed analysis



Hazard Threat

- ▶ Oxygen deficiency in Confinement
- ▶ $\sim 10^{-7}$ /hr fatality rate; 5.3m³ of nitrogen gas a second

20.9%

- Atmospheric Oxygen Level
- Confinement Oxygen Level



19.5%

- Occupational Safety and Health Administration ODH Level
- 2-3 Minutes



<10%

- Death
- 15-18 Minutes

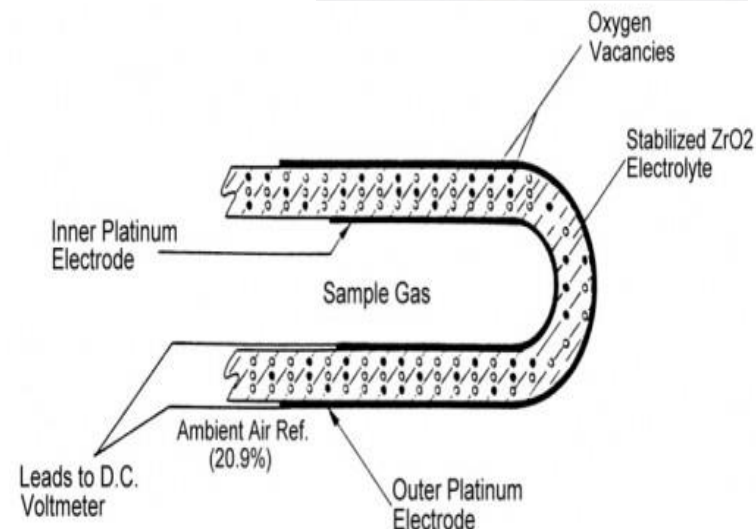


19.5	Minimum "Safe Level" (19% is often the Low level alarm of most O ₂ detectors)
15-19	First sign of hypoxia. Decreased ability to work strenuously. May induce early symptoms in persons with coronary, pulmonary or circulatory problems
12-14	Respiration increases with exertion, pulse up, impaired muscular coordination, perception and judgment
10-12	Respiration further increases in rate and depth, poor judgment, lips blue
8-10	Mental failure, fainting, unconsciousness, ashen face, blueness of lips, nausea, vomiting, inability to move freely
6-8	6 minutes - 50% probability of death 8 minutes - 100% probability of death

Oxygen Deficiency Monitor

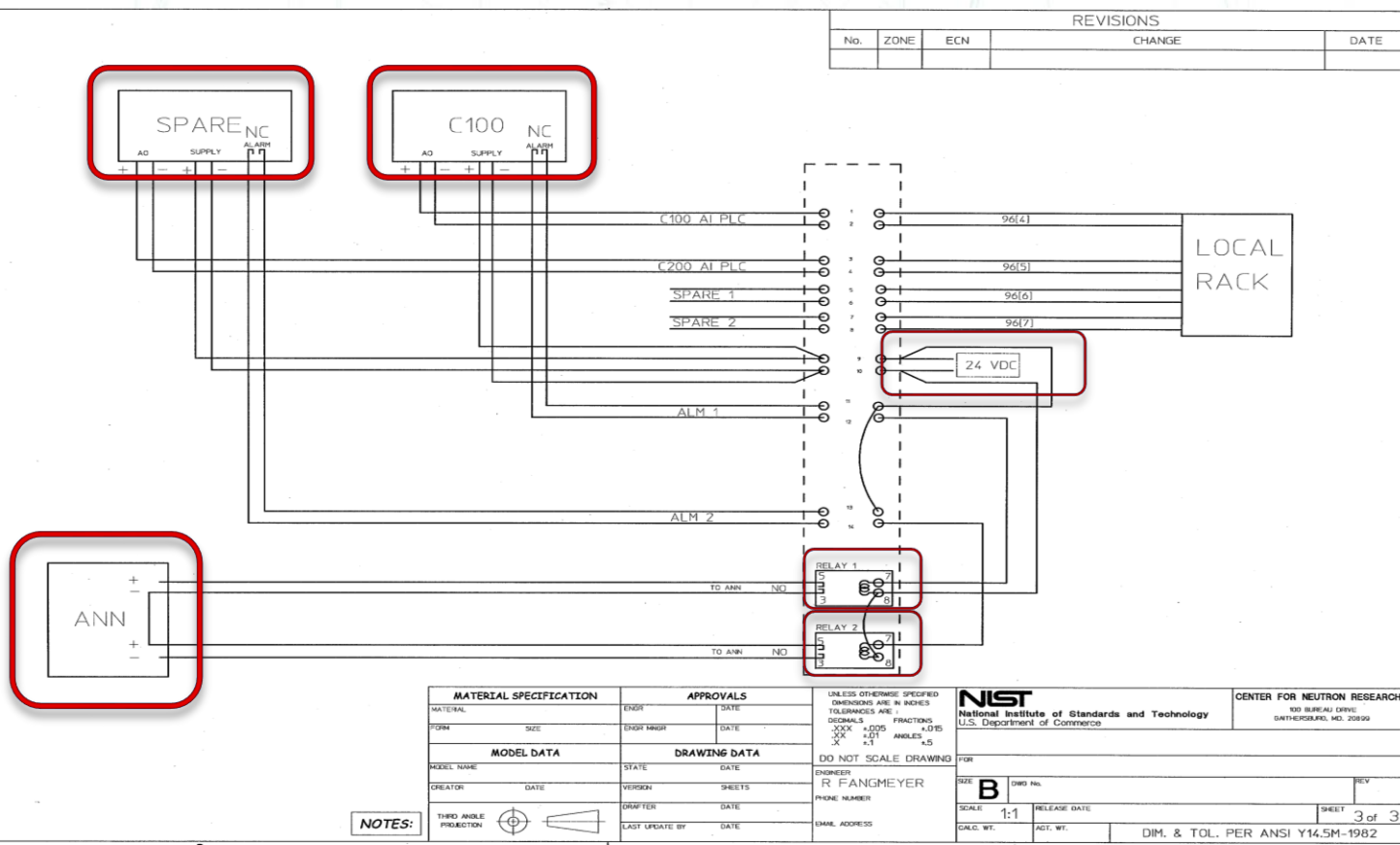
- ▶ Project was to install Oxygen Deficiency Monitors In confinement
- ▶ Used to warn and protect researchers in Confinement
- ▶ Long life zirconium oxide sensor cell

Zirconium oxide sensor



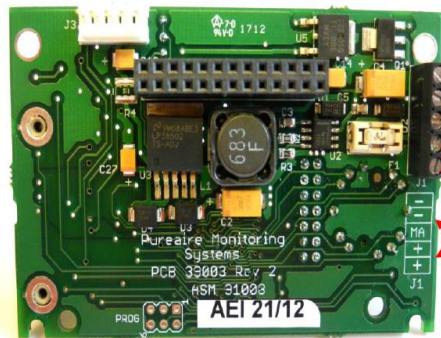
Wiring Diagrams

- ▶ Created diagrams for installation purposes
- ▶ Relays are N.O., alarm contact is N.C.
- ▶ Multiple iterations changed over time

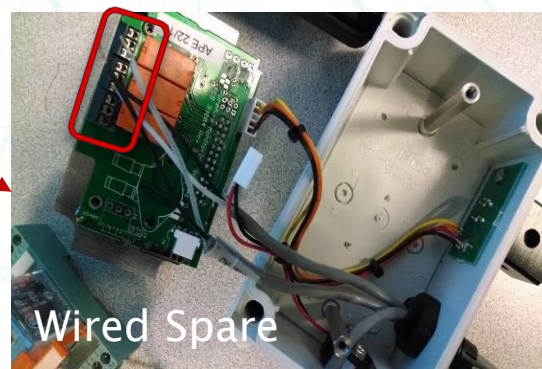
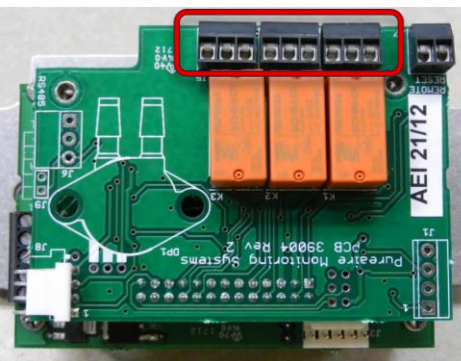


Spare Preparation

- ▶ Wiring of the spare monitor before shutdown occurred
- ▶ Labels attached to each wire for ease of installation and future changes

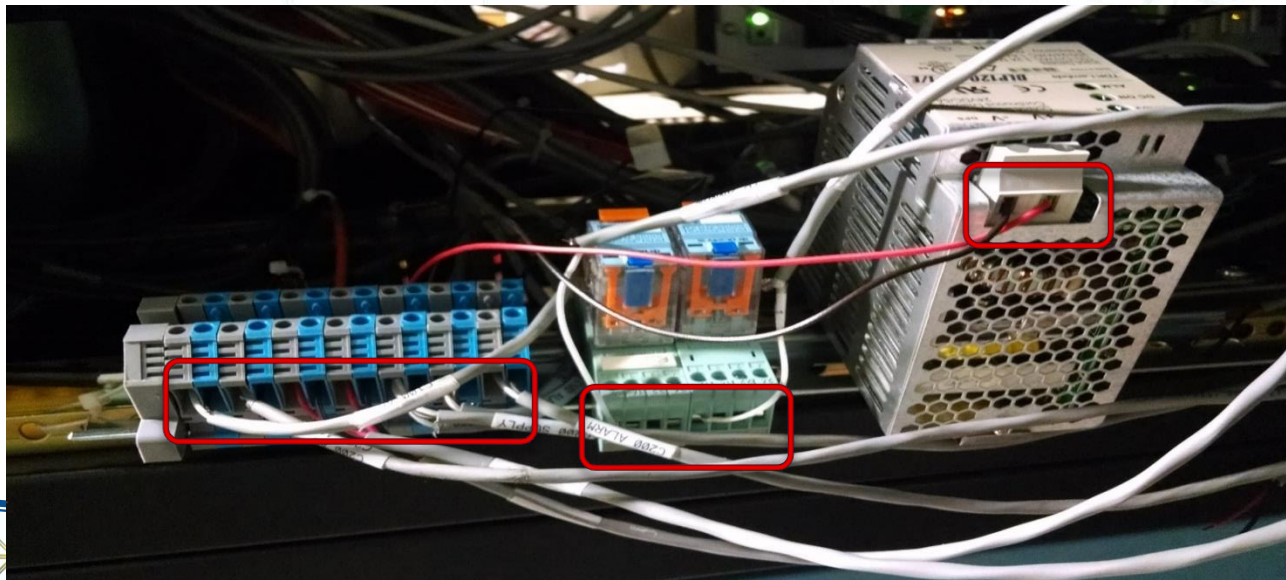


- Common
 - Common
 - mA* 4-20mA signal output to PLC
 - + 24VDC Power
 - + 24VDC Power
- Identification Legend



Shutdown Installation

- ▶ Placement of C100 and spare monitor
- ▶ Spare monitor placement is temporary
- ▶ Wires will be run to C200 from C100 for the existing C200 monitor



Calibration

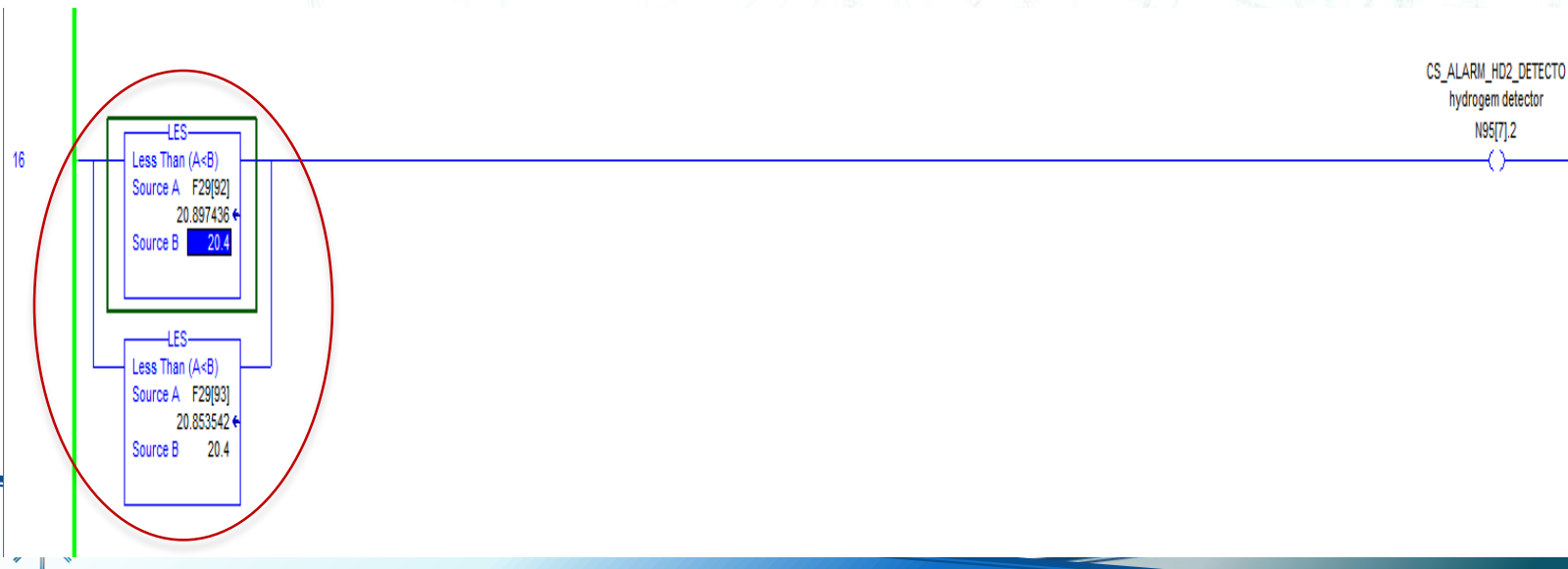
- ▶ Calibrated the sensors to atmospheric oxygen levels of 20.9% O₂
- ▶ Changed alarm threshold to 19.5% O₂
- ▶ Changed alarm delay to minimum .005 seconds



Sensor before calibration

Programming

- ▶ Created tags for the C100 monitor and the spare monitor
- ▶ Programmed PLC to read Analog Output
- ▶ Created a screen interface displaying O₂ levels.
- ▶ Changed the existing code to represent the 20.4% O₂ warning threshold



Operational Testing

- ▶ Operational Test
- ▶ Helium Test
- ▶ Verification of all alarms
- ▶ Complete immersion of sensor

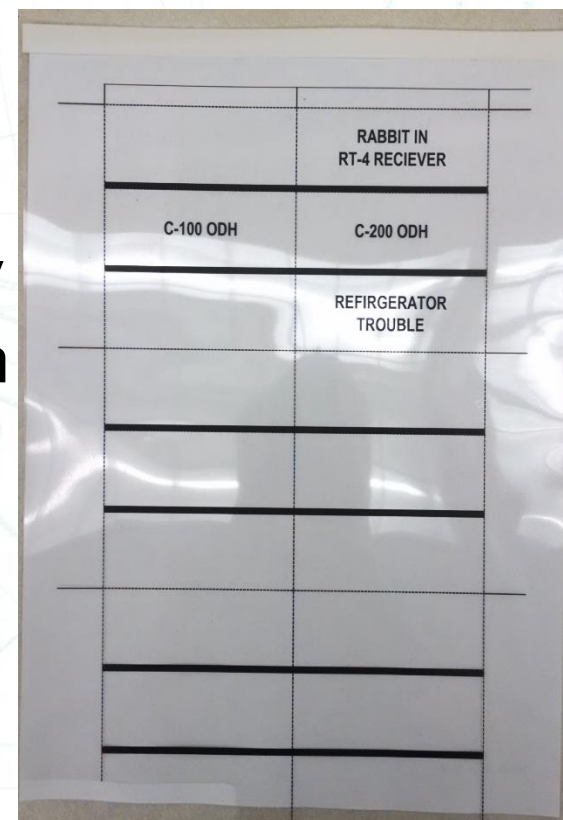


Usage

- ▶ C100 Monitor permanently installed
- ▶ Monitors controlled with software and PLC
- ▶ 20.4% warning only used
- ▶ C200 monitor will be ready before the new refrigerator

Finalization and Future

- ▶ Engineering change notice (ECN) follow-up
 - Overall summary
 - Safety Evaluation
 - Related documents
- ▶ Annunciator not available currently
 - Alarm at 19.5% requires evacuation



Annunciator
slots
included in ECN

Acknowledgments

- ▶ Michael Middleton
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NIST

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