NIST Center for Neutron Research

CHRNS
CENTER FOR HIGH RESOLUTION NEUTRON SCATTERING
NSF
NIST

Upgraded Helium Refrigerator

Ryan Fangmeyer

NIST

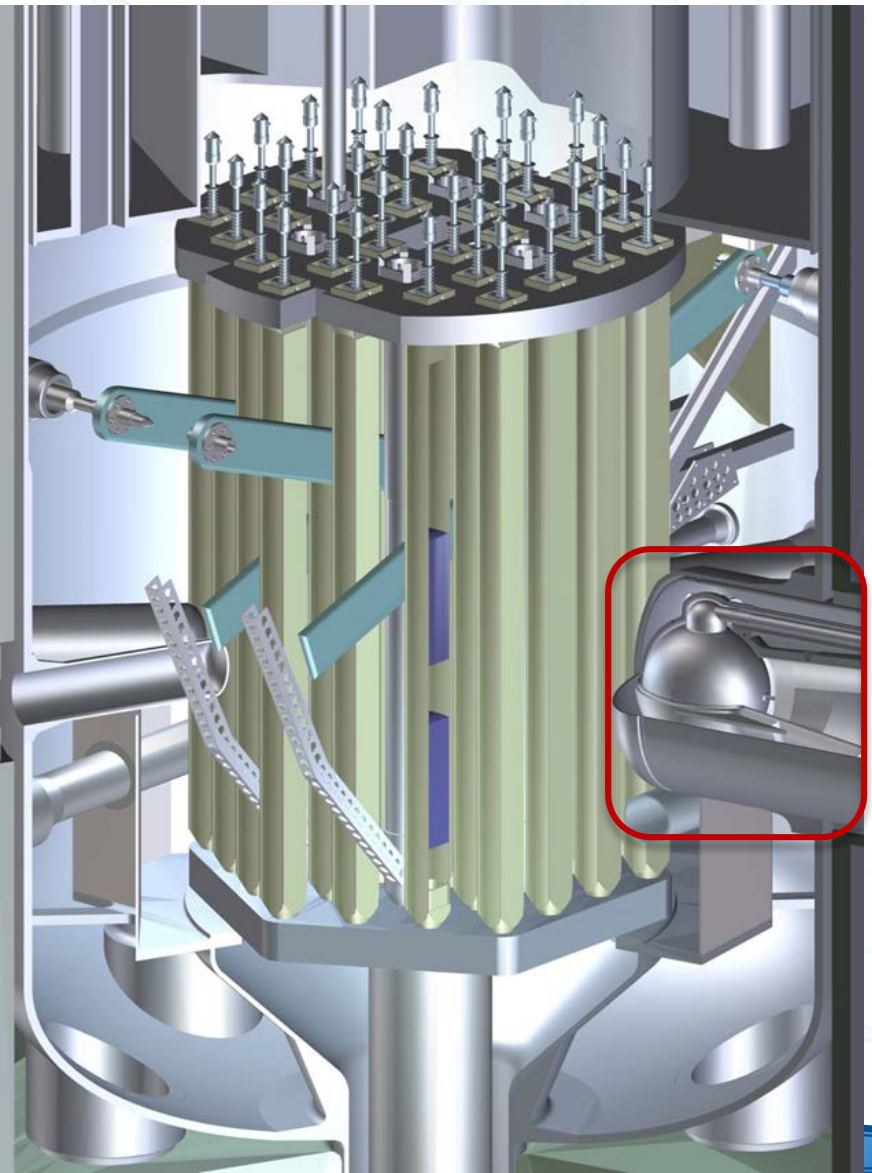
Background

- Conversion to Low Enriched Uranium (LEU)
- Replacing existing hydrogen cold source with deuterium cold source
- New cold source has increased heat load and requires upgraded 7kW helium refrigerator
- New refrigerator received from EDEN Cryogenics uncompleted
  - NCNR will complete and start up the refrigerator

Importance

- Maintaining standards of the NCNR
- Vital to the mission of the NCNR
- Improving the quality of the cold neutrons supplied to the researchers

Creation of New Cold Source



- Existing hydrogen cold source is being replaced with more efficient deuterium cold source
- The deuterium cold source will compensate for the loss in flux
- The entirety of the system is being upgraded

Helium Refrigerator Background

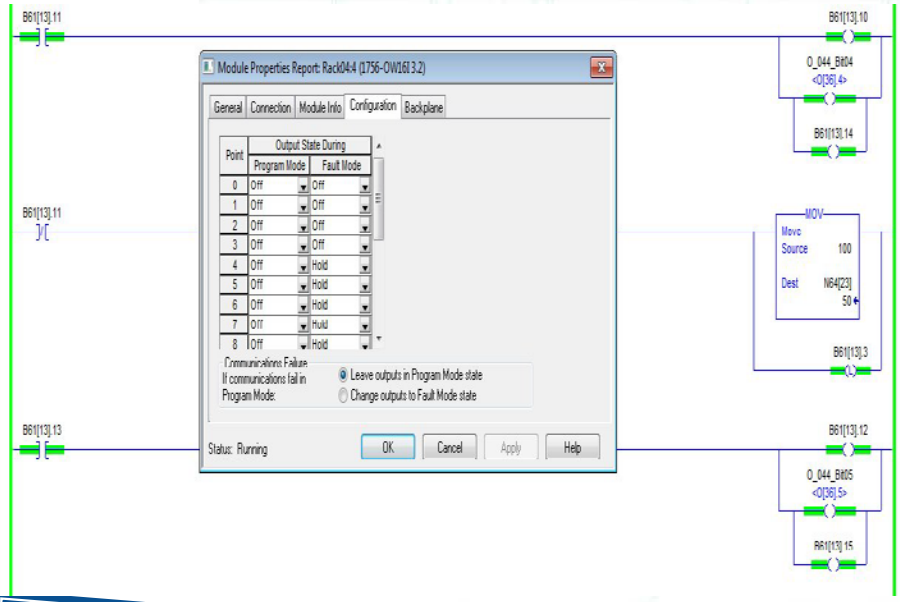
- Helium refrigerant
- Pressure drop turbine allows for greater temperature drop
- Must be enclosed in vacuum
  - (10^{-6} Torr)
- Supplies cold helium to the condenser which condenses the deuterium gas

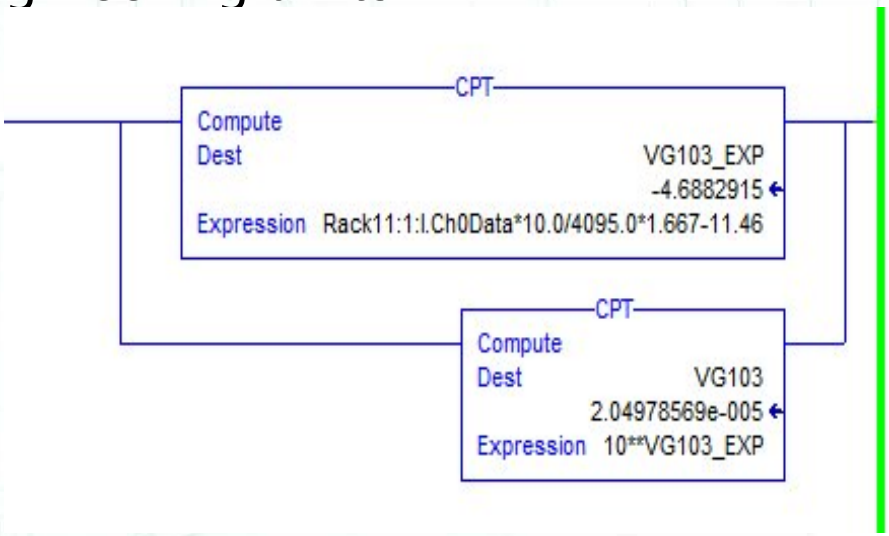
Project Summary

- Programming
  - Programmable Logic Controller
- Human Machine Interfaces
  - Display screens, Alarm, and Bypass screens
- Electrical
  - Wiring, Diagrams, Instrumentation, Air Actuated Control Valves
- Mechanical
  - Turbomolecular Pump

Programming & PLC

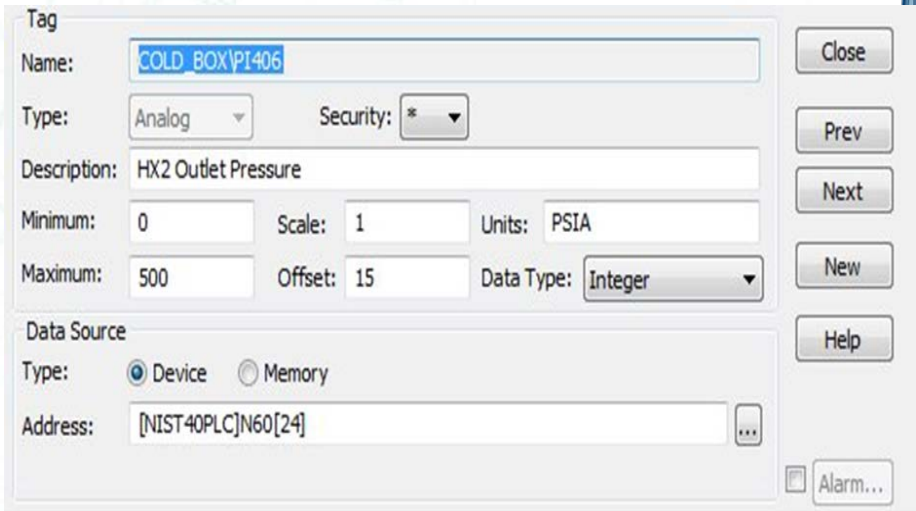
- Ladder logic software
- Inputs vary from 4-20mA, 0-10V, or 1-5V which are converted to counts
- Counts are used to create engineering units

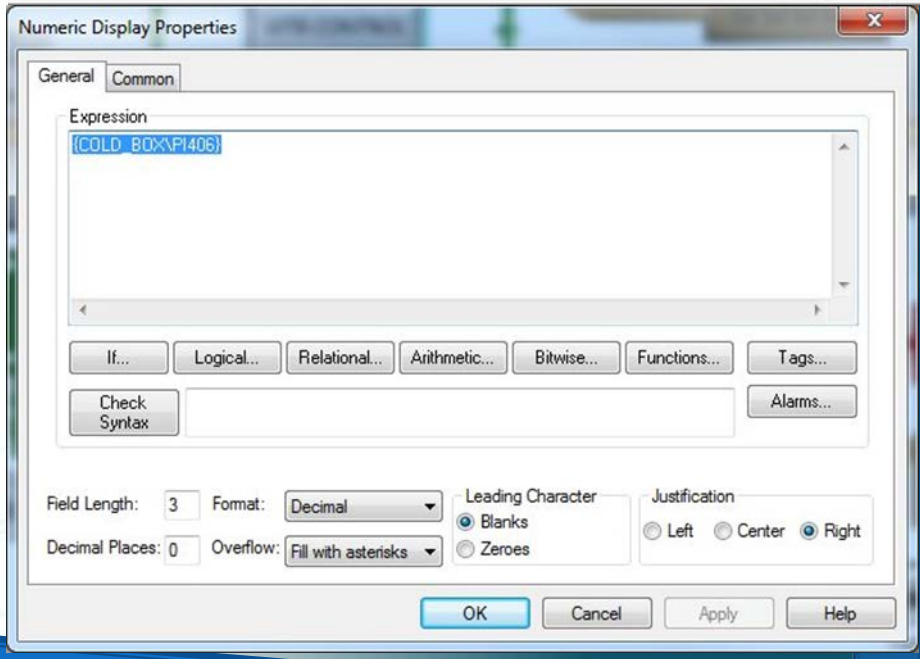




Human Machine Interfaces

- Visual representations of instruments and systems for the reactor operators and engineers
- Uses memory variables called tags to interact with the PLC memory
- Compressor Room/Alarm screen/Bypass screen





System Status

ALARMS BYPASSED

Compressor Status

Selected Compressor	UNIT 2
Auxillary Contact	Motor ON
Compressor Power	Unit2 OK
Refrigerator Status	Normal
Cooldown Sequence	0

Coldbox Status

Helium Flow	123	g/sec
He Discharge	212	PSIA
Turbine Speed	81	k RPM
Turbine Inlet	20.7	K
Turbine Fault	0	

Cold Source Temperature

C100 20.6 %O2	UNIT 2 / BT-9
C200 20.4 %O2	
Condenser Outlet	21.7 K/ 24.7 K
Moderator Vessel	36.0 K/ 42.0 K
Cyrostat Assembly	33.0 C

CS CryoWord 1

1 P5 OOR	Clear
2 TCRYO	Clear
3 P11 LO	Clear
4 P12 OOR	Clear
5 P13 OOR	Clear
8 P1A OOR	Clear
9 TD20 HI	Clear
10 P1B OOR	Clear
11 TCOND HI	Clear
12 TCOND HI	Clear
13 TCOND HI	Clear
14 RACK ERR	Clear

CS CryoWord 2

15 Vac Fail	Clear
16 C100 H2	Clear
17 C100 O2	Clear
18 C200 O2	Clear
19 VAC PWR	Clear
20 FD2O LO	Clear
21 FD2O LO	Clear
22 P1A ERR	Clear
23 P1B ERR	Clear
24 VAC ERR	Clear
25 HE ERR	Clear
26 VAC TEMP	Clear

PW CryoWord 3

27 P105 OOR	Clear
28 P108 OOR	Clear
29 P106 LO	Clear
30 P112 OOR	Clear
31 P113 OOR	Clear
34 P101A OOR	Clear
35 PW TD2O HI	Clear
36 P101B OOR	Clear
37 PW TCOND HI	Clear
38 PW TCOND HI	Clear
39 PW TCOND HI	Clear
40 PW RACK ER	Clear

PW CryoWord 4

41 PW VAC FAIL	Clear
42 D200 H2	Clear
43 PW VAC PWR	Clear
44 PW FD2O LO	Clear
45 PW FD2O LO	Clear
46 P101A ERR	Clear
47 P101B ERR	Clear
48 PW VAC ERR	Bypass
49 PW HE ERR	Clear
50 PW TCRYO	Not Active
51 Turbo Pump Err	Active Alarm

Cold Source Status

Reactor Power	2E-4 MW
CS Cryo Status 1	Normal
CS Cryo Status 2	Normal
PW Cryo Status 1	Normal
PW Cryo Status 2	

Unit2 (Hydrogen Pressure) BT-9

P1A 88.0 kPa		P101A 192.5 kPa	
P1A50A -3.51 psig		P1A50C 11.6 psig	
P1B 95.7 kPa		P101B 188.1 kPa	
P1A50B -2.39 psig		P1A50D 11.0 psig	

Unit2 (Vacuum) BT-9

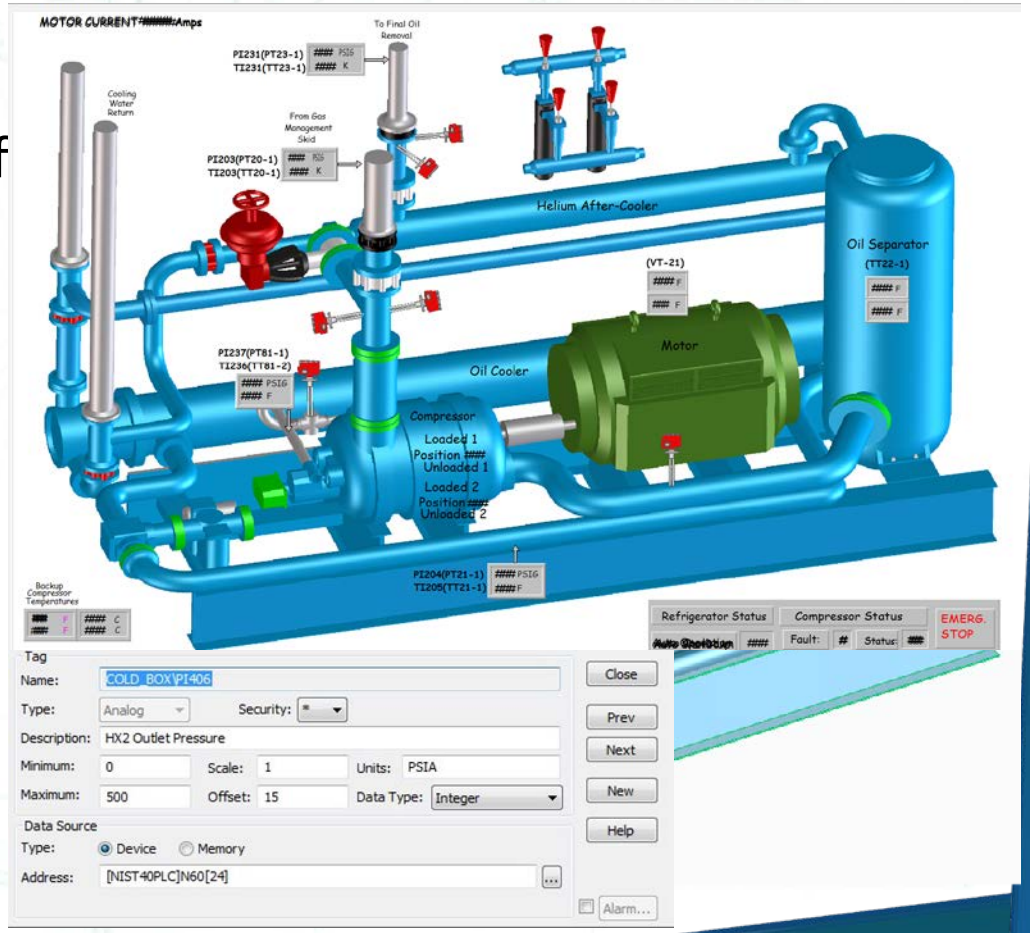
UNIT 2 CS NORMAL VACUUM	Vac. Skid Condenser Cryostat	PEEWEE NORMAL VACUUM

Hydrogen Detectors % LFL

D200	0.0	D100	0.0		
CS	0.0	PW	0.0	PWBT	0.0

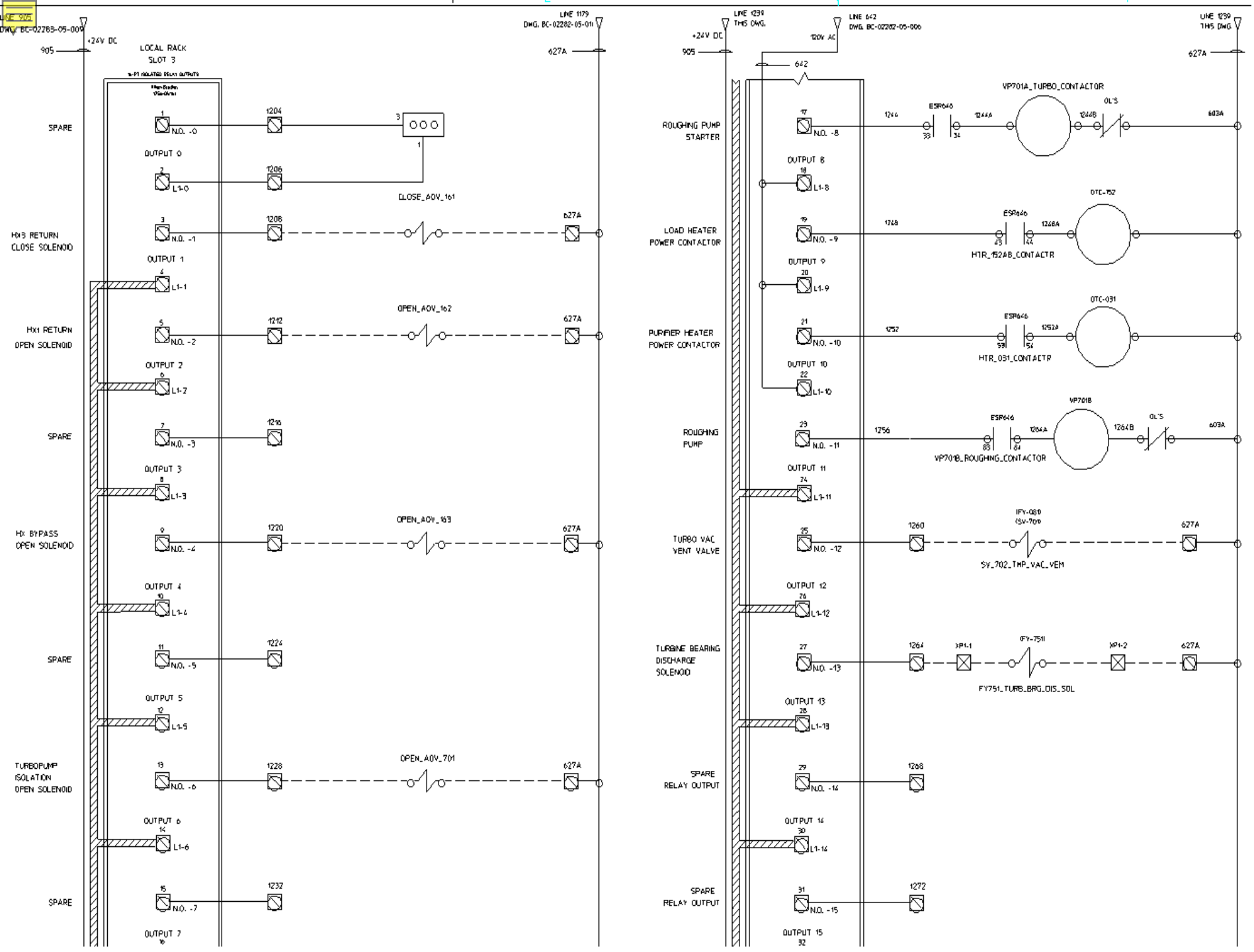
Creation of Display Screens

- Begins with creation of CAD model of unit
- High Resolution Print to .tiff file
- Conversion to Factory Talk wallpaper
- Creation of tags for each instrument
- Placement of display components for data values



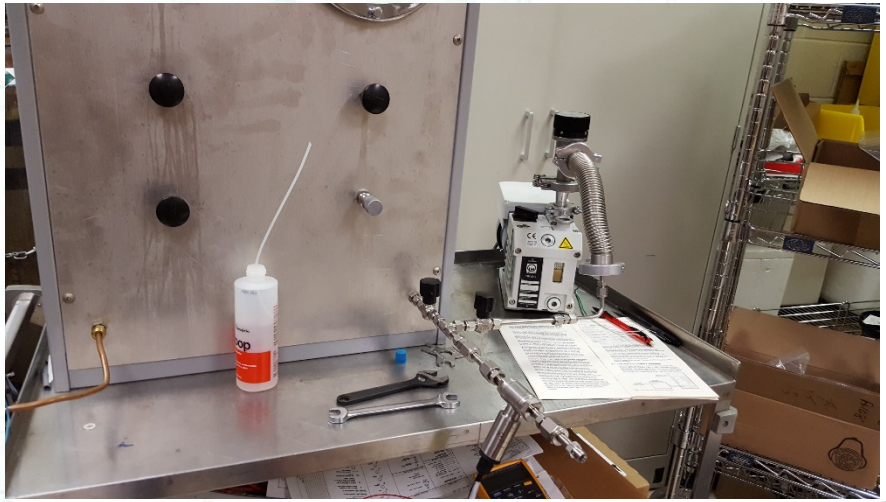
Electrical & Diagramming

- Wiring of several controls, actuators, transmitters, and PLC connections
- Wiring diagrams kept up to date
- Determining the installation of specific instruments
  - (research/contacting people/verifying wiring)


LINE 1179
DWG. BC-02282-05-011
LINE 1239
THIS DWG.
LINE 642
DWG. BC-02282-05-006
LINE 1239
THIS DWG.
+24V DC
905
LOCAL RACK
SLOT 3
+24V DC
120V AC
642
627A
SPARE
OUTPUT 0
L1-0
1204
1206
CLOSE_AOV_161
HX3 RETURN
CLOSE SOLENOID
OUTPUT 1
L1-1
1208
HX1 RETURN
OPEN SOLENOID
OPEN_AOV_162
1212
OUTPUT 2
L1-2
SPARE
1216
OUTPUT 3
L1-3
HX BYPASS
OPEN SOLENOID
OPEN_AOV_163
1220
OUTPUT 4
L1-4
SPARE
1224
OUTPUT 5
L1-5
TURBOPUMP
ISOLATION
OPEN SOLENOID
OPEN_AOV_701
1228
OUTPUT 6
L1-6
SPARE
1232
OUTPUT 7
ROUGHING PUMP
STARTER
VP701A_TURBO_CONTACTOR
ESR646
OL'S
1244
1244A
1244B
603A
OUTPUT 8
L1-8
LOAD HEATER
POWER CONTACTOR
OTC-152
1248
1248A
HTR_152AB_CONTACTR
OUTPUT 9
L1-9
PURIFIER HEATER
POWER CONTACTOR
OTC-031
1252
1252A
HTR_031_CONTACTR
OUTPUT 10
L1-10
VP701B
ROUGHING
PUMP
1256
1264A
1264B
VP701B_ROUGHING_CONTACTOR
OUTPUT 11
L1-11
TURBO VAC
VENT VALVE
IFY-080
ISV-700
1260
SV_702_TMP_VAC_VEM
OUTPUT 12
L1-12
TURBINE BEARING
DISCHARGE
SOLENOID
XP1-1
IFY-751
XP1-2
FY751_TURB_BRG_DIS_SOL
OUTPUT 13
L1-13
SPARE
RELAY OUTPUT
1268
OUTPUT 14
L1-14
SPARE
RELAY OUTPUT
1272
OUTPUT 15

Electrical & Testing

- Pressure testing of transducers, solving problem with continuity
- Must determine varied input the PLC will read based on pressure



Electrical & Troubleshooting

- Air Actuated Control Valves
  - Calibration, troubleshooting, programming of limit switches
  - Digital limit switches or mechanical limit Switches
  - High or low digital readings

Mechanical Installations

- Turbomolecular pump
  - Conduit created and installed
  - Terminal box created, pinned, then wired
  - Create PLC interface

Conclusions

- Refrigerator is closer to operation
- Turbine instrumentation installation completed
- Vacuum system is now operational
- Control valves are now operating properly
- HMI display more comprehensive

Future Work

- Compressors operational
- Flowing helium, completing cold box, cooling helium
- Replacing the operating refrigerator
- Expected to be commissioned in 2017

Acknowledgements

Michael Middleton

Bryan Eyers

Dennis Nester

Sean Mullendore

Dr. Julie Borchers

Dr. Joseph Dura

National Science Foundation – CHRNS