NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE

Development of an Intelligent Monitoring System for the Cold Neutron Source Cryogenics System

Zoë Masters

Mentor: Robert Newby

August 15th, 2024

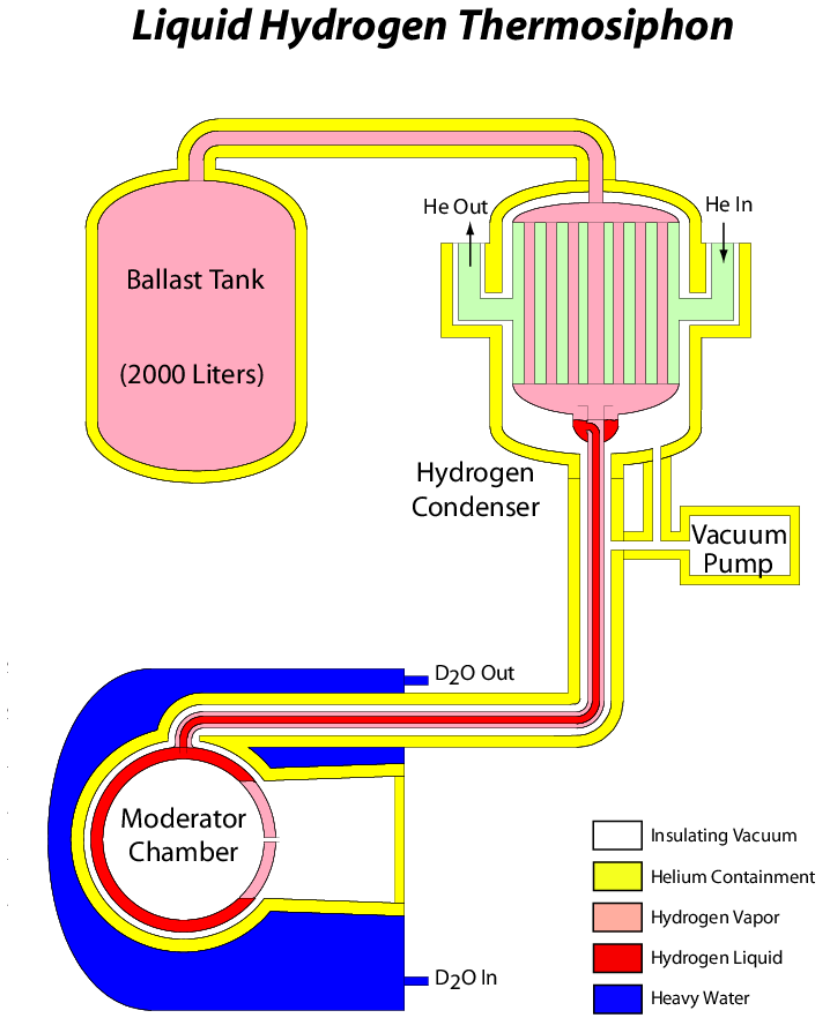
CENTER FOR NEUTRON RESEARCH

Outline

- Cold Source Background
- Project Overview
- Decision Trees
- Current State
- Conclusion

Background

- What is a cold source?
  - Slows down neutrons for use in experiments using a moderator
  - System is made up of multiple components spread throughout the facility
  - Current system was installed in 2002 and updates have continued to make it more automated



Kopetka, P. , Williams, R. and Rowe, J. (2006), NIST liquid hydrogen cold source:, , National Institute of Standards and Technology, Gaithersburg, MD, [online],

Project Overview

- Goal was to create a graphical user interface (GUI) application that can guide operates through an alarm
- Giving a guide so a non-technical person can identify and start to isolate cause of the alarm
  - This will minimize calling the engineer right away to fix the problem and improve efficiency

The Why

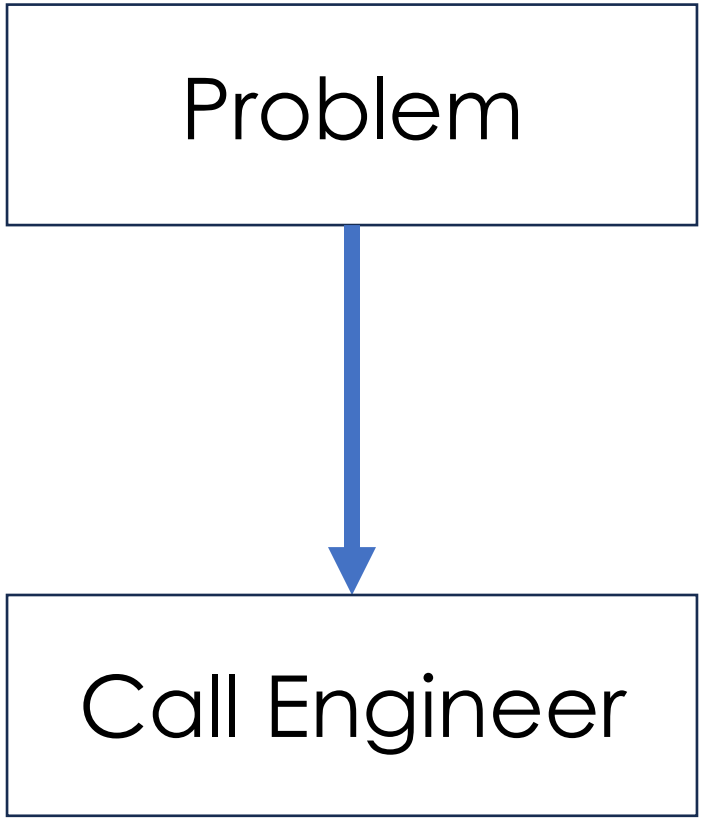
- What happens when something goes wrong with the system?
  - There is a 20-minute window to rectify the issue
  - If problem isn't solved, minimum downtime is 48 hours
  - Some issues require getting to the physical location of the equipment to fix
  - Panic?
- Less downtime means more science and engineering

The Process

- Started with learning about how the components of the systems work together
- Didn’t want to create something that needs another set of directions and further complicate things
- Needs to be clear, concise, and intuitive

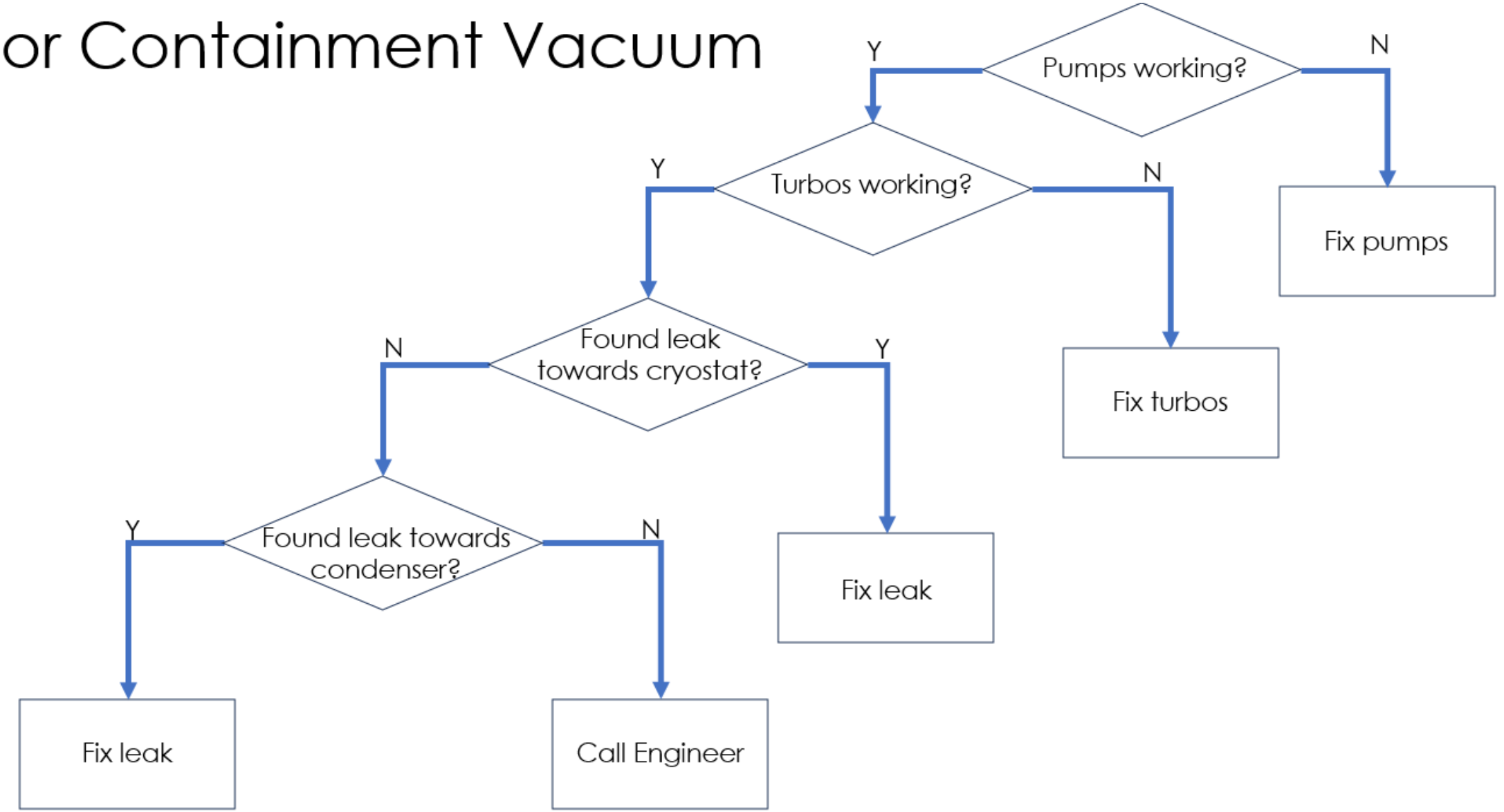
- Using Python as there are programs already written and it doesn’t require third party software

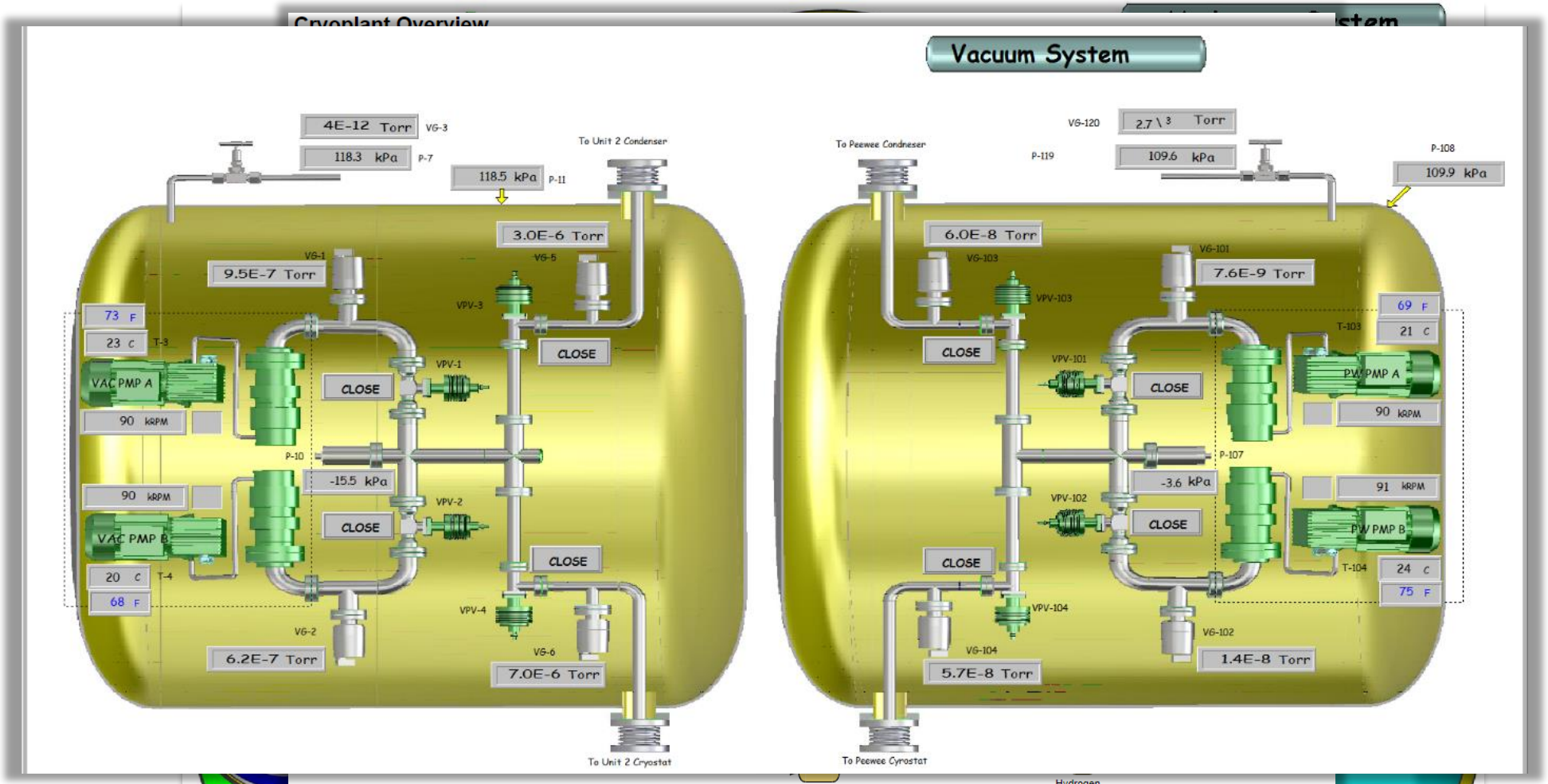
Decision Trees



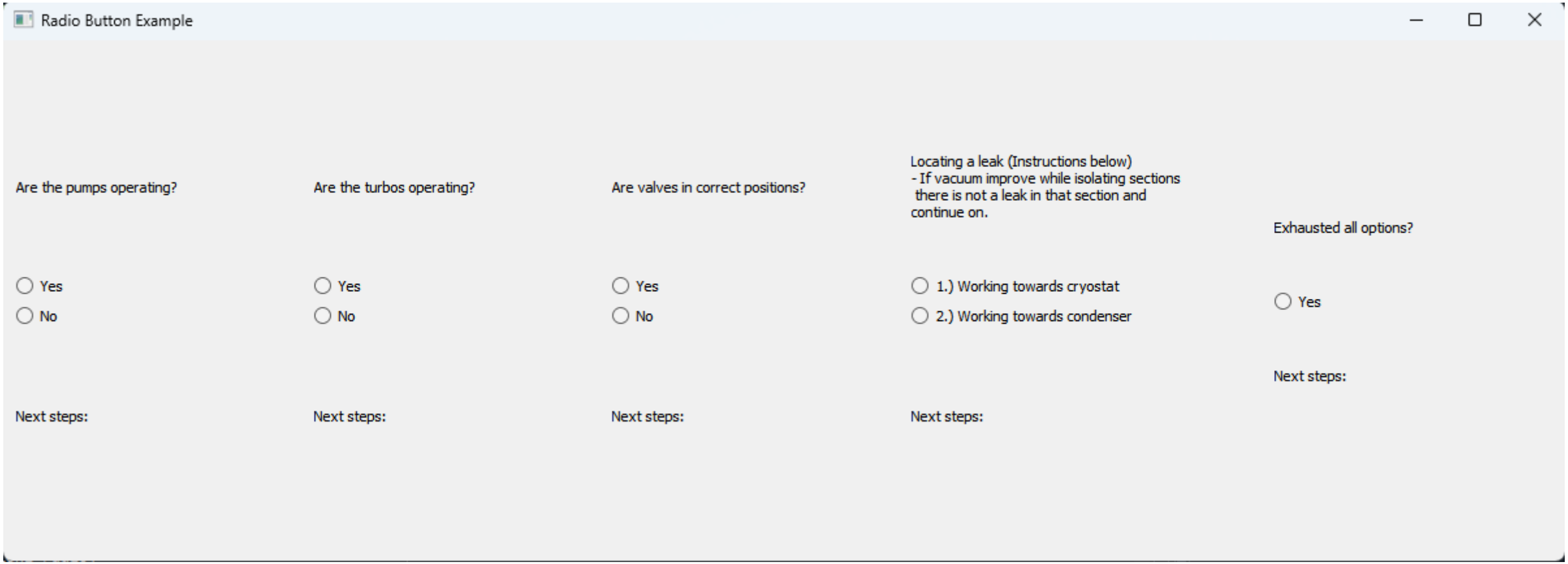
Decision Trees

Poor Containment Vacuum

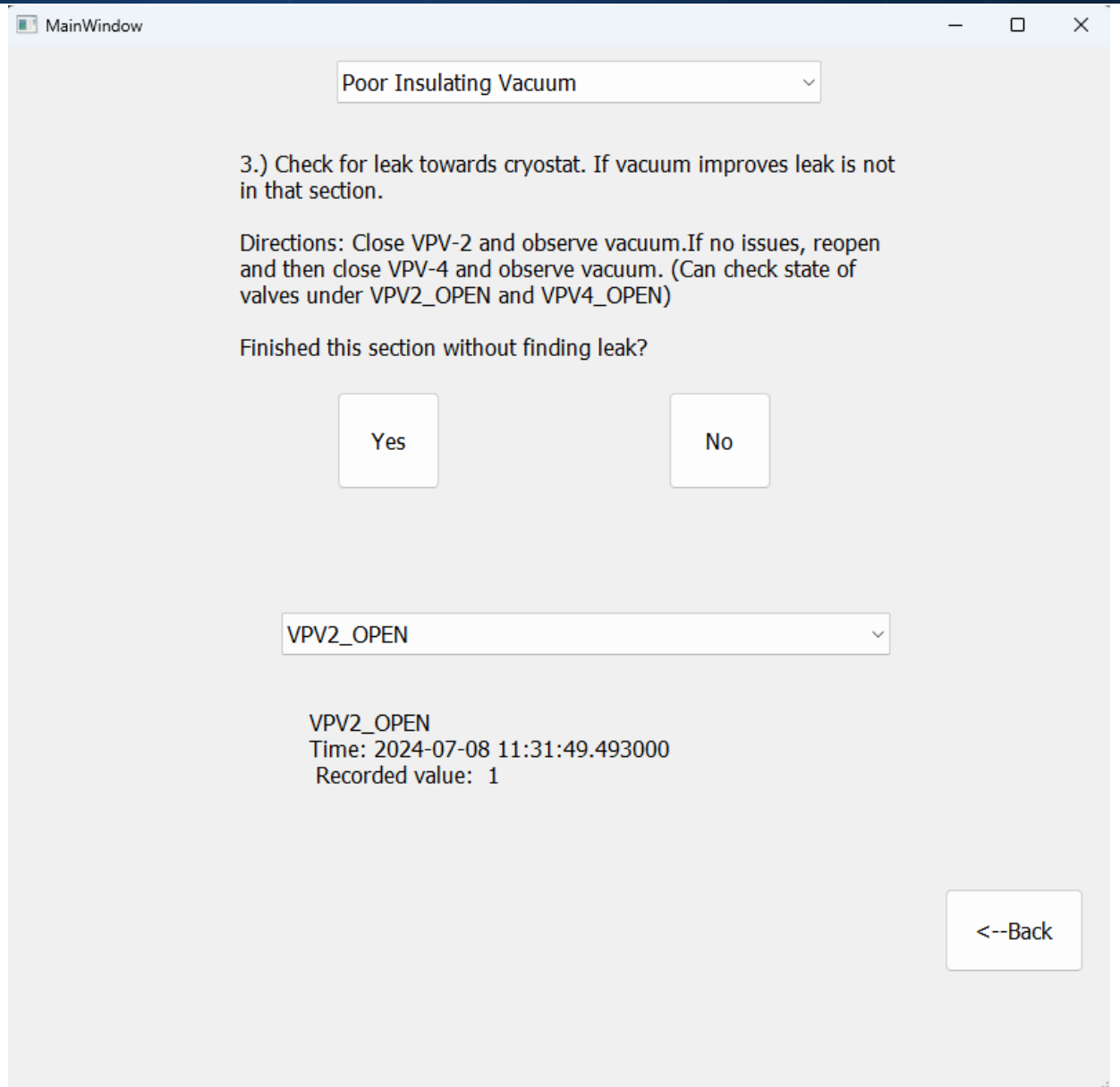



Vacuum System
4E-12 Torr
VG-3
118.3 kPa
P-7
118.5 kPa
P-11
To Unit 2 Condenser
3.0E-6 Torr
VG-5
VG-1
9.5E-7 Torr
VPV-3
73 F
23 C
T-3
CLOSE
VPV-1
VAC PMP A
90 kRPM
P-10
-15.5 kPa
90 kRPM
VAC PMP B
20 C
68 F
T-4
CLOSE
VPV-2
CLOSE
CLOSE
VPV-4
VG-2
6.2E-7 Torr
VG-6
7.0E-6 Torr
To Unit 2 Cryostat
To Peewee Condneser
VG-120
2.7 \ 3 Torr
P-119
109.6 kPa
P-108
109.9 kPa
6.0E-8 Torr
VG-103
VG-101
7.6E-9 Torr
VPV-103
69 F
21 C
T-103
CLOSE
VPV-101
CLOSE
PW PMP A
90 kRPM
P-107
-3.6 kPa
91 kRPM
VPV-102
CLOSE
PW PMP B
CLOSE
T-104
24 C
75 F
VPV-104
VG-102
VG-104
5.7E-8 Torr
1.4E-8 Torr
To Peewee Cyrostat
Hydrogen ballast tank
Hydrogen ballast tank
Last Update: 2024-07-19 18:50:56

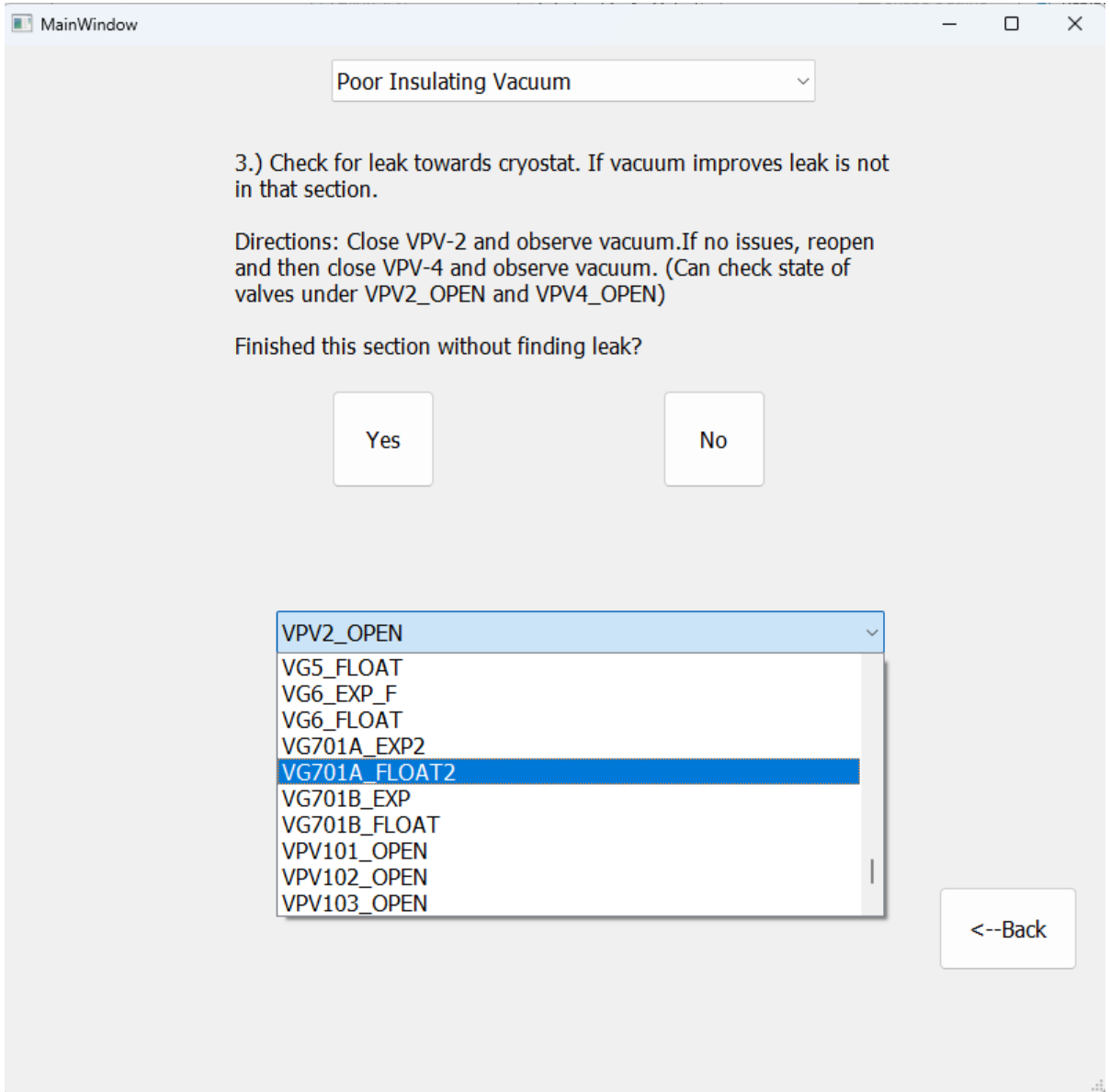
First Iteration



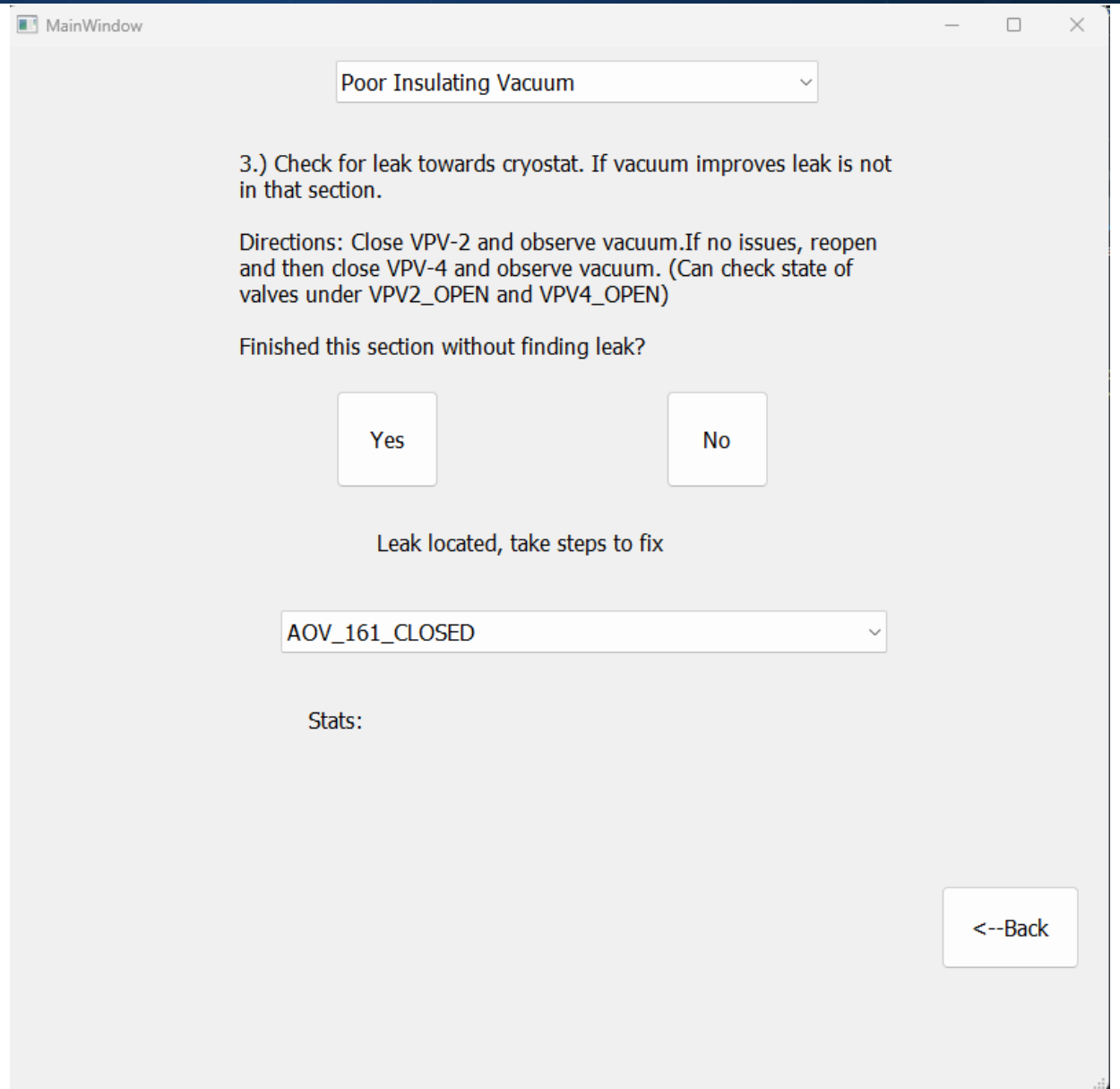
Current Form



Current Form



Current Form



Current State

- 2 trees implemented in the code
  - Abnormal He Containment Pressure
  - Poor Containment Vacuum
- Code is structured and commented to easily add future trees to continue to expand the scope
- Was able to incorporate data from SQL database that pulls most recent sensor states

Conclusion

- Future work includes:
  - Creating more decision trees for other alarm scenarios
  - Testing in system and evaluate effectiveness

- Acknowledgements:
  - Robert Newby
  - SURF Directors: Julie Borchers, Susana Teixeira, Leland Harriger, and Cara O'Malley
  - NSF
  - CHRNS

Questions?

NIST CENTER FOR NEUTRON RESEARCH

CHRNS CENTER FOR HIGH RESOLUTION NEUTRON SCATTERING NSF NIST