Tech Expo, Spring/Fall 2025 – Team 6 and 7

High Pressure Seal Test Bench

BLACK HAWK SEALS®

Team 6: Max Yoder, Ethan Adams, Aditya Kasture, Aditya Panday
Team 7: Cort Marburger, Kaiden Miller, Andrew Hsieh
Mentor: Professor Jose Garcia

Problem Statement

This project aims to solve the problems found in the previous group from last year: maintaining a desired temperature with the heating system, improving safety measures at the bench, looking to improve design issues in the hydraulic system, update and improve the control system.

Customer Background

Black Hawk Seals is a manufacturer of seals for the fluid power industry, that requires testing data for their seals. Over various years teams have worked on testing their seals and improving the data collection methods. They need a reliable easy to use testing system that allows them to see how their seals hold up under different pressure and temperature readings. They should also be able to understand the results of their manufacturing process.

Requirements

The test system need to be able to perform the following:

1. Accuracy - running the test within 10F of the desired range
2. Ability to heat up the oil to 250F
3. Ability to maintain up to 5k psi
4. Able to run up to 10k cycles, non-stop
5. Ability to record pressure & temperature during the test in a user friendly matter.

As for the test bench improvements:

1. Improving safety by allowing the bench to be remotely controlled via a webhook
2. Minimize the contact between the test bench and the operator
3. Store and record the data remotely in an SQL database with context.

Experimentation and Concepts

We had a previous test bench that while semi-functional, had a great deal of experimentation to do.

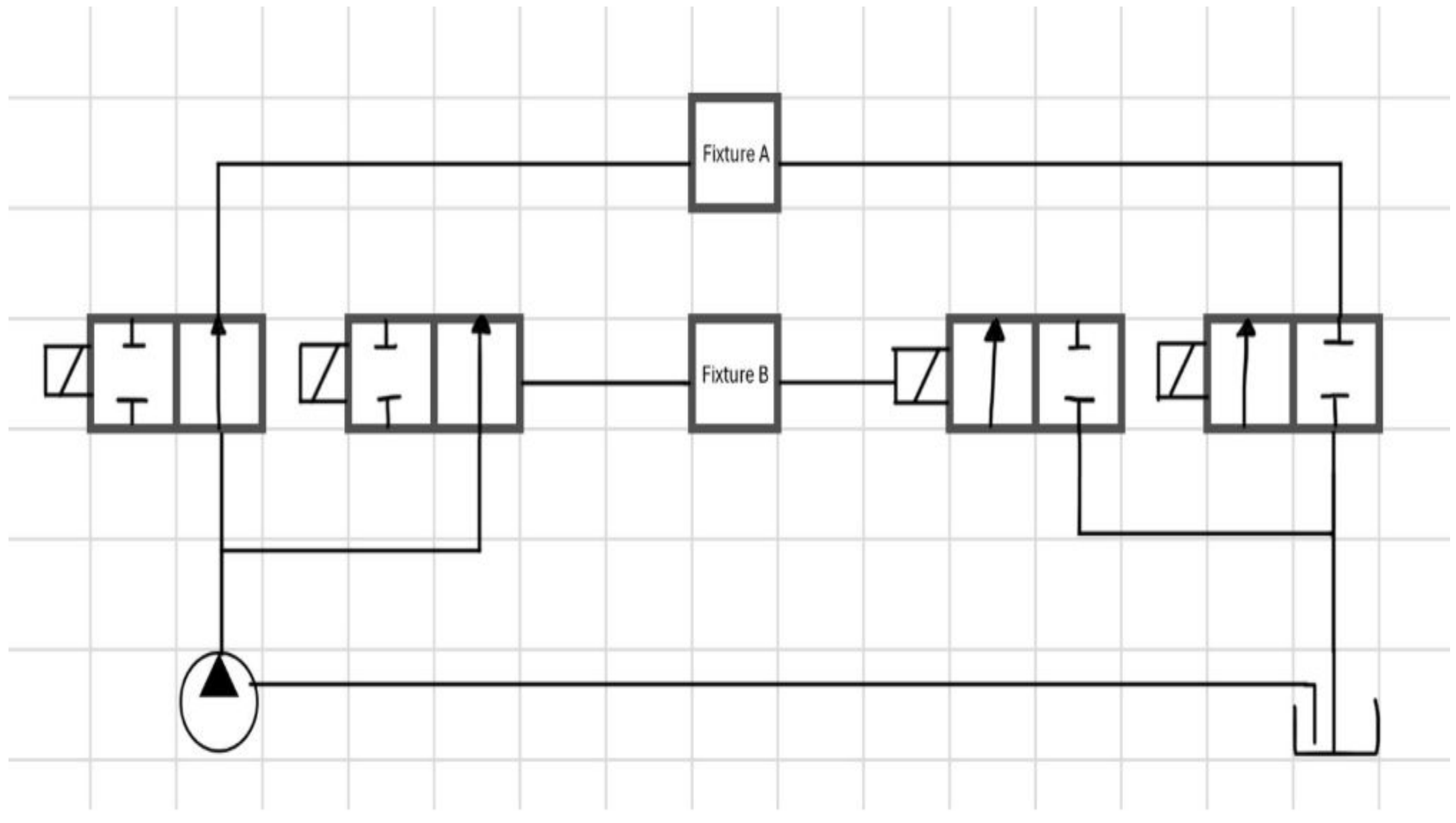
First our data collection system was quite cumbersome, we could not directly get the data off the NI LabView installation and there was no context about the test. Our first concept was using a Rockwell HMI system, however while this would be safer and easier to control - getting data out would be cumbersome. Secondly with the server we had to determine the architecture. We could simply directly export to SQL, but that would hardly be user friendly and would require a great deal more of training.

On the hydraulics side of things we were looking to greatly simplify our nest and add less elements. We needed heating of the oil to be done with one element that would not lose any heat. We looked into various methods, like a microwave and induction heater.

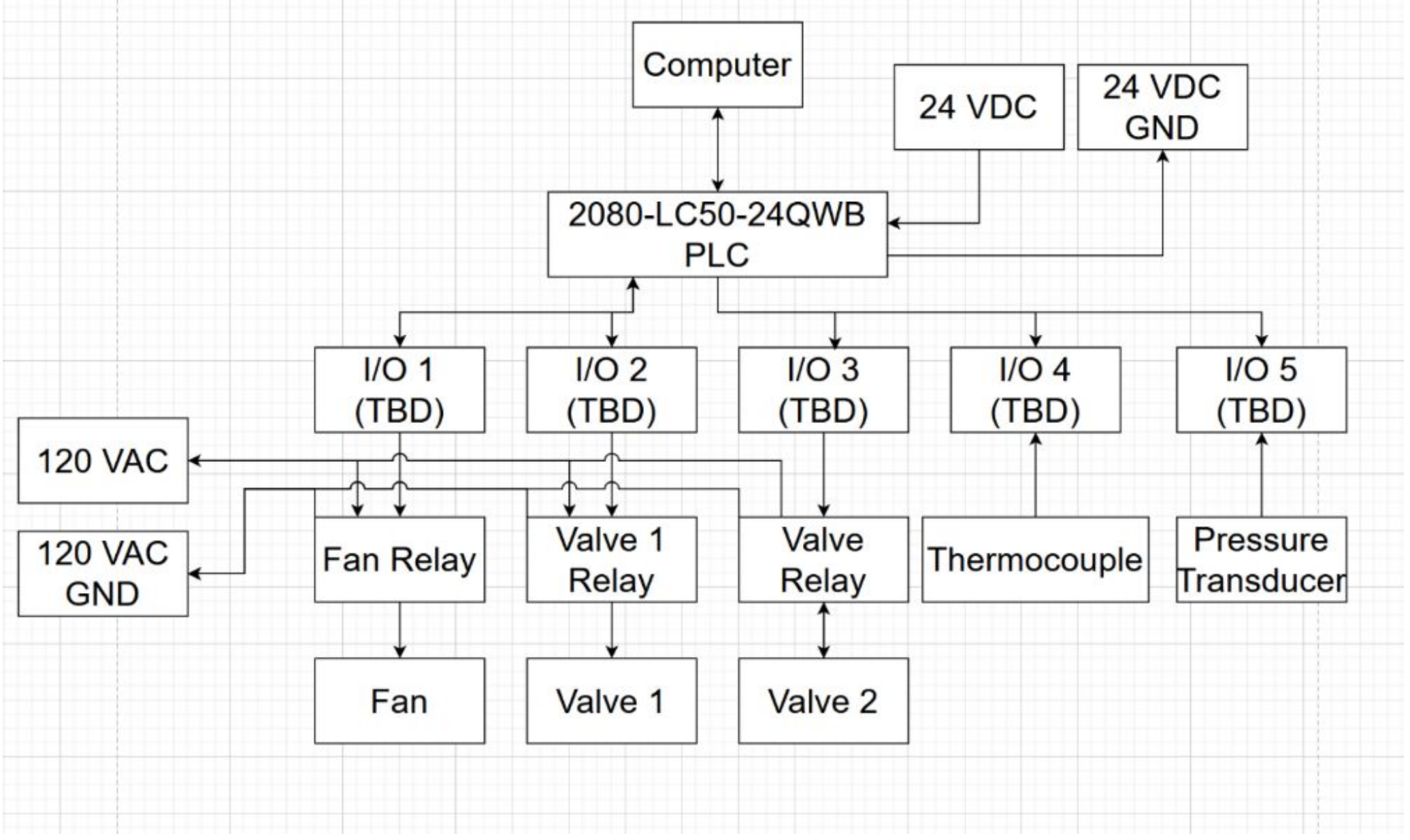
Final Design

For our final design we settled on connecting our pump and bench to a PLC setup connected to a Node.js server with an SQL backend. The Node.js server enables the remote control, measurement, and actuation of the pump, valve, etc. while the SQL backend allows proper organization of the test data. With this setup our data is all organized and can be easily shared and accessed. We can also contain information like Lot Number, Date of Manufacture, etc with the test to allow the firm to know about defects in their process.

On the hydraulics side we built a much more simple bench that is all controlled by a PLC and a few relays. The PLC can turn on and off the relays through bits, which enables much easier control. If we want to extend it in the future with say a heating rod, it will be easier to implement.

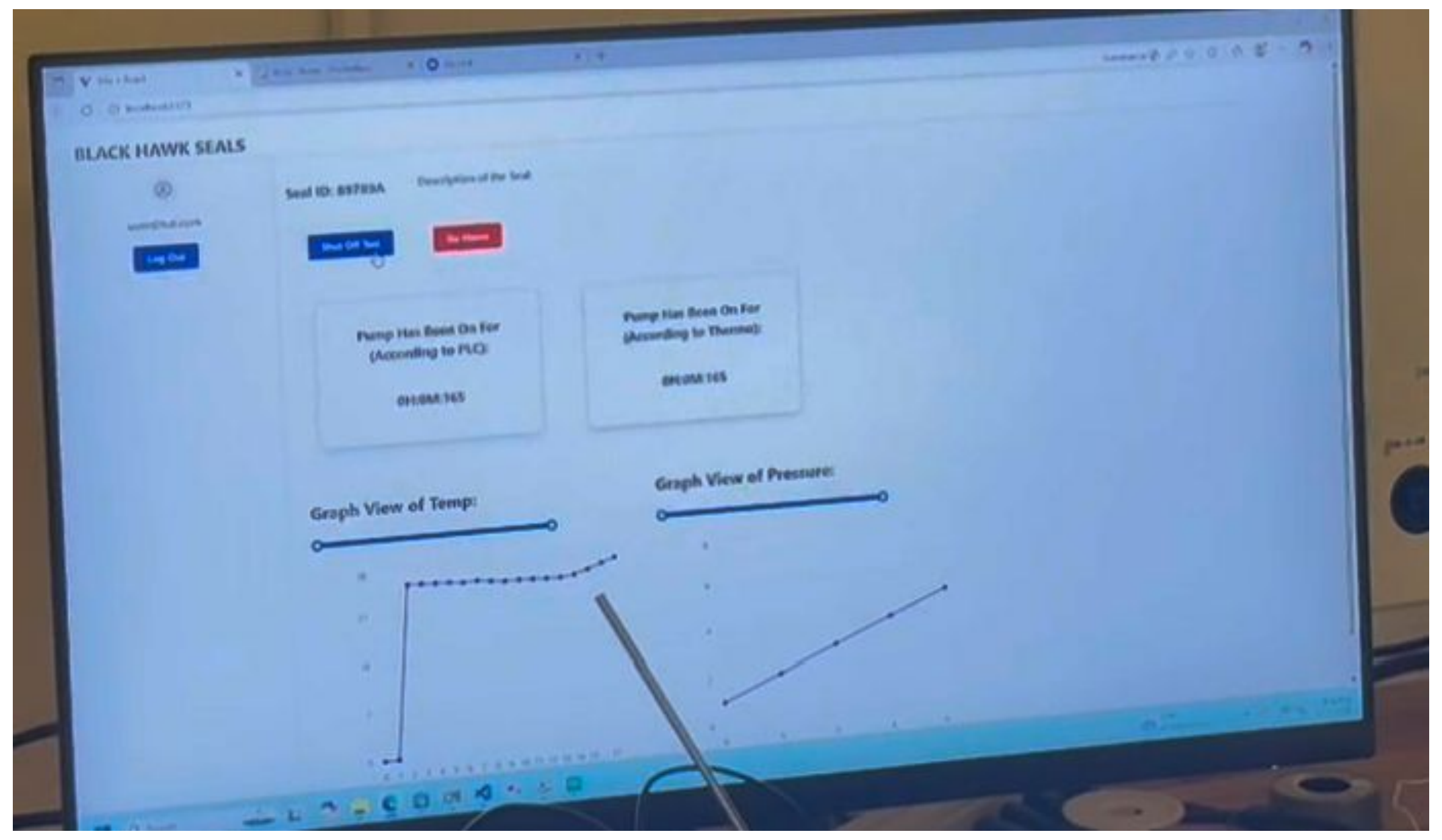


The New Pipe wiring



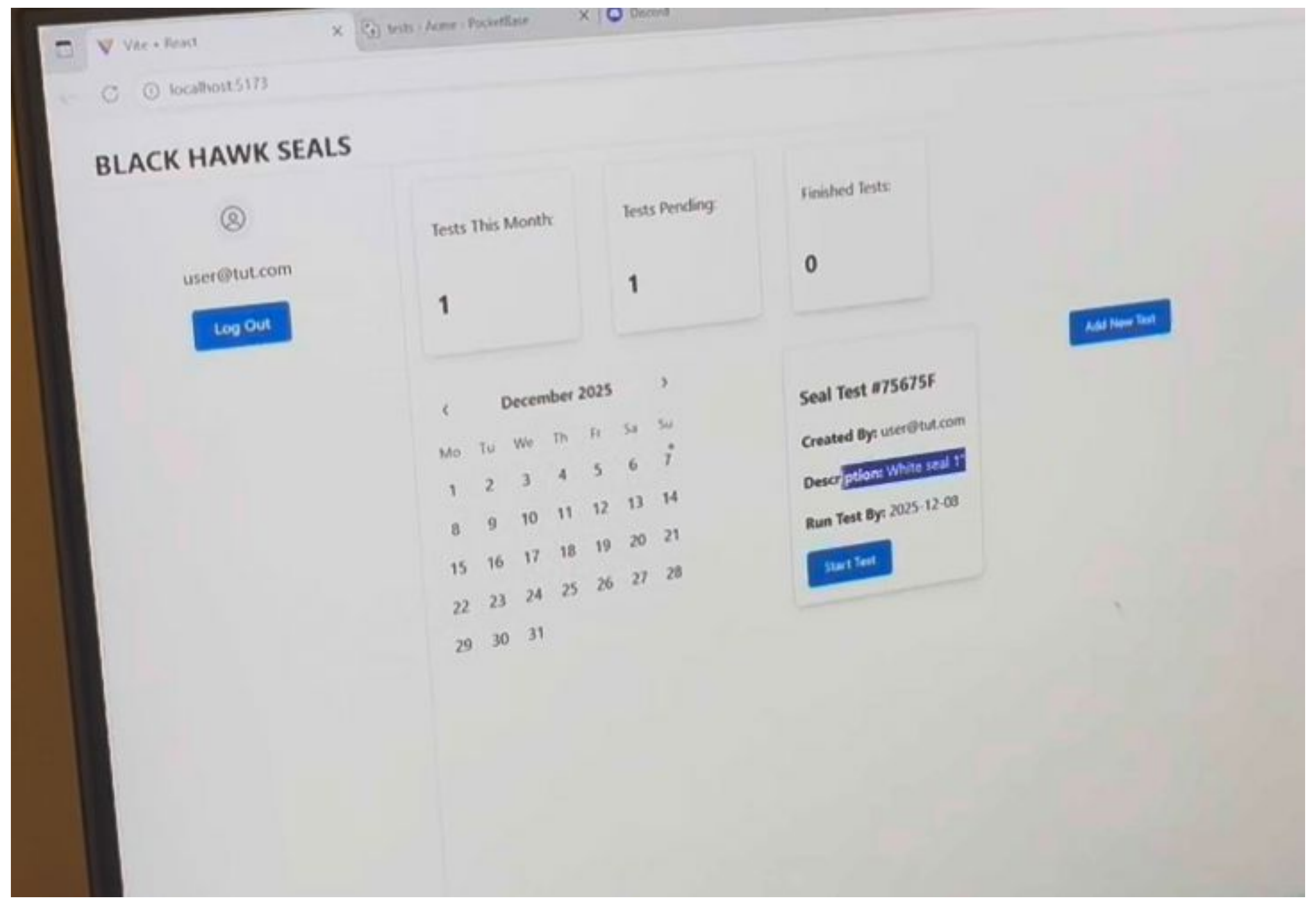
The PLC test bench wiring diagram

Testing and Results



We set up our Node.js server and ran our SQL backend, which was able to create and store tests, with time, temperature, and pressure information. Due to the lack of a fan for safety reasons we could not measure the temperature of the pump, but we confirmed the functionality of our thermocouple. Our system is able to store the temperature data and read it back with the test. Furthermore we can start and stop the test remotely in case of safety issues.

We also confirmed the wiring of our PLC, which is able to start and stop the pump, valves, and fan bit. This makes our testing setup far more extensible and now with SQL integration the tests are much more easy to access, the system is easier to change, and contains useful information.


Vite + React
localhost:5173
BLACK HAWK SEALS
user@tut.com
Log Out
Tests This Month:
1
Tests Pending:
1
Finished Tests:
0
Add New Test
December 2025
Mo Tu We Th Fr Sa Su
Seal Test #75675F
Created By: user@tut.com
Description: White seal 1"
Run Test By: 2025-12-08
Start Test