LITTLE FALLS DAM

SPILL GATE CONTROL SYSTEM

Chris Lum
Ted Moreland
Davin Perry
Brice Trupp

AIM

Implement control of the water level at LITTLE FALLS DAM to provide adequate flow downstream and prevent undesirable overtopping the spillway flash-boards through the use of a Programmable Logic Controller Controller (PLC).

OBJECTIVES

1. The current Bailey controller will be updated to an Allen–Bradley PLC in order to prevent a controller failure, which would cause severe damage to the dam and downstream areas.

2. Develop logic for Allen–Bradley controller to do the following remotely through a Human Machine Interface (HMI):

- Automatic transfer scheme to switch toan emergency generator if the normal source fails.
- Manually control turning the generator on and off.
- Manually switch between the normal and emergency power source.
- Manually control the position of the spill gates.
- Manually turn spillway and outside lights on and off.
- Monitor the height of the spill gates.
- Monitor six generators parameters.
- Monitor 24v DC battery voltage condition.
- Monitoring source for under voltage and loss of phase conditions.

METHOD

1. Complete design review

- Receive, review, and trace existing prints to get an understanding of how the current gate control is implemented.
- Provide red line edits indicating errors and discrepancies.
- Receive and review new prints to compare changes with existing prints.
- Ensure updated drawings capture the desired functionality.

2. Meeting with an engineer from AVISTA and trip to LITTLE FALLS DAM.

- Visit LITTLE FALLS DAM – Evaluate usage and take photos of spill gates, emergency generator house, spill gate house, and control room.
- Gain a physical understanding of where system components are located.
- Speak with operators at dam to review functionality of spill gates and transfer schemes.
- Review adding the inclinometer functionality
- Measured angle of gates fully open and fully closed.

3. Control narrative

- Complete description of PLC functionality and various control processes.
- Include a high level overview to allow non-technical persons to understand operation.
- Describe electrical and logical permissives required for various processes.
- Create points list consisting of digital and analog I/Os.

4. Writing PLC program using RSLOGIX 5000

- RSLOGIX 5000 uses both Ladder Logic and functional block formatting for logic programming. The AVISTA standard requested is functional block formatting for consistency and ease of deciphering
- Conduct several PLC review meetings during programming phase to adjust for errors along the way.
- Deliver final RSLOGIX 5000 file to AVISTA

5. Commissioning

- Initial timetable for commissioning the project was late April and early May but was changed to early July to coincide with additional maintenance while the gates are offline.
- The commission process consists of installing and uploading the new PLC software and checking for all scenarios.
- Any changes to the PLC program can then be implemented on-site.

ABSTRACT

The LITTLE FALLS DAM has a generation capacity of approximately 30MW and is one of the six hydroelectric dams that AVISTA CORP. operates on the Spokane River.

The current control system allows the dam operators to locally and remotely open and close the spill gates, transfer between two power sources, and maintain control of additional auxiliary systems. This allows excess water to bypass the turbines in order tokeep proper CFS flow levels in accordance with the Spokane tribal agreement.

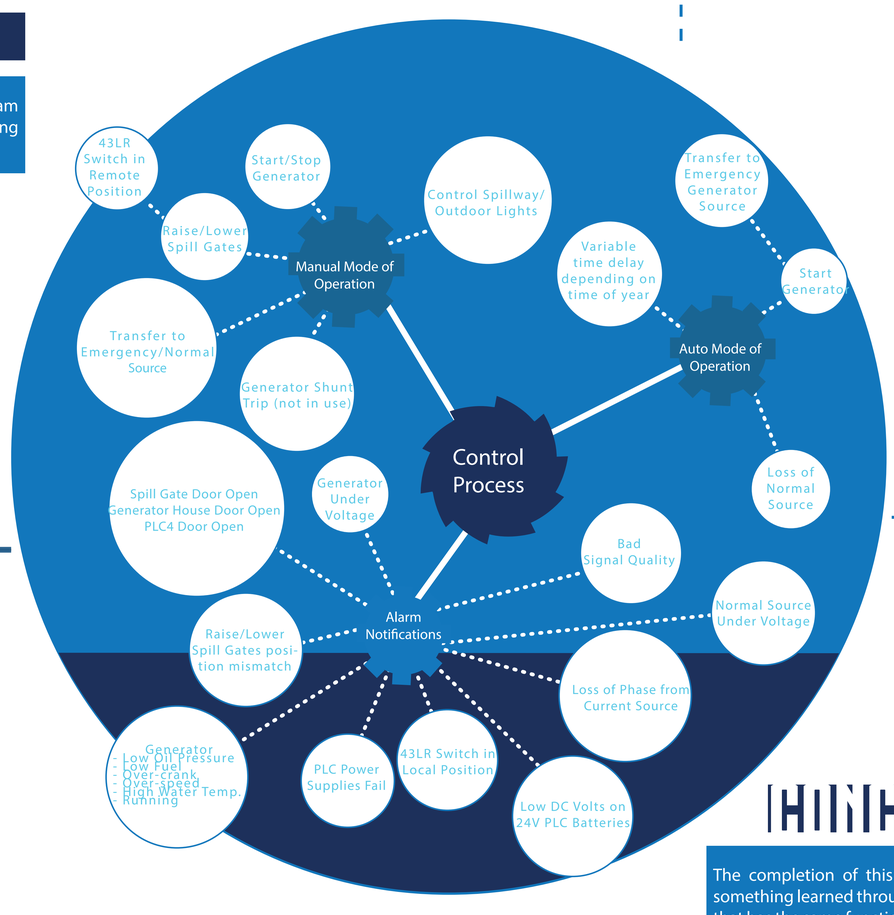
The current system has a controller that is no longer manufactured and has no available replacement parts. Due to the critical need to maintain control of the spill gates at all times, and timing with the current LITTLE FALLS Hydro-electric Development project, AVISTA has committed to an update of the spill gate control system.

RESULTS

An AVISTA controls engineer for accuracy reviews correct operation of program functionality.The final functionality is confirmed during the commissioning process.

Old v. New

Previous Bailey Features	New Allen-Bradley Logic/ Features Added
One source for measuring gate position (Shaft Potentiometer)	Two sources of gate position feedback: Shaft potentiometer and an inclinometer attached to the gate
Dual automatic transfer of source from normal source to emergency source, and emergency source to normal source.	Transfer of source to emergency source from normal source, but not from emergency source to normal source for safety of personnel.
No automatic tripping capability for the emergency diesel generator.	Ability to trip the emergency generators breaker available to operator manually and wirelessly.
Remote control of spill gates only available from an HMI computer station.	Implemented a third level of control through a wall mounted wireless pendant located in the control house.
No ability to determine bad signal quality.	Checks signal quality on analog inputs before a command to enable an output is given.



DESIGN CHALLENGES

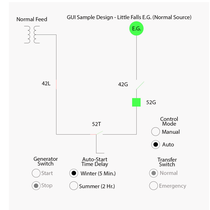
Little experience with electrical drawings required a lot of dedication to gain a system level understanding of how this system worked. Limited experience with PLC's and associated software.

FURTHER WORK

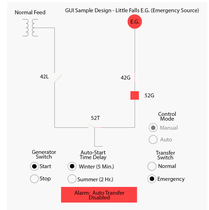
Upon receiving the new PLC logic, AVISTA will begin the commissioning process of the spill gate control system at the LITTLE FALLS DAM. During this process, engineers from Avista will test the program with the equipment installed. Every process and scenario will be tested with the new logic. Additionally, all analog inputs will be measured in various states to define signal min/max parameters that aremonitored by the PLC

PROGRAM SCREENS

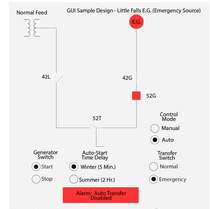
Screens indicating different states and modes of the program



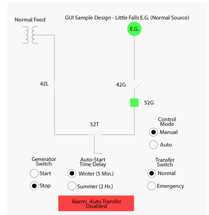
Default/Normal Operation



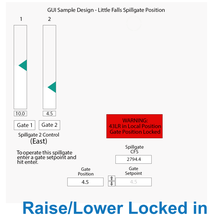
Manual Emergency Source Transfer



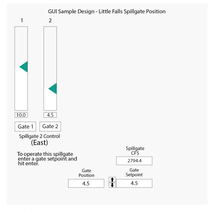
Auto Emergency Source Transfer situation



Manual Normal Source Transfer



Raise/Lower Locked in Local Mode



Raise/Lower Gate in Remote

CONCLUSION

The completion of this capstone project is deeply satisfying. There was something learned through each step of this project. We delivered a program that has the same functionality as the current system in place, and also added additional features to increase the reliability of the overall system.

As students, we were able to put our own touch on the design of a system that will be implemented in a dam for the next forty years. As young, soon to be engineers, this project was a great look at how projects are managed in industry, and how flexibility, communication, and motivation play a pivotal role in the overall success of a project.

Special thanks to Avista Controls Engineer Alexis Alexander.
Contact E-mail: Alexis.Alexander@avistacorp.com