

Dell Coolant Draining and Filling Solution



Ian Greener, Andre Branco, Pavel Lazurenko, Laura Smith, Jackson Colvin, Nathaniel Honl

J. MIKE WALKER '66 DEPARTMENT OF
MECHANICAL ENGINEERING
TEXAS A&M UNIVERSITY

Problem

Synopsis

Dell has liquid-cooled server racks which it currently sells to customers. To streamline the shipping process, Dell would like to drain 10% of the coolant from each server rack before shipping. When the server racks arrive at their destination, their coolant must be topped off. Dell has tasked this team with designing a method to do this.

Needs

Dell needs a closed system device that can store, drain, and fill coolant in a safe and controlled manner. It must integrate the solution in its shipping process without adding significant costs. Therefore, this device must be easy to use, to minimize the labor costs of training technicians and operating the device.

Impact & Existing Solutions

The device adds value by improving Dell's shipping process. The new process will reduce the total amount of liquids being transported, reducing weight and minimizing the possibility of leakage. Dell's current methods for removing coolant are not cost-effective.

Specifications

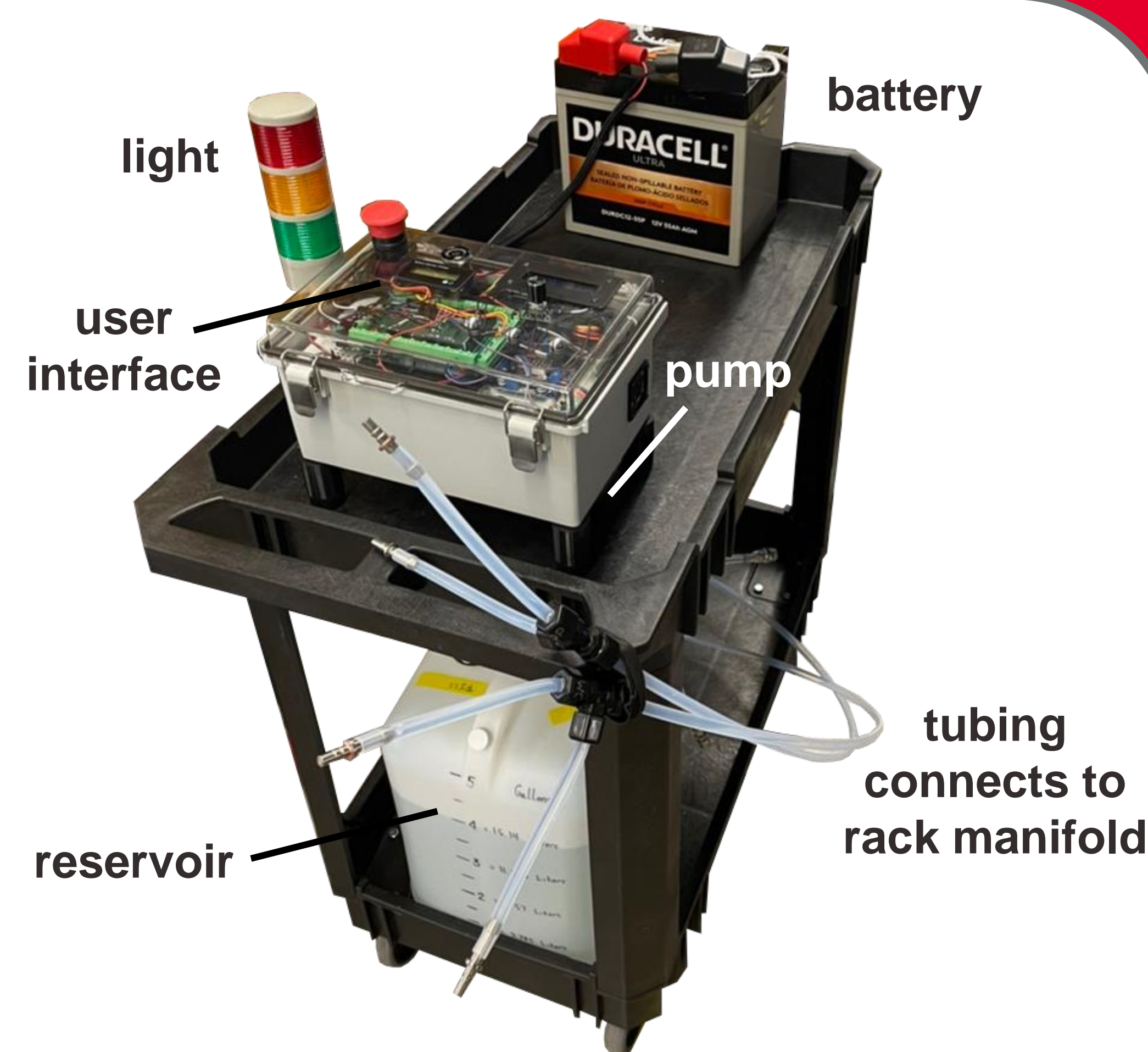
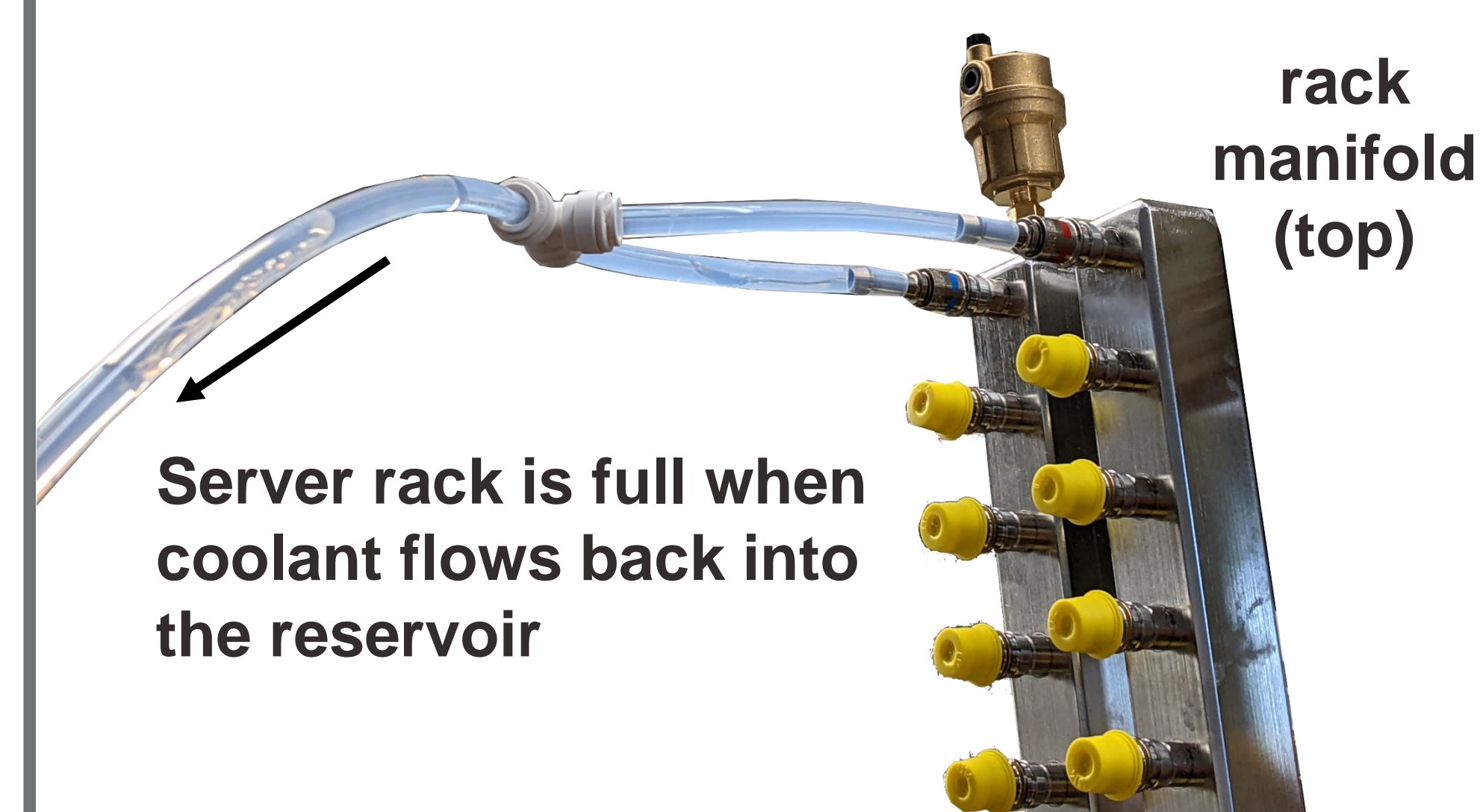
- Stores ≥ 15 L of coolant
- Fills or drains 1.4 L of coolant in ≤ 30 mins
- Drains coolant with a precision of ≤ 4 mL
- Training time takes ≤ 1 hour
- Fills to a pressure head of ≥ 6 ft
- Human interaction time per rack ≤ 2 min
- Number of leaks = 0
- All wetted materials are compatible
- Effort rating to push ≤ 3 on a scale of 0 (easy) to 10 (difficult)
- Dimensions within 3 x 3 x 3 m

Acknowledgements

We would like to thank our sponsors and our studio instructors, Cynthia Hipwell and Chris Seets.

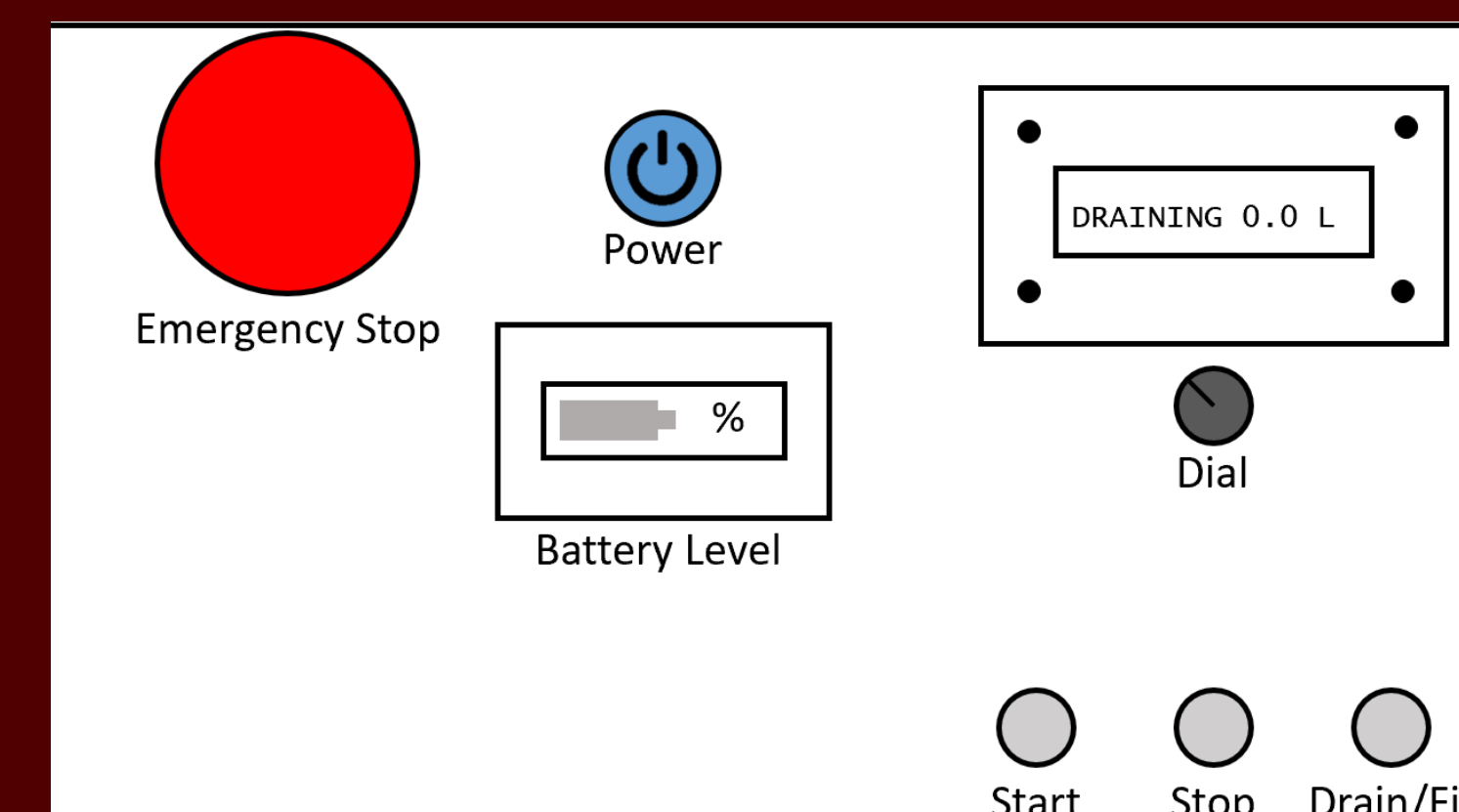
Solution

Solution: A pump that attaches to the server rack to drain and fill coolant with the press of a button.



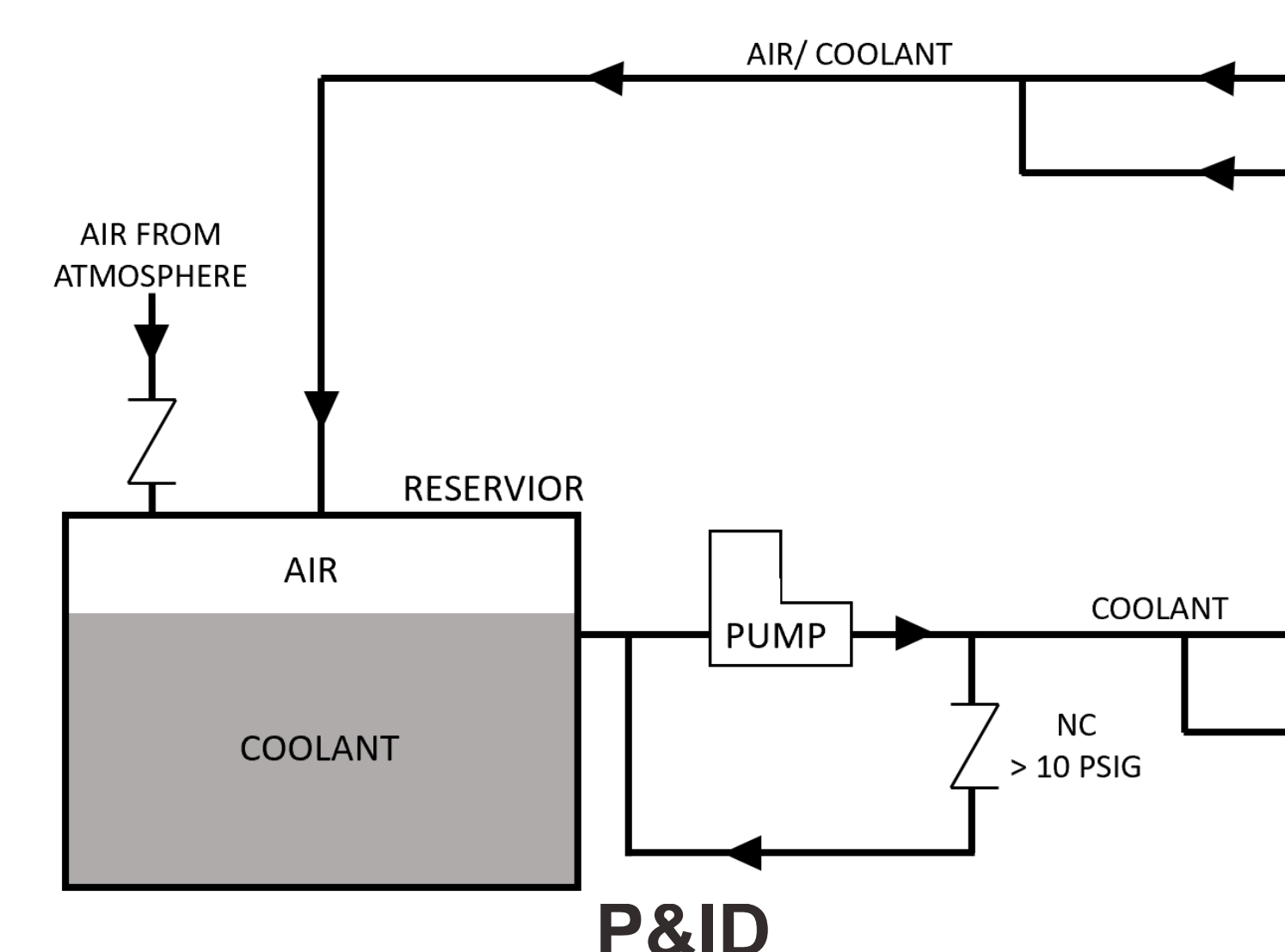
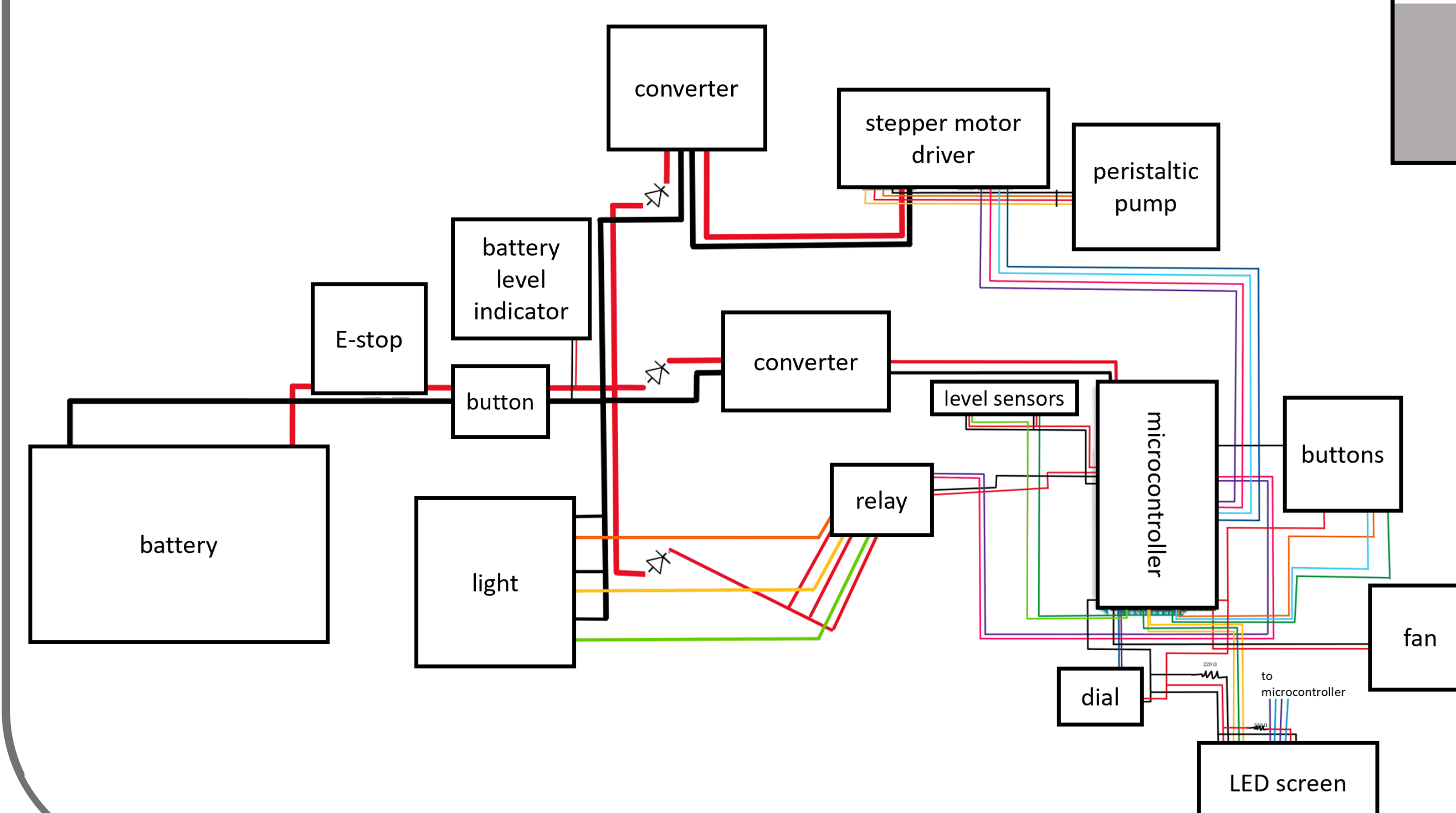
Instructions for Use:

1. Connect device to bottom and top of server rack (as shown above)
2. Use button to toggle between drain and fill mode
3. Use dial to enter # of Liters
4. Press Start
5. If filling, stop the pump when coolant begins to flow back into the reservoir.



Major Components

- **Stepper motor:** Runs the pump in increments.
- **Arduino:** Starts the pump with the press of a button. Shuts off the pump once the desired volume of coolant is filled or removed. Controls the user interface.
- **Battery:** Powers the device. Rechargeable.



- **Peristaltic pump:** Pumps liquid by squeezing it through tubing
- **Reservoir:** Stores coolant, which can be emptied and reused.
- **Tubing:** Creates a closed system with the rack manifold.

Design Methodology

Ergonomics and convenience

- Set-it-and-forget-it functionality lets technicians work on other tasks while the device runs
- Rolling cart and on-board battery makes maneuvering easy

Safety

- Emergency stop button cuts power to the pump directly, in case of a malfunction
- If the device is run while disconnected from the server rack, the tubing will remain sealed and the overpressure valve will open
- The device prevents a server rack from overfilling by creating a closed system. Likewise, the device's reservoir cannot be overfilled.

Life cycle of device

- All wetted materials are corrosion-resistant, giving them a long lifespan
- The device is modular, so it can be disassembled for maintenance
- At the end of the device's life, it can be disassembled and thrown away

Validation

Basic functionality

- Drains 1.4 L in 7.7 ± 0.5 mins
- Fills 1.4 L in 8.6 ± 0.1 mins
- Pumps with an accuracy of 1.2 ± 0.8 mL
- Fills to a pressure head of 6 ft

Ergonomics and convenience

- Human interaction time = 1.7 ± 0.3 mins
- Effort to push the device = 1.8 ± 0.4 on a scale of 0 (easy) to 10 (difficult)
- Stores 22.7 L of coolant
- Outer dimensions: 0.9 m x 0.4 m x 1 m

Safety

- Tubing connections do not leak
- Server rack did not overflow after 30 min of filling
- Overpressure valve opens at 9.0 ± 1.7 psi