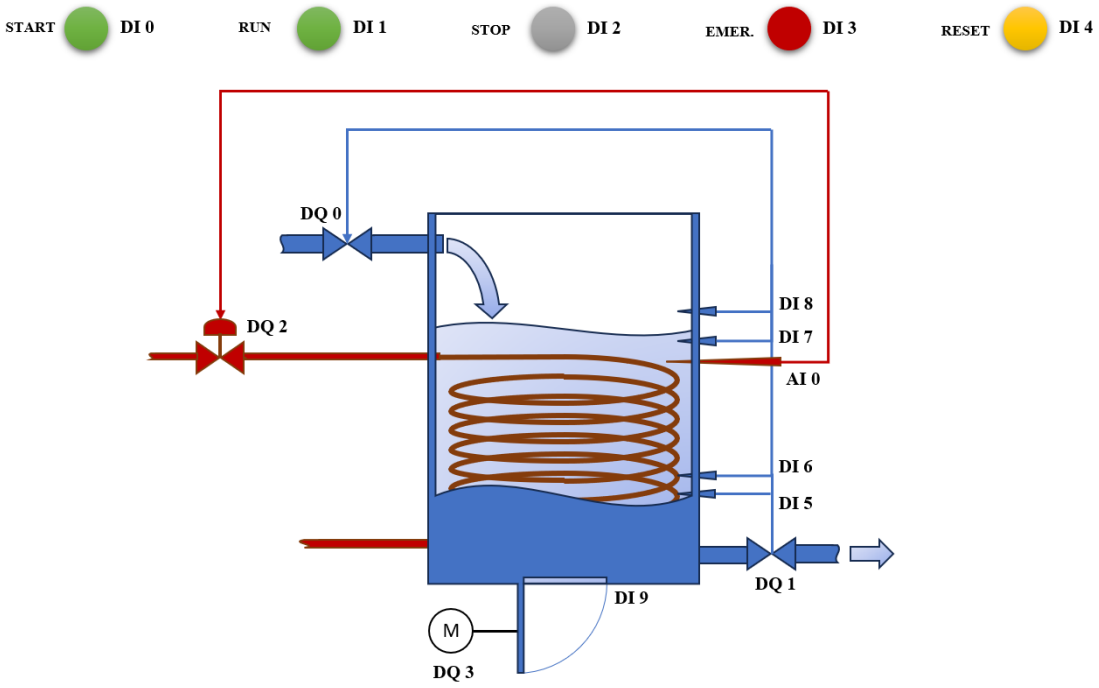
# TSC2025-2 SY-EPC-CCS Challenge

Welcome to the Industrial Automation Challenge for the Technical Student position in the Converters Controls Software section of the Electrical Power Converters group at CERN. In this challenge, you will be working with a simulated industrial Programmable Logic Controller (PLC) to control the regulation of fluid flow, temperature control, and various alarms of the process described below. The goal is to implement the necessary logic and tests to ensure the proper functioning of the control process.

## Control Process Overview:

The industrial control process depicted here involves a fluid flow system into a tank vessel. The primary objective is to heat the fluid within the tank to reach a specific temperature and then feed it into a subsequent stage of the production line.




**Key Components and Features**

1. **Fluid Flow System:**
    - Liquid enters the tank vessel to be heated to a predetermined temperature.
    - The heating process is regulated by a valve controlled by a temperature sensor.
2. **Tank Level Monitoring:**
    - Low-low, low, high and high-high level sensors are employed to monitor the fluid level in the tank.
    - The tank should be filled until the high level and discharged until the low level.

- Low-low and high-high levels should trigger different alarms.

3. **Temperature Control:**
    - A temperature sensor gauges the fluid temperature inside the tank.
    - The valve for the heating system can be controlled to heat the liquid to a desired setpoint.
4. **Tank Discharging Gate:**
    - A motor-controlled gate is installed for discharging the tank.
    - A sensor detects whether the discharging gate is open or closed.
    - The discharging gate remains closed during normal operation.
    - The gate opens only in case of an alarm condition, facilitating complete discharge and system shutdown in response to alarms.
5. **Operator Controls:**
    - **Start Button:** Initiates the system, starting the prefilling process until the low level is reached.
    - **Run Button:** Advances the system from the initialized status to the running status, starting the tank filling and liquid heating processes sequentially.
    - **Stop Button:** Stops the entire system, including fluid inflow, heating, and discharge processes.
    - **Emergency Button:** Triggers an immediate shutdown of the entire system in critical situations.
    - **Reset Button:** Acknowledges alarms after an error.

**Expected Behaviour**

- The system should start with the operator command and begin prefilling the tank until the low level, only if the discharging gate is closed. Otherwise, operator should close it and acknowledge the proper alarm.
- Once the system is ready, and no errors occurring, the operator can pulse the RUN button to start the tank filling.
- The tank should fill until the high level is reached.
- After reaching the high level, the heating process should commence.
- The fluid's temperature should raise until a setpoint of 45ºC.
- With the tank filled and the fluid at the desired temperature, the tank could start the discharging process.
- The tank should discharge until the low level point.
- The operation of filling, heating, and discharging should be performed continuously until the operator presses STOP or an error occurs.

- The tank should open a gate to fully discharge itself and discard the liquid batch if certain alarms would occur.
- The system should be set into an error mode until operators close the gate and reset the system by acknowledging the alarms (resetting the alarms) if no alarm is active anymore.
- The "Emergency" button should trigger an immediate shutdown of the entire process.

**Alarm Definitions**

1. **Tank Level Too High Alarm:**
    - **Description:** Triggered when the fluid level in the tank exceeds the designated high-high level threshold.
    - **Possible Causes:** Overfilling of the tank.
    - **Response:**
        - Initiates an immediate stop of the system to prevent overflow.
        - Sets the system into error mode.
        - Opens the tank discharging door to facilitate full discharge.
        - Requires operator acknowledgment.
2. **Tank Level Too Low Alarm:**
    - **Description:** Activated when the fluid level in the tank falls below the specified low-low level threshold.
    - **Type:** Falling Edge Detection Alarm
    - **Possible Causes:** Excessive fluid discharge or a leak in the system.
    - **Response:**
        - Prompts an immediate stop to prevent the tank from running dry.
        - Sets the system into error mode.
        - Requires operator acknowledgment.
3. **Fluid Temperature Too High Alarm:**
    - **Description:** Occurs when the temperature of the fluid inside the tank surpasses the defined high-temperature limit (> 80ºC).
    - **Possible Causes:** Malfunction in the heating system, leading to overheating.
    - **Response:**
        - Triggers a shutdown of the heating system to prevent fluid overheating.
        - Sets the system into error mode.
        - Opens the tank discharging door to facilitate full discharge.

- Requires operator acknowledgment.

4. **Fluid Temperature Too Low Alarm:**
    - **Description:** Activated when the temperature of the fluid inside the tank drops below the specified low-temperature threshold (< 10ºC).
    - **Possible Causes:** Heating system failure or insufficient heating.
    - **Response:**
        - Stops the fluid flow to prevent the discharge of inadequately heated fluid.
        - Sets the system into error mode.
        - Opens the tank discharging door to facilitate full discharge.
        - Requires operator acknowledgment.
5. **Discharging Door Open Alarm:**
    - **Description**: Activated when the discharging door is detected as open.
    - **Possible Causes**: Unintended opening of the discharging door.
    - **Response:**
        - Prevents the system from starting until the discharging door is closed.
        - Sets the system into error mode.
        - Requires operator acknowledgment and closure of the discharging door before resuming operation.
6. **Emergency Button Pressed Alarm:**
    - **Description:** Triggered when the emergency button is pressed.
    - **Possible Causes:** Critical situations requiring an immediate shutdown.
    - **Response:**
        - Initiates an immediate and complete shutdown of the entire system.
        - Sets the system into error mode.
        - Opens the tank discharging door to facilitate full discharge.
        - Requires operator acknowledgment after the emergency situation is resolved.

## Tasks

0. **Virtual Environment and Installation of Dependencies**
    - Create a Python 3.11 Virtual Environment.
    - Install the necessary dependencies.
1. **Complete the PLCSimulator Class:**
    - Implement the missing parts of the **PLCSimulator** class in **plc_simulator.py**.
    - Ensure that the control logic, alarms, and required functionality are correctly implemented.
    - Follow the provided code comments for guidance.
2. **Implement Tests for GRAFCET Logic and Alarms:**
    - Implement test cases in **test_grafcet.py** and **test_alarm_N.py** for the GRAFCET logic and alarm functionalities.
    - Test the scenarios mentioned in the expected behaviour section and simulate various conditions to ensure proper alarm triggering and system responses.
    - Use the provided **PLCClient** class in **plc_client.py** for communication with the simulator.
    - The tests should run in a parallel terminal to the PLC Simulator process.
3. **Additional Test Cases:**
    - Add more test cases as needed to thoroughly test the GRAFCET logic, alarms, and overall system behaviour.

## Submission Guidelines:

- Provide a zip file containing your project (Python files and Virtual Environment).
- Optionally
    - Provide the local Git folder containing the history.
    - Provide link to a remote Git repository.