OPERATION AND MAINTENANCE MANUAL
LIQUID DELIEVERY SYSTEM FOR THE VIAL FILLING CELL EDUCATIONAL PLATFORM

PREPARED FOR:

CONNECTED SYSTEMS INSTITUTE (CSI)
UNIVERSITY OF WISCONSIN – MILWAUKEE
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GENERAL INFORMATION
LIQUID DELIEVERY SYSTEM FOR THE VIAL FILLING CELL EDUCATIONAL PLATFORM
CSI AT THE UNIVERSITY OF WISCONSIN - MILWAUKEE
MILWAUKEE, WI

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SPARE PARTS LIST
LIQUID DELIEVERY SYSTEM FOR THE VIAL FILLING CELL EDUCATIONAL PLATFORM
CSI AT THE UNIVERSITY OF WISCONSIN - MILWAUKEE
MILWAUKEE WI

The following list is Symbiont's recommendation of spare parts that the University of Wisconsin - Milwaukee should stock for the equipment installed as part of the Liquid Delivery System (LDS) for the Vial Filling Cell Educational Platform. These recommendations are based on past experience and equipment history. However, each equipment manufacturer's operation and maintenance manual should be consulted for a complete list of recommended spare parts.

	Qty.	Part No.
1. Liquiflo Gear Pump		
a. Liquiflo Repair Kit	1	KH7RS6PEES020000
b. Center Housing NPT	1	360002
2. Liquiflo Mag-Drive Gear Pump		
a. Liquiflo Repair Kit	3	KH3FS6PEE002000US
b. Center Housing NPT	1	320001
3. Swagelok Components		
a. 1/4" Needle Valve	1	SS-1RS4
b. 1/2" Needle Valve	1	SS-18RS8
c. 1/2" 1-Piece Ball Valve	1	SS-43GS8
d. 3/4" 1-Piece Ball Valve	1	SS-45S12
e. 1/8" Tube Fitting Union Elbow	1	SS-200-9
f. 1/4" Tube Fitting Union Elbow	1	SS-400-9
g. 1/2" Tube Fitting Union Elbow	1	SS-810-9
h. 1/4"x1/8" Tube Fitting Reducer	1	SS-400-6-2
4. Grainger Components		
a. 1/2" NPT Y-Strainer	1	20XM18
b. 3/4" NPT Y-Strainer	1	20XM19
c. 0-100PSI Pressure Gauge	1	19RZ17
5. Griffco Components		
a. 1/2" NPT Back Pressure Valve	1	BPM050-S-1
b. 3/4" NPT Back Pressure Valve	1	BPG075-S-1
6. Burkert Valves		
a. 1/8" Type 2873 Solenoid	1	236230 2873-A-00,8-FF-VA-NM81-024/DC-09
b. 1/4" Type 2873 Solenoid	1	236243 2873-A-03,0-FF-VA-NM82-024/DC-09
c. 3/8" Type 6213 Set 1 Kit	1	273626 SET 1
d. 3/8" Type 6213 Set 3 Kit	1	273626 SET 3
e. 3/8" Type 6213 Set 7 Kit	1	273626 SET 7

f.	3/8” Type 6213 Solenoid	1	273626 6213-EV-A10,0-FF-VA-NM83-6-024/DC-10
	(Alternative to Type 6213 repair kits)		

7. Allen-Bradley Control Panel Components

a.	Analog Input module w/ HART	1	1759-IF8H
	i. With Wiring Module	1	1492-AIFM8-F-5
	ii. With Pre-Wired Cables	1	1492-ACABLE025UD
b.	High Speed Counter Module	1	1756-HSC
	i. With Wiring Module	1	1492-AIFMCE4-F
	ii. With Pre-Wired Cables	1	1492ACABLE020XA
c.	ArmorBlock Ethernet/IP Modules		
	i. Analog Output Module	1	1732E-OF4M12R
	ii. Digital Output Module	1	1732E-OB8M8SR
d.	Powerflex 527 VFD	1	25B-V2P5N104

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Section 1.0
INTRODUCTION

Rockwell Automation has assembled a large partnership of companies in order to create a teaching program within the University of Wisconsin colleges. This program will be used for both education and research to further the advancement of the Connected Enterprise system.

As part of this endeavor, an automated system which will be used to fill small vials on trays with water and three colors of food dye has been installed. The system has three filling heads with slightly different configurations in order to support variety and student experimentation. The system also has an automated conveyor for moving the vials through various stations, along with robotic systems for manipulating the trays. All of this is overseen by a Connected Enterprise system.

The purpose of this manual is to provide the personnel responsible for the operation of the LDS and their supervisors with:

1. A description of the LDS and equipment used in the process.

2. A summary of the basic operation and control procedures required for successful operation of the system.

3. Information related to the operation and maintenance of the equipment used in the LDS.

As operating experience is gathered and with changing conditions, modification of some of the procedures discussed herein may become necessary. An operating guide, as originally written, is a supplement to, not a substitute for, long-term experience and judgment by the operating staff. In order to maintain its value, this document should be periodically reviewed and updated, as required. Updating the manual should be the responsibility of the operator in charge, and should be done on an annual basis, as a minimum.

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Section 2.0
SYSTEM DESCRIPTION

2.1 GENERAL DESCRIPTION

The liquid portion of the overall system is comprised of a Liquid Delivery Skid (LDS) and 3 separate Flow Plates. The LDS contains the four tanks and four pumps that feed the four flow types to the flow pates. It also contains various load cells, level switches, pressure controls, and temperature sensors. Finally, it contains the flow transmitters for the flow plates, and two control panels. One control panel houses the low voltage PLC, HMI, and IO devices. The other control panel houses the 120 volt and 230 volt components that supply power to the LDS and pumps.

The three flow plates contain the flow meters and electric analog solenoid control valves that will be used to regulate the flow to the filling points above the vials. They are each mounted to the three separate conveyers with filling points for the vials.

2.2 PHYSICAL LAYOUT

See the record drawings in Appendix B for a physical layout of the system.

Section 3.0

FUNCTIONAL DESCRIPTION

3.1 INTRODUCTION

This description of operation covers the LDS skid and three flow plates. The conveyer control system (by APT) will issue batch commands to the LDS control system with PLC to PLC peer communications over the network. The Connected Enterprise system will read data and logs from the LDS control system.

3.2 SYSTEM OPERATIONS

1 Controls Overview

1.1 Tank, Fill Station, and Sequence Overview

The LDS functionality is programmed utilizing the PlantPAx standard object library. The system and its control have been segregated into 3 Fill Stations, a Tank Skid, and Process Control Sequencers.

The LDS has 4 Tank Modules Located on the Tank Skid

- Tank 100 – Water
- Tank 200 – Red Food Coloring
- Tank 300 – Yellow Food Coloring
- Tank 400 – Blue Food Coloring

Each Tank Can Send Liquid to One of the Following Fill Stations:

- Fill Station 3 – Combined Filling
- Fill Station 4 – Simultaneous Filling
- Fill Station 5 – Sequential Filling

Each of the Tank Modules execute certain Sequences. In other words, each of the tanks would be able to execute these Sequences.

- Pressure Sequencers
  - Sequence - Analog Pressure Control – Maintain pressure using the pressure transmitter and controlling the pump speed.
  - Sequence - Mechanical Pressure Control – Run the pump at a fixed speed, let the mechanical regulator maintain pressure.
- Deliver Sequencers
  - Sequence – Fill Station 3 – Delivers liquid from the tank to station 3.
  - Sequence – Fill Station 4 – Delivers liquid from the tank to station 4.
  - Sequence – Fill Station 5 – Delivers liquid from the tank to station 5.

- Water Fill Sequence (for Tank 100 only)
  - Sequence – Fill Water – Delivers water from Tank 100 to selected Tank
  -

See section 2 for detailed descriptions of each Sequence.

1.2 General Sequence of Operation

The following describes a typical operation run for the LDS system.

1. The system is off and empty.
2. The operator would close the drain valves on the tanks.
3. The operator will fill the tanks with the required water and dyes.
4. The operator will activate one of the pressure control sequencers for each of the tank units.
   a. The pumps will turn on and maintain pressure for the fill stations to run.
5. The operator may choose to measure water from the water tank into the dye tanks.
   a. The operator would start the Fill Water Sequencer
   b. The operator would select the desired tank to fill
   c. The LDS control system proceeds through necessary steps on Water Fill sequence, transferring the water to the selected tank.
   d. The operator may need to refill the water tank if enough volume is transferred.
6. The operator would manually Jog each of the Fill Station valves on each of the four tank Units.
   a. This will charge liquid to the fill heads.
   b. It is recommended that small buckets be placed under the fill heads to catch the fluid.
7. The APT conveyer system moves a vial to one of the filling stations.
8. The APT control system would issue a command to the LDS system.
   a. Specifying a vial is in position and volume of each of the four liquids to charge to the vial.
   b. Issue a Start command.
9. The LDS control system activates the necessary fill steps on the required tank units, simultaneously or in sequence, to charge the liquids to the vial in the station.
   a. When complete, the LDS system will respond to the APT control system that the delivery on the commanded fill station is complete.
10. This process repeats (from step 5).
11. When finished with the run…
12. The operator deactivates the pressure control sequencers for each of the tank units.
13. The operator empties the tanks out thru their bottom drains.
14. Rinsing of the system is recommended. The operator would:
    a. Rinse the tanks out with water thru their bottom drains.
    b. Closes the bottom drains.
    c. Fill the tanks with water.
    d. Activate one of the pressure control sequencers for each of the tank units.
    e. Manually jogs each of the Fill Station sequqncers on each of the tank units, until the lines run clear. It is recommended to rinse into a bucket under each filling nozzle.
    f. Open the bottom drains to drain the tanks out again.

1.3 Symbiont and APT Communications

The LDS will receive commands from the APT control system outlined below

Consumed REAL PLC Tags from APT

Tag	Engineering Units
Consumed_WetFillStation3_VolReq_Tank100	ml
Consumed_WetFillStation3_VolReq_Tank200	ml
Consumed_WetFillStation3_VolReq_Tank300	ml
Consumed_WetFillStation3_VolReq_Tank400	ml
Consumed_WetFillStation4_VolReq_Tank100	ml
Consumed_WetFillStation4_VolReq_Tank200	ml
Consumed_WetFillStation4_VolReq_Tank300	ml
Consumed_WetFillStation4_VolReq_Tank400	ml
Consumed_WetFillStation5_VolReq_Tank100	ml
Consumed_WetFillStation5_VolReq_Tank200	ml
Consumed_WetFillStation5_VolReq_Tank300	ml
Consumed_WetFillStation5_VolReq_Tank400	ml

Consumed Status DINTs From APT

Tag	Bit	Description
Consumed_Station3_WetFill_Status	0	Heartbeat
Consumed_Station3_WetFill_Status	1	Fill Station 3 OK To Fill
Consumed_Station3_WetFill_Status	2	Spare
Consumed_Station3_WetFill_Status	3	Spare
Consumed_Station3_WetFill_Status	4	Spare
Consumed_Station3_WetFill_Status	5	Remote Start Command
Consumed_Station3_WetFill_Status	6	Remote Reset Command

Consumed_Station3_WetFill_Status	7	Remote Restart Command
Consumed_Station3_WetFill_Status	8	Remote Abort Command
Consumed_Station3_WetFill_Status	9	Spare
Consumed_Station3_WetFill_Status	10	Red Beacon (Fault)
Consumed_Station3_WetFill_Status	11	Amber Beacon (Attention Required)
Consumed_Station3_WetFill_Status	12	Green Beacon (Running)
Consumed_Station3_WetFill_Status	13-31	Spare
Consumed_Station4_WetFill_Status	0	Hearbeat
Consumed_Station4_WetFill_Status	1	Fill Station 4 OK To Fill
Consumed_Station4_WetFill_Status	2-31	Spare
Consumed_Station5_WetFill_Status	0	Heartbeat
Consumed_Station5_WetFill_Status	1	Fill Station 5 Tank 4 OK To Fill
Consumed_Station5_WetFill_Status	2	Fill Station 5 Tank 3 OK To Fill
Consumed_Station5_WetFill_Status	3	Fill Station 5 Tank 2 OK To Fill
Consumed_Station5_WetFill_Status	4	Fill Station 5 Tank 1 OK To Fill

Produced REAL PLC Tags to APT

Tag	Engineering Units
Produced_WetFillStation3_VolDisp_Tank100	ml
Produced_WetFillStation3_VolDisp_Tank200	ml
Produced_WetFillStation3_VolDisp_Tank300	ml
Produced_WetFillStation3_VolDisp_Tank400	ml
Produced_WetFillStation4_VolDisp_Tank100	ml
Produced_WetFillStation4_VolDisp_Tank200	ml
Produced_WetFillStation4_VolDisp_Tank300	ml

Produced_WetFillStation4_VolDisp_Tank400	ml
Produced_WetFillStation5_VolDisp_Tank100	ml
Produced_WetFillStation5_VolDisp_Tank200	ml
Produced_WetFillStation5_VolDisp_Tank300	ml
Produced_WetFillStation5_VolDisp_Tank400	ml

Produced Status DINTs To APT

Tag	Bit	Description
Produced_Station3_WetFill_Status	0	Heartbeat
Produced_Station3_WetFill_Status	1	Fill Station 3 Sequence Running
Produced_Station3_WetFill_Status	2	Fill Station 3 Sequence Complete
Produced_Station3_WetFill_Status	3	Spare
Produced_Station3_WetFill_Status	4	Fill Station 3 Available
Produced_Station3_WetFill_Status	5	Fill Station 3 Sequence Held
Produced_Station3_WetFill_Status	6	Fill Station 3 Sequence Aborted
Produced_Station3_WetFill_Status	7	Fill Station 3 Sequence Program Control
Produced_Station3_WetFill_Status	8	Spare
Produced_Station3_WetFill_Status	9	Spare
Produced_Station3_WetFill_Status	10	Attention Required (Alarm Severity > 501)
Produced_Station3_WetFill_Status	11	Fault Present (Alarm Severity > 750)
Produced_Station3_WetFill_Status	12-31	Spare
Produced_Station4_WetFill_Status	0	Heartbeat
Produced_Station4_WetFill_Status	1	Fill Station 4 Sequence Running
Produced_Station4_WetFill_Status	2	Fill Station 4 Sequence Complete
Produced_Station4_WetFill_Status	3	Spare

Produced_Station4_WetFill_Status	4	Fill Station 4 Available
Produced_Station4_WetFill_Status	5	Fill Station 4 Sequence Held
Produced_Station4_WetFill_Status	6	Fill Station 4 Sequence Aborted
Produced_Station4_WetFill_Status	7	Fill Station 4 Program Control
Produced_Station4_WetFill_Status	8-31	Spare
Produced_Station5_WetFill_Status	0	Heartbeat
Produced_Station5_WetFill_Status	1	SV-151 Fill Running
Produced_Station5_WetFill_Status	2	SV-251 Fill Running
Produced_Station5_WetFill_Status	3	SV-351 Fill Running
Produced_Station5_WetFill_Status	4	SV-451 Fill Running
Produced_Station5_WetFill_Status	5	SV-151 Fill Complete
Produced_Station5_WetFill_Status	6	SV-251 Fill Complete
Produced_Station5_WetFill_Status	7	SV-351 Fill Complete
Produced_Station5_WetFill_Status	8	SV-451 Fill Complete
Produced_Station5_WetFill_Status	9	Fill Station 5 Available
Produced_Station5_WetFill_Status	10	Fill Station 5 Sequence Held
Produced_Station5_WetFill_Status	11	Fill Station 5 Sequence Aborted
Produced_Station5_WetFill_Status	12	Fill Station 5 Sequence Program Control
Produced_Station5_WetFill_Status	13-31	Spare

The general command sequence would be:

1. APT updates / populates the tank *Target Volumes* in the applicable consumed REAL to Symbiont.
2. APT aligns a vial at the fill station.
3. APT raises and maintains the *OK To Fill* bits for some or all of the tanks.
    a. So long as the bits are maintained, the LDS skid will deliver fluid up to the *Target Volumes*.
    b. If the *Start Fill* bits are dropped prematurely, the LDS will update the *Volume Filled*, but not raise the corresponding *Fill Complete* bits.
        i. Restarting the *Start Fill* will initiate a NEW fill with a reset totalizer.

4. The LDS delivers fluid up to the *Target Volumes*.
    a. As each tank completes, it will update the *Volume Filled* data and raise the corresponding *Fill Complete* bits.
    b. As APT sees the *Fill Complete* bits, it may drop the *Start Fill* bits to reset the station.

1.4 Filling Sequence

A few things to note about filling sequence:

- Multiple fill stations can be filled simultaneously and asynchronously.
- A fill station may be given individual component fill commands, or multiple commands at once.
- Fill Stations 4 and 5 can fill multiple components simultaneously, depending on an operator setting (simultaneous or sequence).
- Fill Station 3 will always fill components in sequence.
- Fill Station 3 has line push functionality that will be tracked internally a *Filling Vial* bit. This bit will latch on when a Tank 200, 300, or 400 color is injected, and cleared when the Tank 100 water is finished injecting. In other words, the water must be the last item injected.
- The HMI will have buttons on the Overview screens, where the operator can initiate fills. Using these buttons will allow a sequence to occur automatically.

1.5 Valve Filling Profiles

The fill station solenoid valves are analog control capable of opening 0 to 100%, not simply on off valves. The % open of the valve is intended to be varied over the course of a component fill, or order to minimize fill time without sacrificing accuracy. A default fill profile will be programmed into the system, but it can be modified later by editing tables in the PLC.

Each valve in each station has its own filling table, and they can be modified separately.

Table 1.5 – Default Valve Filling Profile

Fill % of Target Volume	Valve % Open
0	25
10	100
20	100
30	100
40	100
50	100
60	100
70	75
80	50
90	25
100	0

When the running totalizer has passed a Fill % threshold, the % output will be adjusted per the table. For instance, with the table above, when the totalizer has passed the 70% threshold, the will close from 100% to 75%.

The filling will be noted as complete when the totalizer has reached the *Target Volume*.

Closing the valve prior to reaching 100% may cause the fill to become stuck, as it will never complete.

A preact volume will be programmed such that the PLC target will be equal to the Target Volume - Preact Volume. The intention is to begin closing the valve prior to a complete fill, minimizing overshoot.

2 Sequencer Descriptions

The following is a description of each step of each unit type.

2.1 Tank 100

This unit operation type represents the water tank.

2.1.1 Sequence – Analog Pressure Controls

Description

This sequence is used to control the pump using the analog pressure sensor.

Parameters

Pressure Setpoint

- Operator adjustable on HMI
- 0 to 60 PSIG

States

2.1.1.1 Idle

Description

This is the state for the sequence when not in use.

Devices

P-101 is at zero % output.

Transition Conditions

Transition to Running

- Upon Operator Command - Start.
  - AND
- Sequence – Mechanical Pressure Controls is in Stopped state.

2.1.1.2 Running

Description

This is the state that maintains pressure on the system.

Devices

P-101 is controlled by PID using PT-101 as the process variable and the *Pressure Setpoint* parameter from the sequence as the setpoint.

Transition Conditions

Transition to Idle
- Upon Operator Command.

Transition to Held
- When LSL-101 does not make fluid contact.
  - OR
- WT-101 is in a Low Low Alarm state.
  OR
- E-Stop is in an Alarm state (as signaled from the APT system).
  - OR
- PT-101 is in a High High or Low Low Alarm state.

Steps

1. Check Pump Status
   a. Verify VFD is available and in Program Control Mode
2. Run Pump
   a. Operator Prompt to modify pressure setpoint enabled
      i. Pressure setpoint can be changed later by pressing “Adjust Pressure Setpoint” button
   b. Continue to Run Pump utilizing PIDE control at user defined pressure setpoint until sequencer is stopped.

2.1.1.3 Held

Description

This is the state that the system goes to when there is a fault that requires an operator reset.

Devices

P-101 is at zero % output.

Transition Conditions

Transition to Idle
- Upon Operator Command – Stop

Transition to Running
- Upon Operator Command - Restart.

2.1.1.4 Paused

Description

This is the state that the system goes to when the operator pushes the pause button

Devices

P-101 maintains previous setpoint

Transition Conditions

Transition to Idle
- Upon Operator Command – Stop

Transition to Running
- Upon Operator Command - Restart.

2.1.1.5 Aborted

Description

This is the state that the system goes to when the operator aborts the sequence

Devices

P-101 is at zero % output.

Transition Conditions

Transition to Idle
- Upon Operator Command – Reset

Transition to Running
- Upon Operator Command – NA

2.1.2 Sequence – Mechanical Pressure Controls

Description

This sequence is used to control the pump using the mechanical regulator sensor.

Parameters

Pump Speed
- Operator adjustable on HMI
- 0 to 100 %

States

2.1.2.1 Idle

Description

This is the state for the sequence when not in use.

Devices

P-101 is at zero % output.

Transition Conditions

Transition to Running

- Upon Operator Command - Start.
  - AND
- Sequence – Analog Pressure Controls is in Stopped state.

2.1.2.2 Running

Description

This is the state that maintains pressure on the system.

Devices

P-101 is set to speed command output

Transition Conditions

Transition to Idle
- Upon Operator Command.

Transition to Held
- When LSL-101 does not make fluid contact.
  OR
- WT-101 is in a Low Low Alarm state.
  OR
- E-Stop is in an Alarm state (as signaled from the APT system).
  OR
- PT-101 is in a High High or Low Low Alarm state.

Steps

1. Check Pump Status
   a. Verify VFD is available and in Program Control Mode
2. Run Pump
   a. Operator Prompt to modify speed setpoint enabled
      i. Speed setpoint can be changed later by pressing “Adjust Speed Setpoint” button
   b. Continue to Run Pump overriding PIDE control with user defined speed setpoint until sequencer is stopped.
      i. Manually adjust needle valves to regulate line pressure

2.1.2.3 Held

Description

This is the state that the system goes to when there is a fault that requires an operator reset.

Devices

P-101 is at zero % output.

Transition Conditions

Transition to Idle
- Upon Operator Command - Stop.

Transition to Running
- Upon Operator Command - Restart.

2.1.2.4 Paused

Description

This is the state that the system goes to when the operator pushes the pause button

Devices

P-101 maintains previous setpoint

Transition Conditions

Transition to Idle
- Upon Operator Command – Stop

Transition to Running
- Upon Operator Command - Restart.

2.1.2.5 Aborted

Description

This is the state that the system goes to when the operator aborts the sequence

Devices

P-101 is at zero % output.

Transition Conditions

Transition to Idle
- Upon Operator Command – Reset

Transition to Running
- Upon Operator Command - NA

2.2 Tank 200

This unit operation type represents the red food coloring tank.

2.2.1 Sequence – Analog Pressure Controls

Description

This sequence is used to control the pump using the analog pressure sensor.

Parameters

Pressure Setpoint

- Operator adjustable on HMI
- 0 to 60 PSIG

States

2.2.1.1 Idle

Description

This is the state for the sequence when not in use.

Devices

P-201 is at zero % output.

Transition Conditions

Transition to Running
- Upon Operator Command - Start.
  - AND
- Sequence – Mechanical Pressure Controls is in Stopped state.

2.2.1.2 Running

Description

This is the state that maintains pressure on the system.

Devices

P-121 is controlled by PID using PT-201 as the process variable and the *Pressure Setpoint* parameter from the sequence as the setpoint.

Transition Conditions

Transition to Idle
- Upon Operator Command.

Transition to Held
- When LSL-201 does not make fluid contact.
  - OR
- WT-201 is in a Low Low Alarm state.
  - OR
- E-Stop is in an Alarm state (as signaled from the APT system).
  - OR
- PT-201 is in a High High or Low Low Alarm state.

Steps

1. Check Pump Status
   a. Verify VFD is available and in Program Control Mode
2. Run Pump
   a. Operator Prompt to modify pressure setpoint enabled

i. Pressure setpoint can be changed later by pressing “Adjust Pressure Setpoint” button

b. Continue to Run Pump utilizing PIDE control at user defined pressure setpoint until sequencer is stopped.

2.2.1.3 Held

Description

This is the state that the system goes to when there is a fault that requires an operator reset.

Devices

P-201 is at zero % output.

Transition Conditions

Transition to Idle
- Upon Operator Command – Stop

Transition to Running
- Upon Operator Command - Restart.

2.2.1.4 Paused

Description

This is the state that the system goes to when the operator pushes the pause button

Devices

P-201 maintains previous setpoint

Transition Conditions

Transition to Idle
- Upon Operator Command – Stop

Transition to Running
- Upon Operator Command - Restart.

2.2.1.5 Aborted

Description

This is the state that the system goes to when the operator aborts the sequence

Devices

P-201 is at zero % output.

Transition Conditions

Transition to Idle
- Upon Operator Command – Reset

Transition to Running
- Upon Operator Command – NA

2.2.2 Sequence – Mechanical Pressure Controls

Description

This sequence is used to control the pump using the mechanical regulator sensor.

Parameters

Pump Speed
- Operator adjustable on HMI
- 0 to 100 %

States

2.2.2.1 Idle

Description

This is the state for the sequence when not in use.

Devices

P-201 is at zero % output.

Transition Conditions

Transition to Running
- Upon Operator Command - Start.
  - AND
- Sequence – Analog Pressure Controls is in Stopped state.

2.2.2.2 Running

Description

This is the state that maintains pressure on the system.

Devices

P-201 is set to speed command output

Transition Conditions

Transition to Idle
- Upon Operator Command.

Transition to Held

- When LSL-201 does not make fluid contact.
  OR
- WT-201 is in a Low Low Alarm state.
  OR
- E-Stop is in an Alarm state (as signaled from the APT system).
  OR
- PT-201 is in a High High or Low Low Alarm state.

Steps

1. Check Pump Status
   a. Verify VFD is available and in Program Control Mode
2. Run Pump
   a. Operator Prompt to modify speed setpoint enabled
      i. Speed setpoint can be changed later by pressing “Adjust Speed Setpoint” button
   b. Continue to Run Pump overriding PIDE control with user defined speed setpoint until sequencer is stopped.
      i. Manually adjust needle valves to regulate line pressure

2.2.2.3 Held

Description

This is the state that the system goes to when there is a fault that requires an operator reset.

Devices

P-201 is at zero % output.

Transition Conditions

Transition to Idle
- Upon Operator Command - Stop.

Transition to Running
- Upon Operator Command - Restart.

2.2.2.4 Paused

Description

This is the state that the system goes to when the operator pushes the pause button

Devices

P-201 maintains previous setpoint

Transition Conditions

Transition to Idle
- Upon Operator Command – Stop

Transition to Running

- Upon Operator Command - Restart.

2.2.2.5 Aborted

Description

This is the state that the system goes to when the operator aborts the sequence

Devices

P-201 is at zero % output.

Transition Conditions

Transition to Idle
- Upon Operator Command – Reset

Transition to Running
- Upon Operator Command - NA

2.3 Tank 300

This unit operation type represents the yellow food coloring tank.

2.3.1 Sequence – Analog Pressure Controls

Description

This sequence is used to control the pump using the analog pressure sensor.

Parameters

Pressure Setpoint
- Operator adjustable on HMI
- 0 to 60 PSIG

States

2.3.1.1 Idle

Description

This is the state for the sequence when not in use.

Devices

P-301 is at zero % output.

Transition Conditions

Transition to Running
- Upon Operator Command - Start.

- AND
- Sequence – Mechanical Pressure Controls is in Stopped state.

Steps

1. Check Pump Status
   a. Verify VFD is available and in Program Control Mode
2. Run Pump
   a. Operator Prompt to modify pressure setpoint enabled
      i. Pressure setpoint can be changed later by pressing “Adjust Pressure Setpoint” button
   b. Continue to Run Pump utilizing PIDE control at user defined pressure setpoint until sequencer is stopped.

2.3.1.2 Running

Description

This is the state that maintains pressure on the system.

Devices

P-301 is controlled by PID using PT-301 as the process variable and the *Pressure Setpoint* parameter from the sequence as the setpoint.

Transition Conditions

Transition to Idle
- Upon Operator Command.

Transition to Held
- When LSL-301 does not make fluid contact.
  - OR
- WT-301 is in a Low Low Alarm state.
  OR
- E-Stop is in an Alarm state (as signaled from the APT system).
  - OR
- PT-301 is in a High High or Low Low Alarm state.

2.3.1.3 Held

Description

This is the state that the system goes to when there is a fault that requires an operator reset.

Devices

P-301 is at zero % output.

Transition Conditions

Transition to Idle
- Upon Operator Command – Stop

Transition to Running
- Upon Operator Command - Restart.

2.3.1.4 Paused

Description

This is the state that the system goes to when the operator pushes the pause button

Devices

P-301 maintains previous setpoint

Transition Conditions

Transition to Idle
- Upon Operator Command – Stop

Transition to Running
- Upon Operator Command - Restart.

2.3.1.5 Aborted

Description

This is the state that the system goes to when the operator aborts the sequence

Devices

P-301 is at zero % output.

Transition Conditions

Transition to Idle
- Upon Operator Command – Reset

Transition to Running
- Upon Operator Command - NA

2.3.2 Sequence – Mechanical Pressure Controls

Description

This sequence is used to control the pump using the mechanical regulator sensor.

Parameters

Pump Speed
- Operator adjustable on HMI
- 0 to 100 %

States

2.3.2.1 Idle

Description

This is the state for the sequence when not in use.

Devices

P-301 is at zero % output.

Transition Conditions

Transition to Running

- Upon Operator Command - Start.
  - AND
- Sequence – Analog Pressure Controls is in Stopped state.

2.3.2.2 Running

Description

This is the state that maintains pressure on the system.

Devices

P-301 is set to speed command output

Transition Conditions

Transition to Idle

- Upon Operator Command.

Transition to Held

- When LSL-301 does not make fluid contact.
  OR
- WT-301 is in a Low Low Alarm state.
  OR
- E-Stop is in an Alarm state (as signaled from the APT system).
  OR
- PT-301 is in a High High or Low Low Alarm state.

2.3.2.3 Held

Description

This is the state that the system goes to when there is a fault that requires an operator reset.

Devices

P-301 is at zero % output.

Transition Conditions

Transition to Idle
- Upon Operator Command - Stop.

Transition to Running
- Upon Operator Command - Restart.

2.3.2.4 Paused

Description

This is the state that the system goes to when the operator pushes the pause button

Devices

P-301 maintains previous setpoint

Transition Conditions

Transition to Idle
- Upon Operator Command – Stop

Transition to Running
- Upon Operator Command - Restart.

Steps

1. Check Pump Status
    a. Verify VFD is available and in Program Control Mode
2. Run Pump
    a. Operator Prompt to modify speed setpoint enabled
        i. Speed setpoint can be changed later by pressing “Adjust Speed Setpoint” button
    b. Continue to Run Pump overriding PIDE control with user defined speed setpoint until sequencer is stopped.
        i. Manually adjust needle valves to regulate line pressure

2.3.2.5 Aborted

Description

This is the state that the system goes to when the operator aborts the sequence

Devices

P-301 is at zero % output.

Transition Conditions

Transition to Idle
- Upon Operator Command – Reset

Transition to Running
- Upon Operator Command – NA

2.4 Tank 400

This unit operation type represents the blue food coloring tank.

2.4.1 Sequence – Analog Pressure Controls

Description

This sequence is used to control the pump using the analog pressure sensor.

Parameters

Pressure Setpoint

- Operator adjustable on HMI
- 0 to 60 PSIG

States

2.4.1.1 Idle

Description

This is the state for the sequence when not in use.

Devices

P-401 is at zero % output.

Transition Conditions

Transition to Running

- Upon Operator Command - Start.
  - AND
- Sequence – Mechanical Pressure Controls is in Stopped state.

2.4.1.2 Running

Description

This is the state that maintains pressure on the system.

Devices

P-401 is controlled by PID using PT-401 as the process variable and the *Pressure Setpoint* parameter from the sequence as the setpoint.

Transition Conditions

Transition to Idle

- Upon Operator Command.

Transition to Held

- When LSL-401 does not make fluid contact.

- OR
- WT-401 is in a Low Low Alarm state.
  OR
- E-Stop is in an Alarm state (as signaled from the APT system).
  - OR
- PT-401 is in a High High or Low Low Alarm state.

Steps

1. Check Pump Status
   a. Verify VFD is available and in Program Control Mode
2. Run Pump
   a. Operator Prompt to modify pressure setpoint enabled
      i. Pressure setpoint can be changed later by pressing “Adjust Pressure Setpoint” button
   b. Continue to Run Pump utilizing PIDE control at user defined pressure setpoint until sequencer is stopped.

2.4.1.3 Held

Description

This is the state that the system goes to when there is a fault that requires an operator reset.

Devices

P-401 is at zero % output.

Transition Conditions

Transition to Idle
- Upon Operator Command – Stop

Transition to Running
- Upon Operator Command - Restart.

2.4.1.4 Paused

Description

This is the state that the system goes to when the operator pushes the pause button

Devices

P-401 maintains previous setpoint

Transition Conditions

Transition to Idle
- Upon Operator Command – Stop

Transition to Running
- Upon Operator Command - Restart.

2.4.1.5 Aborted

Description

This is the state that the system goes to when the operator aborts the sequence

Devices

P-401 is at zero % output.

Transition Conditions

Transition to Idle
- Upon Operator Command – Reset

Transition to Running
- Upon Operator Command - NA

2.4.2 Sequence – Mechanical Pressure Controls

Description

This sequence is used to control the pump using the mechanical regulator sensor.

Parameters

Pump Speed
- Operator adjustable on HMI
- 0 to 100 %

States

2.4.2.1 Idle

Description

This is the state for the sequence when not in use.

Devices

P-401 is at zero % output.

Transition Conditions

Transition to Running
- Upon Operator Command - Start.
  - AND
- Sequence – Analog Pressure Controls is in Stopped state.

2.4.2.2 Running

Description

This is the state that maintains pressure on the system.

Devices

P-401 is set to speed command output

Transition Conditions

Transition to Idle

- Upon Operator Command.

Transition to Held

- When LSL-401 does not make fluid contact.
  OR
- WT-401 is in a Low Low Alarm state.
  OR
- E-Stop is in an Alarm state (as signaled from the APT system).
  OR
- PT-401 is in a High High or Low Low Alarm state.

Steps

1. Check Pump Status
   a. Verify VFD is available and in Program Control Mode
2. Run Pump
   a. Operator Prompt to modify speed setpoint enabled
      i. Speed setpoint can be changed later by pressing “Adjust Speed Setpoint” button
   b. Continue to Run Pump overriding PIDE control with user defined speed setpoint until sequencer is stopped.
      i. Manually adjust needle valves to regulate line pressure

2.4.2.3 Held

Description

This is the state that the system goes to when there is a fault that requires an operator reset.

Devices

P-401 is at zero % output.

Transition Conditions

Transition to Idle

- Upon Operator Command - Stop.

Transition to Running

- Upon Operator Command - Restart.

2.4.2.4 Paused

Description

This is the state that the system goes to when the operator pushes the pause button

Devices

P-401 maintains previous setpoint

Transition Conditions

Transition to Idle
- Upon Operator Command – Stop

Transition to Running
- Upon Operator Command - Restart.

2.4.2.5 Aborted

Description

This is the state that the system goes to when the operator aborts the sequence

Devices

P-401 is at zero % output.

Transition Conditions

Transition to Idle
- Upon Operator Command – Reset

Transition to Running
- Upon Operator Command - NA

2.5 Tank Skid

This unit operation type represents filling the tank skid.

2.5.1 Sequence – Water Fill

Description

This sequence is used to add water to from tank T-100 to the color tanks T-200-400

Parameters

Fill Volume
- 1000 ml

States

2.5.1.1 Idle

Description

This is the state for the sequence when not in use.

Devices

SV-152 is closed
SV-201 is closed
SV-301 is closed
SV-401 is closed

Transition Conditions

Transition to Running

- Upon Operator Command - Start.

2.5.1.2 Running

Description

This is the state that fills the selected tank from T-100

Transition Conditions

Transition to Idle

- Upon Operator Command.

Transition to Held

- When target volume is not completed within allotted time

Steps

1. Check Start Mode
    a. By default, the system will always default to manual mode. Automatic commands from APT have not been integrated.
        i. If Automatic Mode Selected Continue to Step 2
        ii. If Manual Mode Selected Branch to Step 3
2. Select Fill Tank
    a. Operator Prompt to select Fill Tank (Tank to be Filled)
3. Enter Fill Volume
    a. Operator Prompt to enter Fill Volume
        i. Note: by default, this step is bypassed – fill volume is entered automatically in program at 1000 ml
4. Check Tank Selection
    a. Sequence will check operator prompt to determine selected tank
        i. If Tank T-200 selected Branch to Step 7; Else Continue to Step 5
5. Check Tank Selection
    a. Sequence will check operator prompt to determine selected tank
        i. If Tank T-300 selected Branch to Step 12; Else Continue to Step 6
6. Check Tank Selection
    a. Sequence will check operator prompt to determine selected tank
        i. If Tank T-400 selected Branch to Step 17; Else Transition to Held
7. T-200 Water Fill

   a. Open SV-152
8. Open SV-201
9. Fill Tank T-200
   a. Fill Tank T-200 utilizing FIT-151-Dose PlantPAx object
      i. Dose object will totalize flow from FIT-151 and output a complete bit when target volume is reached
   b. Branch to Step 20
10. Spare
11. Spare
12. T-300 Water Fill
   a. Open SV-152
13. Open SV-301
14. Fill Tank T-300
   a. Fill Tank T-300 utilizing FIT-151-Dose PlantPAx object
      i. Dose object will totalize flow from FIT-151 and output a complete bit when target volume is reached
   b. Branch to Step 20
15. Spare
16. Spare
17. T-400 Water Fill
   a. Open SV-152
18. Open SV-401
19. Fill Tank T-400
   a. Fill Tank T-400 utilizing FIT-151-Dose PlantPAx object
      i. Dose object will totalize flow from FIT-151 and output a complete bit when target volume is reached
20. Fill Complete
   a. Close SV-201 if open
   b. Close SV-301 if open
   c. Close SV-401 if open
   d. Close SV-152 if open

2.5.1.3 Held

Description

This is the state that the system goes to when there is a fault that requires an operator reset.

Devices

SV-152 is closed
SV-201 is closed
SV-301 is closed
SV-401 is closed

Transition Conditions

Transition to Idle
- Upon Operator Command – Stop

Transition to Running
- Upon Operator Command - Restart.

2.5.1.4 Paused

Description

This is the state that the system goes to when the operator pushes the pause button

Devices

SV-152 maintains previous position
SV-201 maintains previous position
SV-301 maintains previous position
SV-401 maintains previous position

Transition Conditions

Transition to Idle
- Upon Operator Command – Stop

Transition to Running
- Upon Operator Command - Restart.

2.5.1.5 Aborted

Description

This is the state that the system goes to when the operator aborts the sequence

Devices

SV-152 is closed
SV-201 is closed
SV-301 is closed
SV-401 is closed

Transition Conditions

Transition to Idle
- Upon Operator Command – Reset

Transition to Running
- Upon Operator Command – NA

2.6 Fill Station 3

This unit operation type represents fill station 3

2.6.1 Sequence – Fill 300

Description

This sequence is used to dose water to from Tanks T-100-400 to vials at Fill Station 3

Parameters

Fill Volumes

- T-100 Volume
- T-200 Volume
- T-300 Volume
- T-400 Volume
- Push Water Volume

States

2.6.1.1 Idle

Description

This is the state for the sequence when not in use.

Devices

SV-131 is closed
SV-231 is closed
SV-331 is closed
SV-431 is closed
SV-032 is open
SV-031 is closed

Transition Conditions

Transition to Running

- Upon Operator Command - Start.
  - OR
- APT Command – Start

2.6.1.2 Running

Description

This is the state that fills the vials

Transition Conditions

Transition to Idle

- Upon Operator Command.

Transition to Held

- When target volume is not completed within allotted time

Steps

1. Automatic Mode Check
   a. If Sequencer is started Automatically (from APT) branch to Step 3; Else continue to Step 2
2. Enter Fill Volumes
   a. Enable Operator Prompt to enter Fill Volume to be dosed from each Tank.

3. Check Fill Mode
    a. Check whether Fill Mode is Set as Simultaneous or Sequential
        i. Note: For Fill Station 3 Sequential Mode is always chosen
4. Divert to Drain
    a. Open SV-032
5. Add T-200 Volume
    a. Utilize Symbiont Valve Control AOI and FIT-031 pulse count to dose T-200 Volume
        i. If Push Water Volume is reached
            1. Close SV-032
            2. Open SV-031
6. Add T-300 Volume
    a. Utilize Symbiont Valve Control AOI and FIT-031 pulse count to dose T-300 Volume
        i. If Push Water Volume is reached
            1. Close SV-032
            2. Open SV-031
7. Add T-400 Volume
    a. Utilize Symbiont Valve Control AOI and FIT-031 pulse count to dose T-400 Volume
        i. If Push Water Volume is reached
            1. Close SV-032
            2. Open SV-031
8. Add T-100 Volume
    a. Utilize Symbiont Valve Control AOI and FIT-031 pulse count to dose T-100 Volume
        i. If Push Water Volume is reach
            1. Open SV-032
            2. Open SV-031
    b. Branch to Step 10
9. Fill from All Tanks
    a. Step is bypassed for Fill Station 3; This step is only used during Simultaneous fills.
10. Shift Data Logs
11. Reset Totalizers
    a. Send APT Fill Complete Bit and Flow Totals
12. Clear Outputs
    a. Close SV-131
    b. Close SV-231
    c. Close SV-331
    d. Close SV-431
    e. Open SV-032
    f. Close SV-031

2.6.1.3 Held

Description

This is the state that the system goes to when there is a fault that requires an operator reset.

Devices

SV-131 is closed
SV-231 is closed
SV-331 is closed
SV-431 is closed
SV-032 maintains last position
SV-031 maintains last position

Transition Conditions

Transition to Idle
- Upon Operator Command – Stop

Transition to Running
- Upon Operator Command - Restart.

2.6.1.4 Paused

Description

This is the state that the system goes to when the operator pushes the pause button

Devices

SV-131 maintains previous position
SV-231 maintains previous position
SV-331 maintains previous position
SV-431 maintains previous position
SV-031 maintains previous position
SV-032 maintains previous position

Transition Conditions

Transition to Idle
- Upon Operator Command – Stop

Transition to Running
- Upon Operator Command - Restart.

2.6.1.5 Aborted

Description

This is the state that the system goes to when the operator aborts the sequence

Devices

SV-131 is closed
SV-231 is closed
SV-331 is closed
SV-431 is closed
SV-032 is open
SV-031 is closed

Transition Conditions

Transition to Idle
- Upon Operator Command – Reset

Transition to Running
- Upon Operator Command – NA

2.7 Fill Station 4

This unit operation type represents fill station 4

2.7.1 Sequence – Fill 400

Description

This sequence is used to dose water to from Tanks T-100-400 to vials at Fill Station 4

Parameters

Fill Volumes

- T-100 Volume
- T-200 Volume
- T-300 Volume
- T-400 Volume

States

2.7.1.1 Idle

Description

This is the state for the sequence when not in use.

Devices

SV-141 is closed
SV-241 is closed
SV-341 is closed
SV-441 is closed

Transition Conditions

Transition to Running

- Upon Operator Command - Start.
  - OR
- APT Command – Start

2.7.1.2 Running

Description

This is the state that fills the vials

Transition Conditions

Transition to Idle

- Upon Operator Command.

Transition to Held

- When target volume is not completed within allotted time

Steps

1. Automatic Mode Check
    a. If Sequencer is started Automatically (from APT) branch to Step 3; Else continue to Step 2
2. Enter Fill Volumes
    a. Enable Operator Prompt to enter Fill Volume to be dosed from each Tank.
3. Check Fill Mode
    a. Check whether Fill Mode is Set as Simultaneous or Sequential
        i. If Simultaneous mode is set Branch to Step 8
4. Add T-400 Volume
    a. Utilize Symbiont Valve Control AOI to modulate SV-441
    b. Count FIT-441 pulses to record dosed volume
5. Add T-300 Volume
    a. Utilize Symbiont Valve Control AOI to modulate SV-341
    b. Count FIT-341 pulses to record dosed volume
6. Add T-200 Volume
    a. Utilize Symbiont Valve Control AOI to modulate SV-241
    b. Count FIT-241 pulses to record dosed volume
7. Add T-100 Volume
    a. Utilize Symbiont Valve Control AOI to modulate SV-141
    b. Count FIT-141 pulses to record dosed volume
    c. Branch to Step 9
8. Fill from All Tanks
    a. Utilize Symbiont Valve Control AOIs and Fill Station 4 Flow Meter pulse counts to dose selected volumes simultaneously
9. Shift Data Logs
10. Reset Totalizers
    a. Send APT Fill Complete Bit and Flow Totals
11. Clear Outputs
    a. Close SV-141
    b. Close SV-241
    c. Close SV-341
    d. Close SV-441

2.7.1.3 Held

Description

This is the state that the system goes to when there is a fault that requires an operator reset.

Devices

SV-141 is closed
SV-241 is closed
SV-341 is closed
SV-441 is closed

Transition Conditions

Transition to Idle

- Upon Operator Command – Stop

Transition to Running

- Upon Operator Command - Restart.

2.7.1.4 Paused

Description

This is the state that the system goes to when the operator pushes the pause button

Devices

SV-141 maintains previous position
SV-241 maintains previous position
SV-341 maintains previous position
SV-441 maintains previous position

Transition Conditions

Transition to Idle
- Upon Operator Command – Stop

Transition to Running
- Upon Operator Command - Restart.

2.7.1.5 Aborted

Description

This is the state that the system goes to when the operator aborts the sequence

Devices

SV-141 is closed
SV-241 is closed
SV-341 is closed
SV-441 is closed

Transition Conditions

Transition to Idle
- Upon Operator Command – Reset

Transition to Running
- Upon Operator Command – NA

2.8 Fill Station 5

This unit operation type represents fill station 5

2.8.1 Sequence – Fill 500

Description

This sequence is used to dose water to from Tanks T-100-400 to vials at Fill Station 5

Parameters

Fill Volumes

- T-100 Volume
- T-200 Volume
- T-300 Volume
- T-400 Volume

States

2.8.1.1 Idle

Description

This is the state for the sequence when not in use.

Devices

SV-151 is closed
SV-251 is closed
SV-351 is closed
SV-451 is closed

Transition Conditions

Transition to Running

- Upon Operator Command - Start.
  - OR
- APT Command – Start

2.8.1.2 Running

Description

This is the state that fills the vials

Transition Conditions

Transition to Idle

- Upon Operator Command.

Transition to Held

- When target volume is not completed within allotted time

Steps

12. Automatic Mode Check
    a. If Sequencer is started Automatically (from APT) branch to Step 3; Else continue to Step 2
13. Enter Fill Volumes
    a. Enable Operator Prompt to enter Fill Volume to be dosed from each Tank.
14. Check Fill Mode
    a. Check whether Fill Mode is Set as Simultaneous or Sequential

i. If Simultaneous mode is set Branch to Step 8
b. By default Fill Station 500 is set to sequential fill mode; Note that a mechanical piping change is required to change to simultaneous mode

15. Add T-400 Volume
    a. Utilize Symbiont Valve Control AOI to modulate SV-451
    b. Count FIT-451 pulses to record dosed volume
16. Add T-300 Volume
    a. Utilize Symbiont Valve Control AOI to modulate SV-351
    b. Count FIT-351 pulses to record dosed volume
17. Add T-200 Volume
    a. Utilize Symbiont Valve Control AOI to modulate SV-251
    b. Count FIT-251 pulses to record dosed volume
18. Add T-100 Volume
    a. Utilize Symbiont Valve Control AOI to modulate SV-151
    b. Count FIT-151 pulses to record dosed volume
    c. Branch to Step 9
19. Fill from All Tanks
    a. Utilize Symbiont Valve Control AOIs and Fill Station 5 Flow Meter pulse counts to dose selected volumes simultaneously
20. Shift Data Logs
21. Reset Totalizers
    a. Send APT Fill Complete Bit and Flow Totals
22. Clear Outputs
    a. Close SV-151
    b. Close SV-251
    c. Close SV-351
    d. Close SV-451

2.8.1.3 Held

Description

This is the state that the system goes to when there is a fault that requires an operator reset.

Devices

SV-151 is closed
SV-251 is closed
SV-351 is closed
SV-451 is closed

Transition Conditions

Transition to Idle
- Upon Operator Command – Stop

Transition to Running
- Upon Operator Command - Restart.

2.8.1.4 Paused

Description

This is the state that the system goes to when the operator pushes the pause button

Devices

SV-151 maintains previous position
SV-251 maintains previous position
SV-351 maintains previous position
SV-451 maintains previous position

Transition Conditions

Transition to Idle

- Upon Operator Command – Stop

Transition to Running

- Upon Operator Command - Restart.

2.8.1.5 Aborted

Description

This is the state that the system goes to when the operator aborts the sequence

Devices

SV-151 is closed
SV-251 is closed
SV-351 is closed
SV-451 is closed

Transition Conditions

Transition to Idle

- Upon Operator Command – Reset

Transition to Running

- Upon Operator Command – NA

3 P&ID

Description

In Appendix B, please find the process flow diagram referenced in this document.

Section 4.0
HMI SYSTEM

Tank Overview

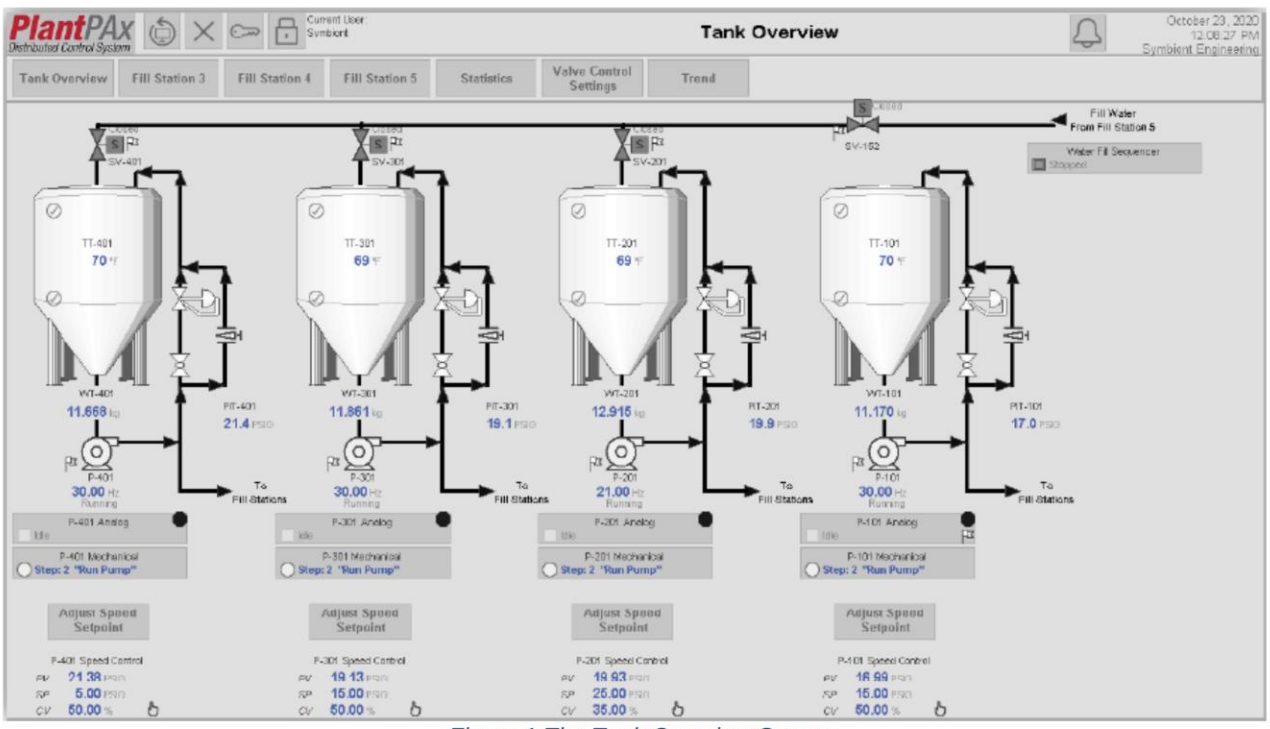

Figure 1 The Tank Overview Screen

The Tank Overview Screen provides an overview of the tank skid, including pump and water fill control. Each pump has the option to be operated using either a mechanical or analog sequencer object. The PIDE tuning is also displayed for each pump for analog control mode. When the pumps are running in mechanical control mode, a static speed will be set to the PIDE Control Variable.

The image (Figure 1) shows a Tank Overview screen from a PlantPAx Distributed Control System. The screen displays three tanks, each with various sensors and control elements. Here are the key components and their details:

1. Tanks:
   - Tank 1 (TT-401):
     - Temperature: 70°F
     - Flow Rate: 11.668 kg/s
     - Pressure: 21.4 PSIG
   - Tank 2 (TT-301):
     - Temperature: 69°F
     - Flow Rate: 11.861 kg/s
     - Pressure: 19.1 PSIG
   - Tank 3 (TT-101):
     - Temperature: 70°F
     - Flow Rate: 12.196 kg/s
     - Pressure: 17.0 PSIG

2. Valves: Each tank has several valves (e.g., SV-401, SV-301, SV-101) for controlling the flow of materials in and out of the tanks.

3. Pumps: Each tank is associated with a pump (e.g., P-401, P-301, P-101) that can be controlled to adjust the speed and flow rate.

4. Control Panels: Each tank has a control panel for adjusting the speed setpoint of the associated pump. The setpoints are displayed in RPM (e.g., 91.08 RPM for P-401).

5. Fill Stations: The tanks are connected to fill stations, and the flow can be directed to these stations as needed.

6. Temperature and Pressure Indicators: Each tank has temperature (TT) and pressure (PIT) indicators to monitor the conditions inside the tanks.

7. User Interface: The interface includes tabs for different sections such as Tank Overview, Fill Station 3, Fill Station 4, Fill Station 5, Statistics, Valve Control Settings, and Trend.

8. Additional Information: The screen shows the current user (Symbiont) and the date and time (October 23, 2020, 12:08:27 PM).

This overview screen is likely used by operators to monitor and control the process parameters of the tanks in a plant.

Fill Station 3

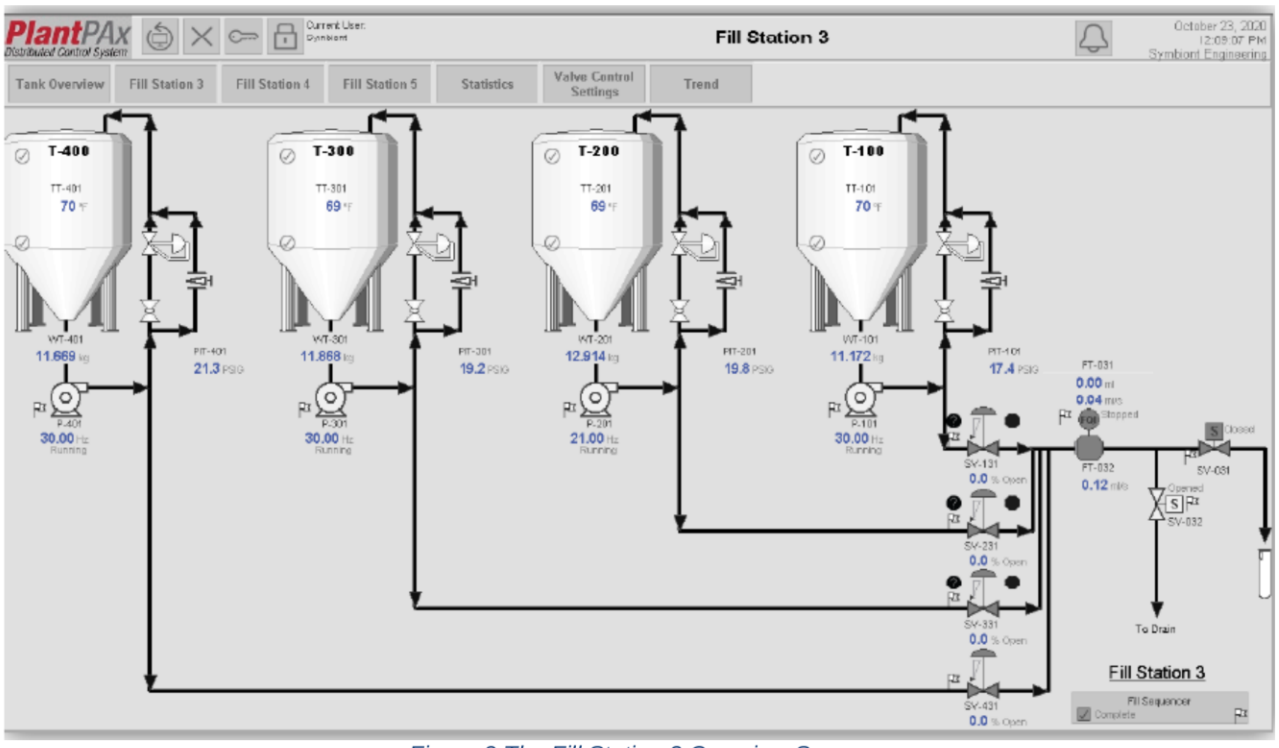

Figure 2 The Fill Station 3 Overview Screen

The Fill Station 3 Overview Screen provides an overview of the tank skid as well as an overview and sequencer control for Fill Station 3. Under normal operation, Fill Station 3 will be in program mode and triggered automatically. However, the ability is present to operate the fill sequence manually for testing purposes.

The image (Figure 2) is a screenshot of a control system interface for Fill Station 3, part of a PlantPAx Distributed Control System. The interface displays a schematic diagram of four tanks (T-400, T-300, T-200, and T-100) and their associated instrumentation and control elements.

Key elements in the image include:

1. Tanks (T-400, T-300, T-200, T-100):

- Each tank has a temperature transmitter (TT) indicating the temperature in degrees Fahrenheit.

- Each tank has a weight transmitter (WT) showing the weight in kilograms.

2. Pumps (P-401, P-301, P-201, P-101):

- Each pump has a pressure transmitter (PT) showing the pressure in PSI.

- The frequency (Hz) at which each pump is running is also displayed.

3. Valves:

- Several solenoid valves (SV) are shown, with their status (open or closed) indicated.

- Flow transmitters (FT) and other control elements are also present.

4. Control Panel:

- The top of the screen shows the PlantPAx logo, the current user, and the date and time.

- Tabs for different sections such as Tank Overview, Fill Station 3, Fill Station 4, Fill Station 5, Statistics, Valve Control Settings, and Trend are visible.

5. Status Indicators:

- Various status indicators for the pumps, valves, and flow rates are displayed.

The diagram provides a detailed overview of the operational status and control settings for Fill Station 3, allowing operators to monitor and manage the filling process effectively.

Fill Station 4

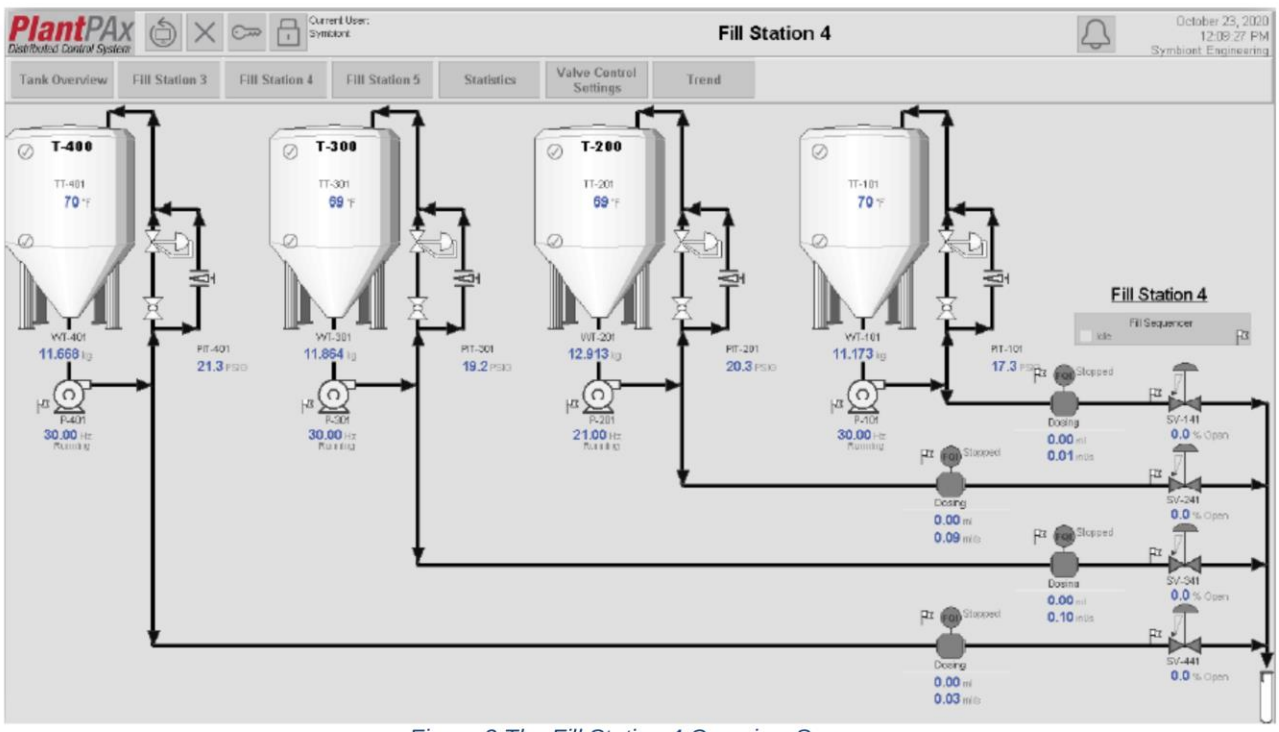

Figure 3 The Fill Station 4 Overview Screen

The Fill Station 4 Overview Screen provides an overview of the tank skid as well as an overview and sequencer control for Fill Station 4. Under normal operation, Fill Station 4 will be in program mode and triggered automatically. However, the ability is present to operate the fill sequence manually for testing purposes.

The image (Figure 3) is a screenshot of a control system interface for Fill Station 4, part of the PlantPAx Distributed Control System. The interface displays an overview of the fill station, including four tanks labeled T-400, T-300, T-200, and T-100. Each tank has associated temperature (TT), weight (WT), and pressure (PIT) readings.

Key elements in the interface include:

1. Tanks and Sensors:

- T-400: Temperature (70°F), Weight (11.668 kg), Pressure (21.3 PSIG)

- T-300: Temperature (69°F), Weight (11.864 kg), Pressure (19.2 PSIG)

- T-200: Temperature (69°F), Weight (12.913 kg), Pressure (20.3 PSIG)

- T-100: Temperature (70°F), Weight (11.173 kg), Pressure (17.3 PSIG)

2. Flow Indicators and Valves:

- Each tank has flow indicators and control valves for managing the flow of materials.

- The interface shows the status of these valves (e.g., open, closed) and the flow rates.

3. Fill Sequencer:

- The right side of the interface shows the Fill Sequencer, which includes dosing information and the status of various valves (SV-41, SV-42, SV-43, SV-44).

- The dosing section shows the amount dosed and the status (e.g., stopped, running).

4. Navigation and Control:

- The top menu bar includes options for navigating to different sections such as Tank Overview, Fill Station 3, Fill Station 4, Fill Station 5, Statistics, Valve Control Settings, and Trend.

- The current user is "Symbot," and the system is managed by Symbotic Engineering.

5. System Status:

- The top right corner shows the date and time (October 23, 2020, 12:09:27 PM).

- An alarm bell icon is present, indicating the system may have an alert or notification feature.

This interface provides a comprehensive view of the fill station's operational status, allowing operators to monitor and control the filling process efficiently.

Fill Station 5

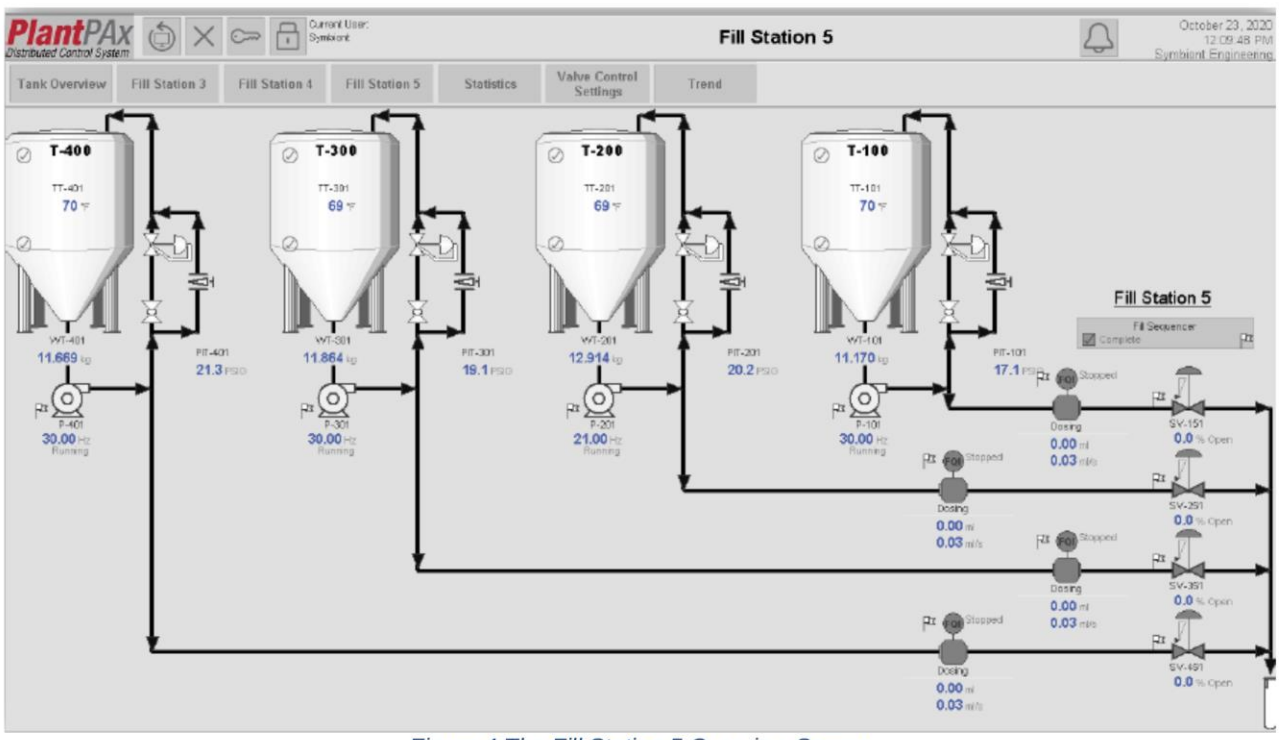

Figure 4 The Fill Station 5 Overview Screen

The Fill Station 5 Overview Screen provides an overview of the tank skid as well as an overview and sequencer control for Fill Station 5. Under normal operation, Fill Station 5 will be in program mode and triggered automatically. However, the ability is present to operate the fill sequence manually for testing purposes.

The image (Figure 4) is a screenshot of a control system interface for Fill Station 5, part of a PlantPAx Distributed Control System. The interface displays the status and parameters of four tanks labeled T-400, T-300, T-200, and T-100. Each tank has associated temperature (TT-401, TT-301, TT-201, TT-101) and weight (WT-401, WT-301, WT-201, WT-101) measurements, as well as pressure indicators (PIT-401, PIT-301, PIT-201, PIT-101).

Key elements in the interface include:

1. Tanks: Each tank shows a temperature reading (e.g., 70°F for T-400) and a weight measurement (e.g., 11.669 kg for T-400).

2. Pumps and Valves: The interface shows the status of pumps (e.g., P-401, P-301, P-201, P-101) and their running frequencies (e.g., 30.00 Hz Running).

3. Flow Rates: Flow rates are indicated in kg (e.g., 11.669 kg for T-400) and pressure in PSI (e.g., 21.3 PSI for PIT-401).

4. Fill Sequencer: On the right side, there is a fill sequencer with indicators for dosing and valve status (e.g., SV-151, SV-251, SV-351, SV-451).

5. Navigation Tabs: The top of the interface has navigation tabs for different sections such as Tank Overview, Fill Station 3, Fill Station 4, Fill Station 5, Statistics, Valve Control Settings, and Trend.

6. User Information: The top right corner shows the current user (Symbiont) and the date and time (October 23, 2020, 12:03:48 PM).

This interface provides a comprehensive overview of the operational status and parameters of the fill station, allowing operators to monitor and control the process effectively.

Statistics

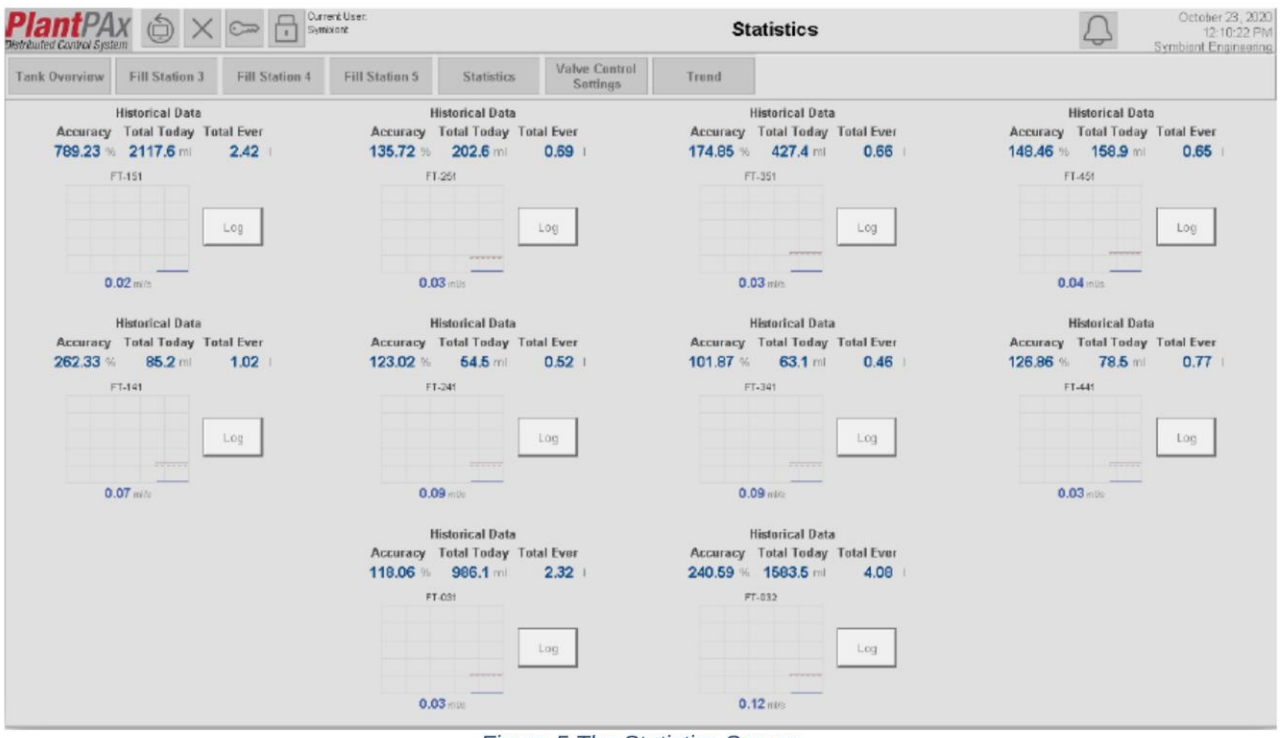

Figure 5 The Statistics Screen

The Statistics Screen provides a trend snapshot for each flow meters as well as historical data for Accuracy (Actual Volume/Target Volume*100), Total Flow Today, and Total Flow Ever. There is a Log button available for each flow meter which provides additional details.

The image (Figure 5) shows a screenshot from a PlantPAx Distributed Control System, specifically the "Statistics" screen. The screen displays various metrics for different fill stations, including accuracy, total today, and total ever. Each fill station is represented by a box with the following details:

1. FT-151: Accuracy: 789.23%; Total Today: 2117.6 ml; Total Ever: 2.42 l; Graph with a log button.
2. FT-261: Accuracy: 135.72%; Total Today: 202.6 ml; Total Ever: 0.59 l; Graph with a log button.
3. FT-351: Accuracy: 174.65%; Total Today: 427.4 ml; Total Ever: 0.66 l; Graph with a log button.
4. FT-451: Accuracy: 148.46%; Total Today: 158.9 ml; Total Ever: 0.65 l; Graph with a log button.
5. FT-141: Accuracy: 262.33%; Total Today: 86.2 ml; Total Ever: 1.02 l; Graph with a log button.
6. FT-241: Accuracy: 123.02%; Total Today: 54.5 ml; Total Ever: 0.52 l; Graph with a log button.
7. FT-341: Accuracy: 101.87%; Total Today: 63.1 ml; Total Ever: 0.46 l; Graph with a log button.
8. FT-441: Accuracy: 126.86%; Total Today: 78.5 ml; Total Ever: 0.77 l; Graph with a log button.
9. FT-091: Accuracy: 118.06%; Total Today: 966.1 ml; Total Ever: 2.32 l; Graph with a log button.
10. FT-032: Accuracy: 240.59%; Total Today: 1633.5 ml; Total Ever: 4.08 l; Graph with a log button.

The screen also includes navigation tabs at the top for "Tank Overview," "Fill Station 3," "Fill Station 4," "Fill Station 5," "Statistics," "Valve Control Settings," and "Trend." The current user is "Symbiont," and the date and time are displayed as October 23, 2020, 12:10:22 PM.

Log

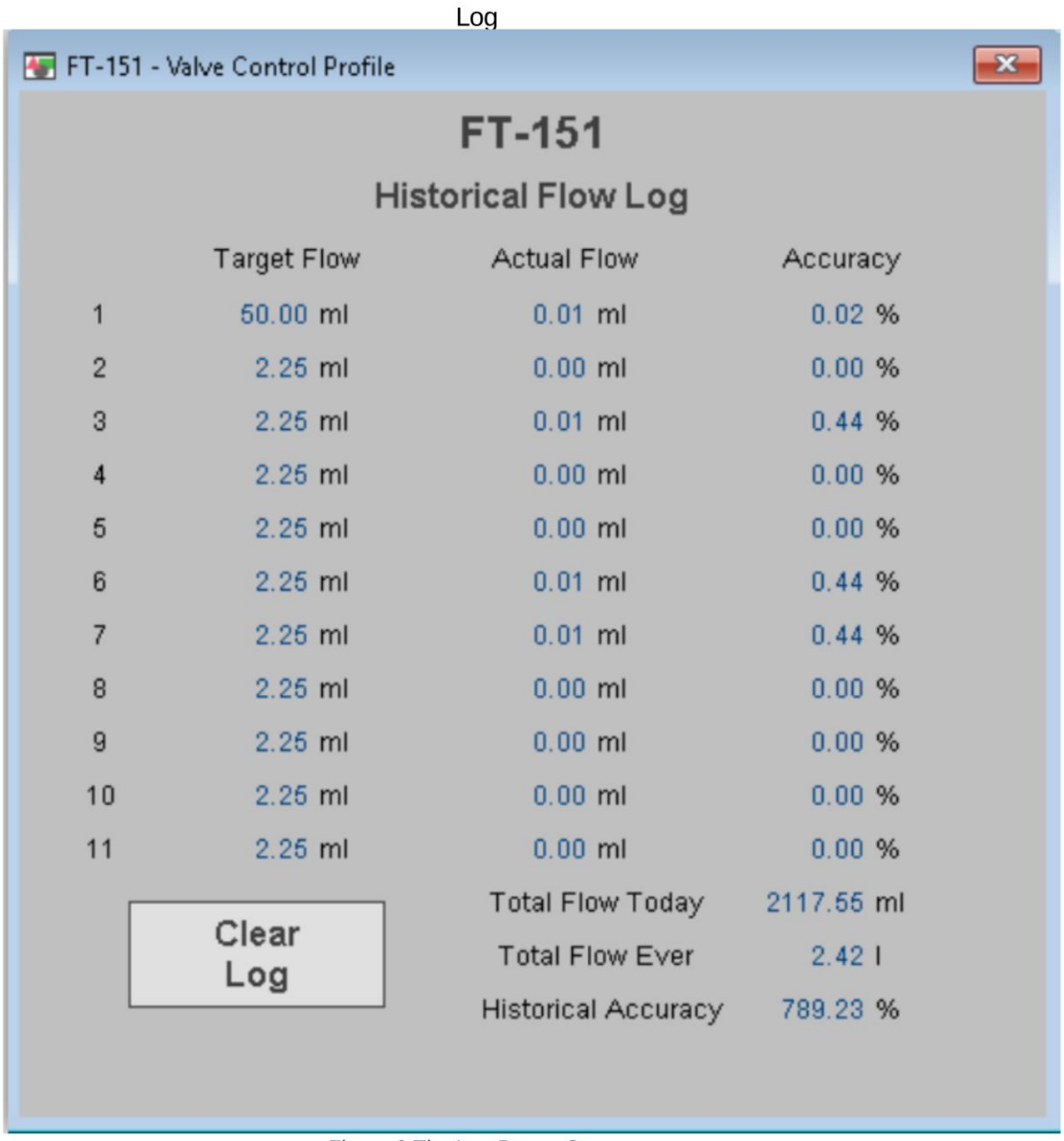

Figure 6 The Log Popup Screen

The Log Popup displays the last 10 flow commands for the selected flow meter. Each command line will display the Target Flow, Actual Flow, and Accuracy (Actual Volume/Target Volume*100). While only 10 entries are displayed, the log is 2000 entries long. Pushing the “Clear Log” button will clear all 2000 entries.

The image (Figure 6) shows a screenshot of a software interface titled "FT-151 - Valve Control Profile." The main section of the interface is labeled "FT-151 Historical Flow Log" and displays a table with three columns: "Target Flow," "Actual Flow," and "Accuracy."

Here are the details from the table:

1. Target Flow: 50.00 ml, Actual Flow: 0.01 ml, Accuracy: 0.02%

2. Target Flow: 2.25 ml, Actual Flow: 0.00 ml, Accuracy: 0.00%

3. Target Flow: 2.25 ml, Actual Flow: 0.01 ml, Accuracy: 0.44%

4. Target Flow: 2.25 ml, Actual Flow: 0.00 ml, Accuracy: 0.00%

5. Target Flow: 2.25 ml, Actual Flow: 0.00 ml, Accuracy: 0.00%

6. Target Flow: 2.25 ml, Actual Flow: 0.01 ml, Accuracy: 0.44%

7. Target Flow: 2.25 ml, Actual Flow: 0.01 ml, Accuracy: 0.44%

8. Target Flow: 2.25 ml, Actual Flow: 0.00 ml, Accuracy: 0.00%

9. Target Flow: 2.25 ml, Actual Flow: 0.00 ml, Accuracy: 0.00%

10. Target Flow: 2.25 ml, Actual Flow: 0.00 ml, Accuracy: 0.00%

11. Target Flow: 2.25 ml, Actual Flow: 0.00 ml, Accuracy: 0.00%

At the bottom of the interface, there are three summary statistics:

- Total Flow Today: 2117.55 ml

- Total Flow Ever: 2.42 l

- Historical Accuracy: 789.23%

There is also a button labeled "Clear Log" on the left side of the interface.

Below the interface, there is a caption that reads "Figure 6 The Log Popup Screen."

Valve Control Settings

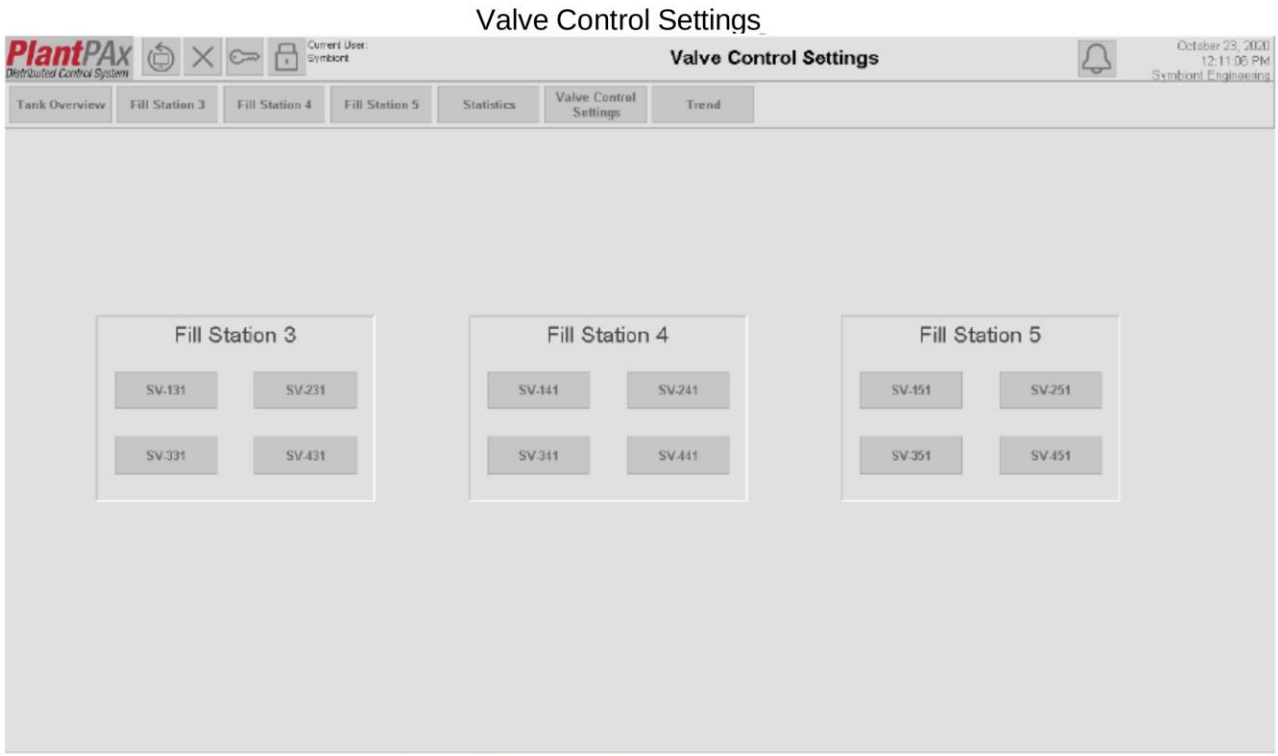

Figure 7 The Valve Control Settings Screen

The Valve Control Settings Screen is an interface to select any valve one wants to view or modify the current valve profile. Pushing a valve button will open a Valve Control Profile Popup for said valve.

The image (Figure 7) shows a screenshot of the "Valve Control Settings" screen from a PlantPAx Distributed Control System. The screen is divided into three sections, each representing a different fill station:

1. Fill Station 3:
   - SV-131
   - SV-231
   - SV-331
   - SV-431
2. Fill Station 4:
   - SV-141
   - SV-241
   - SV-341
   - SV-441
3. Fill Station 5:
   - SV-151
   - SV-251
   - SV-351
   - SV-451

The top of the screen has a navigation bar with the following tabs:

- Tank Overview
- Fill Station 3
- Fill Station 4
- Fill Station 5
- Statistics
- Valve Control Settings (currently selected)
- Trend

In the top right corner, the current user is identified as "symbmt" and the time and date are displayed as "October 23, 2021, 12:11:06 PM". The user is associated with "Symbmt Engineering". There is also a bell icon, likely for notifications.

Valve Control Profile

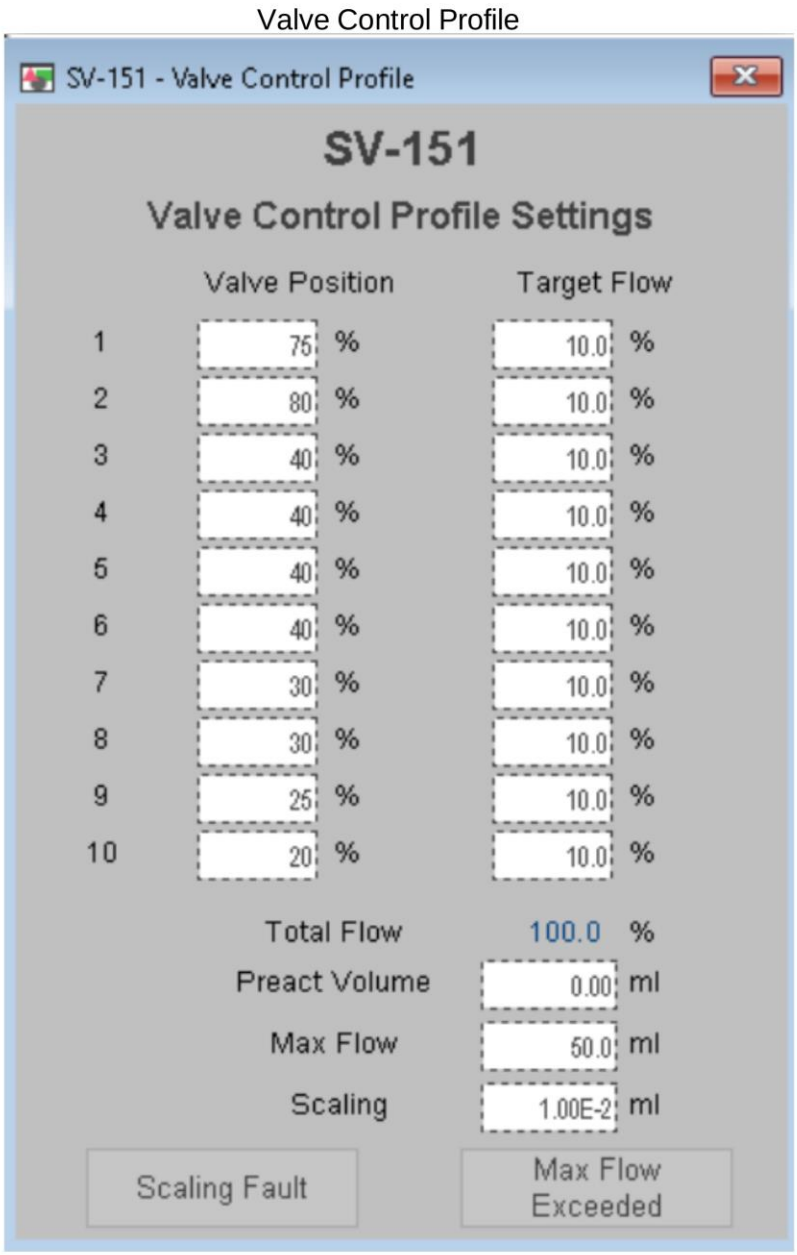

Figure 8 The Valve Control Profile Popup Screen

The Valve Control Profile Popup allows users to modify the valve control settings. Each valve is setup to dose a target % of total flow volume for 10 different programmable positions. There is also an Preact field that can be entered. The preact will cause the valve to targe the target volume minus the preact volume. This value is entered in an attempt to adjust for the delay in valve reaction. Users can also enter the Scaling parameter, which is the amount of volume per pulse as setup in the flow meters. By default this value is 0.01ml/pulse.

The image (Figure 8) shows a screenshot of a software interface titled "SV-151 - Valve Control Profile." The interface is designed for setting the valve control profile, which includes configuring the valve position and target flow for different steps.

Interface Details:

- Title: SV-151 - Valve Control Profile

- Main Section: Valve Control Profile Settings

  - Valve Position: Listed from 1 to 10 with corresponding percentage values.

    - 1: 75%

    - 2: 80%

    - 3: 40%

    - 4: 40%

    - 5: 40%

    - 6: 40%

    - 7: 30%

    - 8: 30%

    - 9: 25%

    - 10: 20%

  - Target Flow: Each valve position has a target flow of 10.0%.

Additional Information:

- Total Flow: 100.0%

- Preact Volume: 0.00 ml

- Max Flow: 50.0 ml

- Scaling: 1.00E-2 ml

Buttons:

- Scaling Fault

- Max Flow Exceeded

Caption:

- Figure 8 The Valve Control Profile Popup Screen

This interface appears to be part of a control system for managing the flow through a valve, allowing the user to set specific positions and flow targets for different steps in a process.

Trend

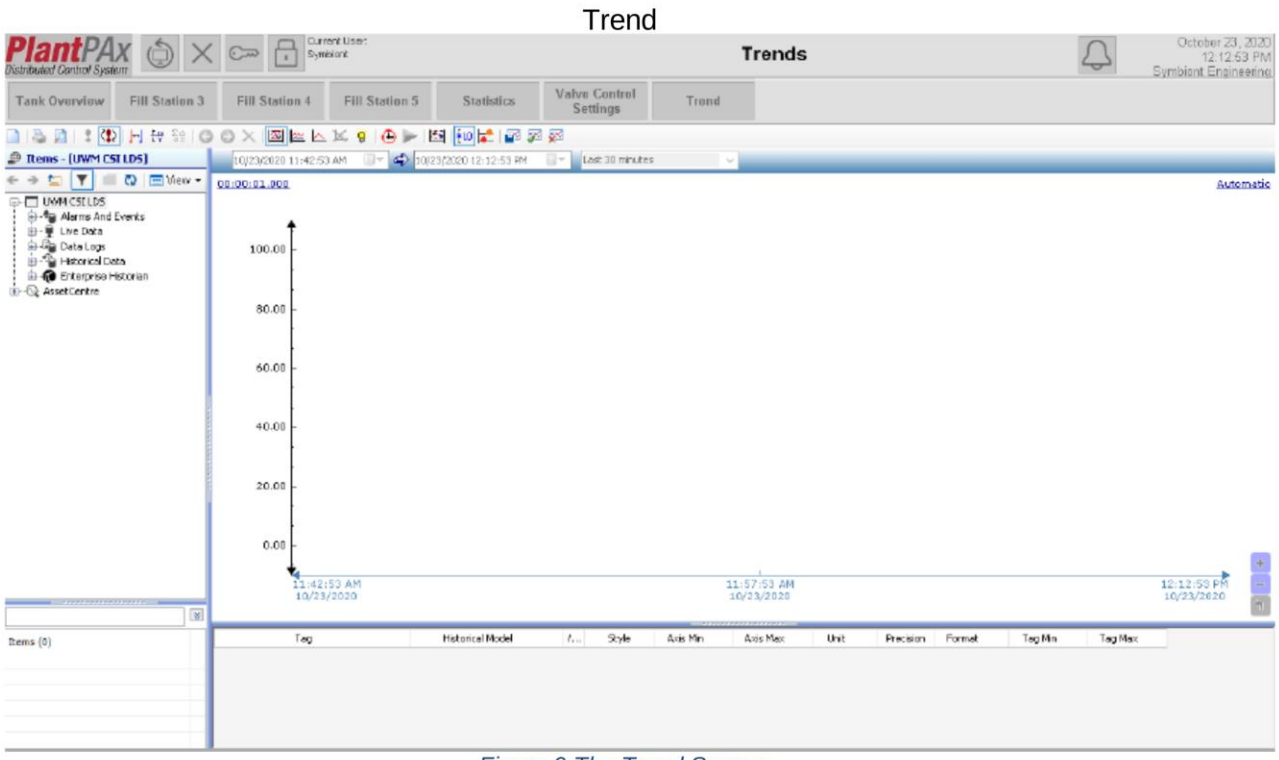

Figure 9 The Trend Screen

The Trend Screen utilizes the Allen-Bradley Trend Pro object to give users access to multiple data sources for trending. Trends can then be manipulated to the desired scaling and style. Trend templates can even be saved to be recalled at a later time.

The image (Figure 9) shows a screenshot of a software interface from PlantPAx, a distributed control system. The interface is labeled "Trends" and displays a trend screen for monitoring data over time.

Key elements in the screenshot include:

1. Top Menu Bar:

- Contains options such as "Tank Overview," "Fill Station 3," "Fill Station 4," "Fill Station 5," "Statistics," "Valve Control Settings," and "Trend."

- The current user is "Symbiont."

- The date and time are displayed as "October 23, 2020, 12:12:53 PM."

2. Left Panel:

- Displays a tree structure with items such as "Alarms and Events," "Live Data," "Data Logs," "Historical Data," "Enterprise Historian," and "AssetCentre."

3. Main Graph Area:

- A blank graph with a vertical axis ranging from 0 to 100 and a horizontal time axis.

- The time range is set to "Last 30 minutes."

- The graph is currently not displaying any data points.

4. Bottom Panel:

- Contains columns for "Tag," "Historical Model," "Style," "Axis Min," "Axis Max," "Unit," "Precision," "Format," "Tag Min," and "Tag Max."

- This section is currently empty.

5. Toolbar:

- Located above the graph area, it includes various icons for different functions such as zooming, panning, and other data manipulation tools.

6. Figure Caption:

- At the bottom of the image, there is a caption labeled "Figure 9 The Trend Screen."

This interface is typically used for monitoring and analyzing trends in industrial processes, allowing operators to visualize data over time and make informed decisions based on historical and real-time data.

Alarm Summary

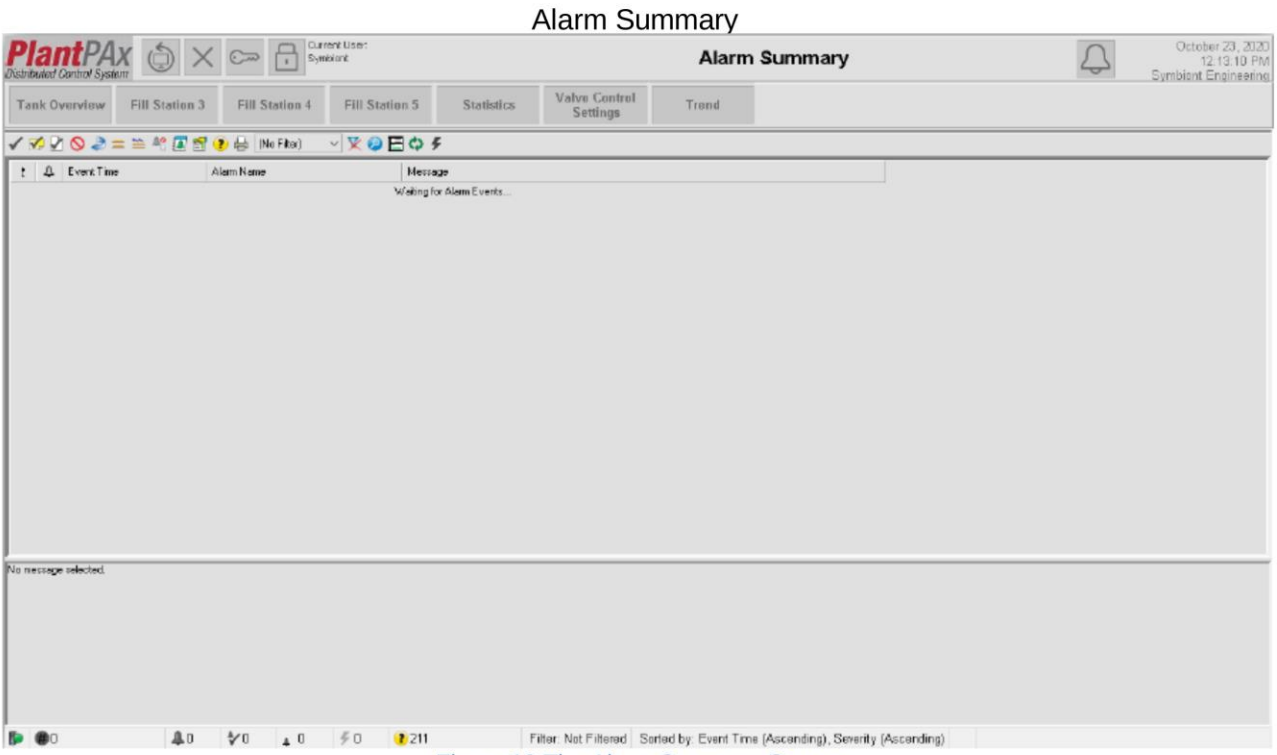

Figure 10 The Alarm Summary Screen

The Alarm Summary Screen will display the list of current alarms. Using the PlantPAx features, when devices are in an alarm state the associated navigation button and device symbol will also be highlighted to indicate a problem. Depending on the severity of the alarm these indicators will change color (yellow = warning, orange = alarm, red = severe alarm).

The image (Figure 10) shows a screenshot of the "Alarm Summary" screen from a PlantPAx Distributed Control System. The interface is designed to monitor and display alarm events within the system.

Key elements of the screen include:

1. Top Menu Bar: Contains various tabs and options such as "Tank Overview," "Fill Station 3," "Fill Station 4," "Fill Station 5," "Statistics," "Valve Control Settings," and "Trend."

2. Alarm Summary Section: This section is currently empty and displays the message "Waiting for Alarm Events..." indicating that no alarms are currently active.

3. Toolbar: Located below the top menu bar, it includes icons for various functions like filtering, sorting, and acknowledging alarms.

4. Current User and Time: Displays the current user as "Symbolx" and the date and time as "October 23, 2020, 12:13:10 PM."

5. Status Bar: At the bottom, it shows the status of messages, with indicators for different types of alarms (e.g., active, acknowledged, etc.).

The figure caption at the bottom reads "Figure 10 The Alarm Summary Screen," indicating that this image is part of a larger document or manual.

Refresh

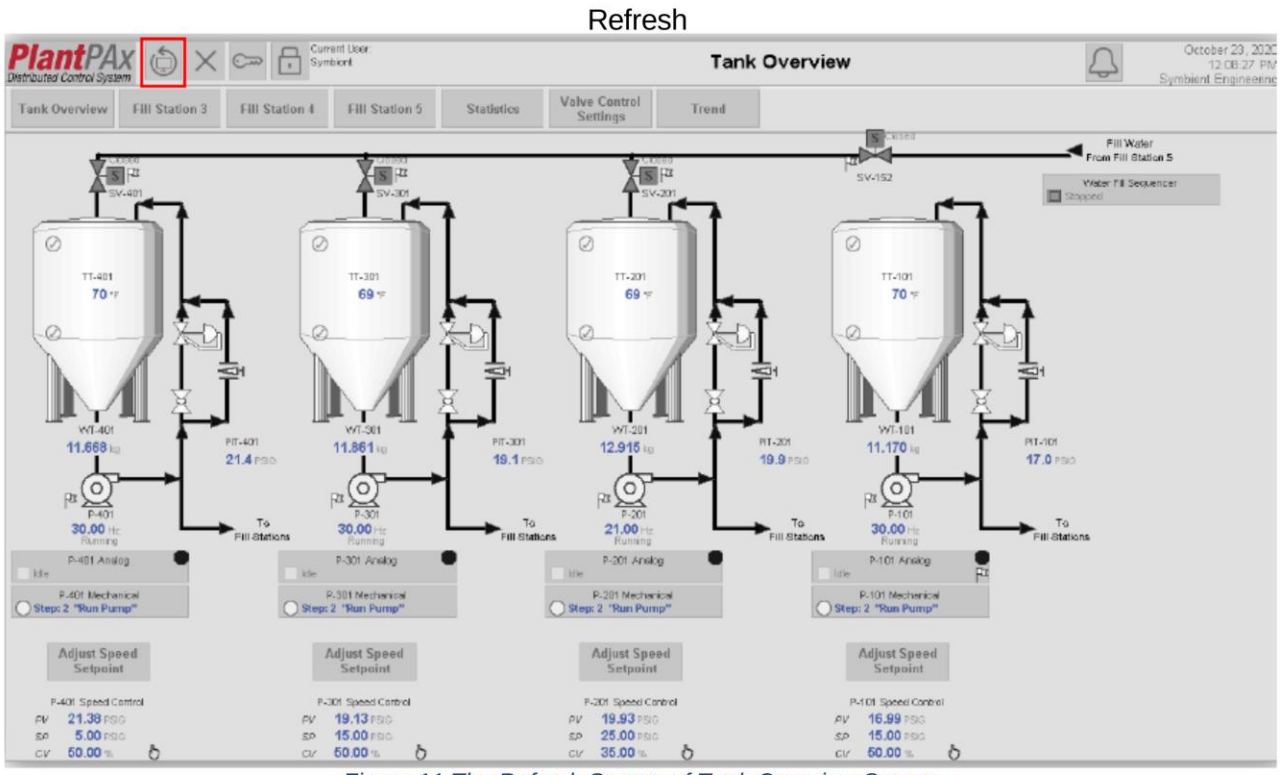

Figure 11 The Refresh Screen of Tank Overview Screen

The Repaint button will clear all open screen and reload the HMI to the Tank Overview Screen. This can be useful when making updates to the HMI. Instead of rebooting the HMI after an update, a simple repaint command will update the screens.

The image (Figure 11) shows a screenshot of a Distributed Control System (DCS) interface, specifically the "Tank Overview" screen from PlantPAx. The screen displays the status and control parameters for four tanks, labeled TT-401, TT-301, TT-201, and TT-101. Each tank has associated temperature (TT), pressure (PT), and flow (FT) transmitters, as well as control valves (SV) and pumps (P).

Key elements in the interface include:

1. Tank Information: Each tank shows temperature readings (e.g., 70°F for TT-401), flow rates (e.g., 11.668 for FT-401), and pressure readings (e.g., 21.4 PSI for PT-401).

2. Control Valves and Pumps: The status of control valves (e.g., SV-401) and pumps (e.g., P-401) is indicated, with options to adjust speed setpoints and control modes (e.g., "Step 2: Run Pump").

3. Navigation Tabs: The top of the screen has navigation tabs for different sections such as "Tank Overview," "Fill Station 3," "Fill Station 4," "Fill Station 5," "Statistics," "Valve Control Settings," and "Trend."

4. System Status: The top right corner shows the current date and time (October 23, 2002, 12:01:27 PM) and the current user (Symbiont).

5. Flow Paths: The diagram includes flow paths for fill water and connections to fill stations, with indicators for the direction of flow and the status of the system (e.g., "Running").

6. Adjust Speed Setpoint: Each tank has a section for adjusting the speed setpoint of the associated pump, with current values for process variable (PV), setpoint (SP), and output (OP).

This interface allows operators to monitor and control the process parameters of the tanks, ensuring efficient and safe operation of the system.

Close

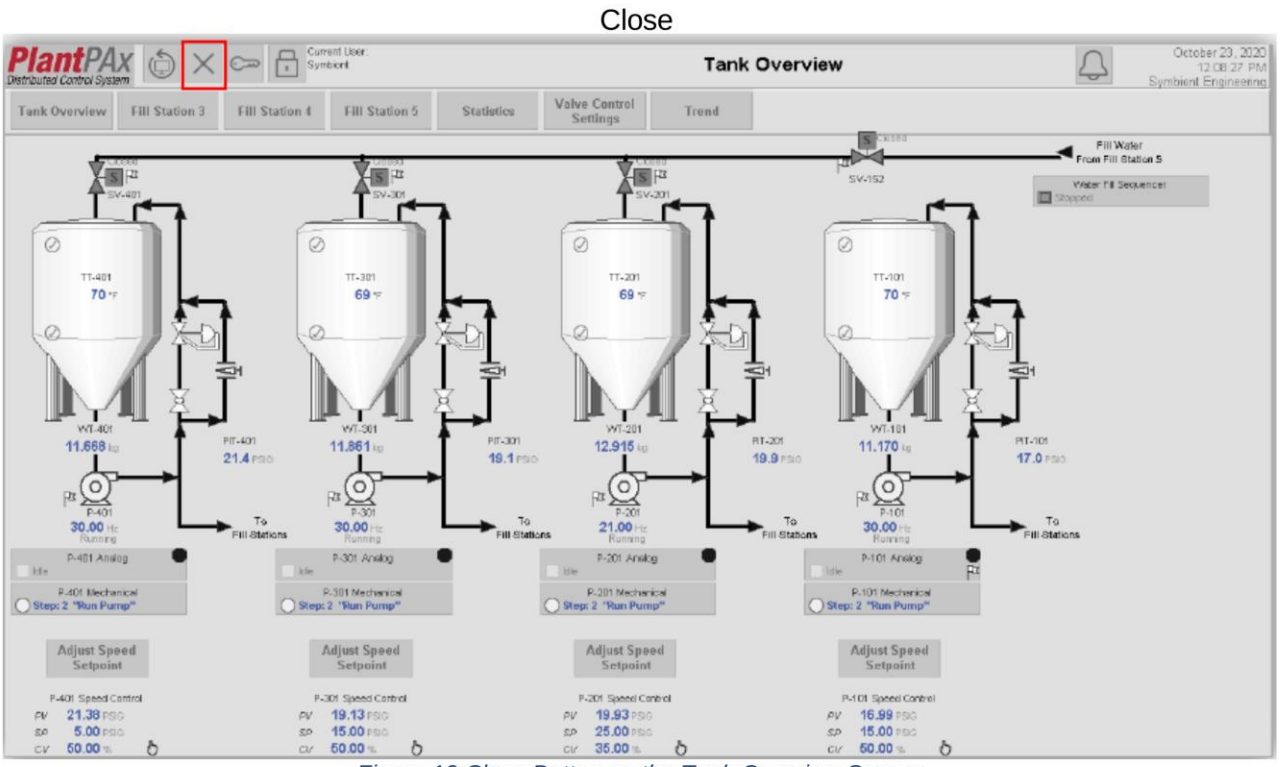

Figure 12 Close Button on the Tank Overview Screen

The Close Button will shut down the HMI Client

The image (Figure 12) shows a screenshot of a PlantPAx Distributed Control System (DCS) interface, specifically the "Tank Overview" screen. The interface displays the status and control settings for four tanks, labeled TT-401, TT-301, TT-201, and TT-101. Each tank has associated parameters such as temperature (in degrees Fahrenheit), pressure (in PSIG), and flow rates (in GPM).

Key elements in the interface include:

1. Tank Overview: The top section of the screen shows the navigation tabs for different sections such as Fill Station 3, Fill Station 4, Fill Station 5, Statistics, Valve Control Settings, and Trend.

2. Tank Details: Each tank is depicted with its respective temperature (e.g., 70°F, 69°F, 70°F, 70°F), pressure (e.g., 21.4 PSIG, 19.1 PSIG, 17.0 PSIG, 21.3 PSIG), and flow rates (e.g., 11.668 GPM, 11.861 GPM, 12.196 GPM, 11.173 GPM).

3. Control Valves and Pumps: The diagram includes control valves (e.g., SV-401, SV-301, SV-201, SV-101) and pumps (e.g., P-401, P-301, P-201, P-101) with their operational status (e.g., Running, Stopped).

4. Adjust Speed Setpoint: Each tank has a section for adjusting the speed setpoint of the associated pump, with current values (PV) and setpoints (SP) displayed in PSIG.

5. System Status: The top right corner shows the current date and time, user information, and system status.

6. Close Button: The red "X" button at the top left corner is labeled as "Figure 12 Close Button on the Tank Overview Screen," indicating its function to close the current screen.

This interface is used for monitoring and controlling the operations of the tanks in an industrial setting, providing real-time data and control options to the operator.

Login/Logout

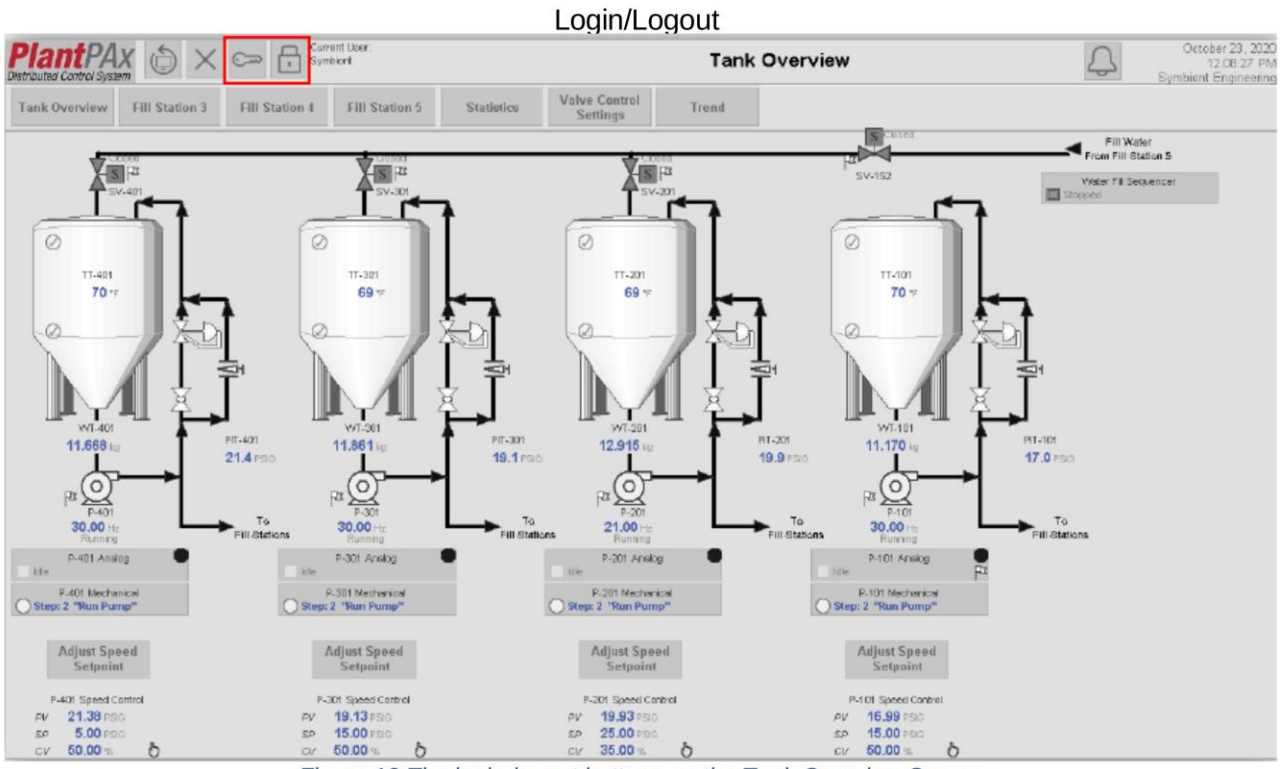

Figure 13 The login-logout buttons on the Tank Overview Screen

The login/logout buttons allow users to change who is currently logged into the HMI. While logins can be setup to utilize the domain server, there can also be local logins.

The image (Figure 13) shows a screenshot of a PlantPAx Distributed Control System (DCS) interface, specifically the "Tank Overview" screen. The interface displays detailed information about four tanks, including various parameters and controls.

Key elements in the image include:

1. Header Section:

- The PlantPAx logo and the text "Distributed Control System" are located in the top left corner.

- The current user is indicated as "Current User: Support."

- The date and time are displayed in the top right corner: "October 23, 2020, 12:27:32 PM."

- The title "Tank Overview" is centered at the top.

2. Navigation Tabs:

- Tabs for different sections of the system are visible, including "Tank Overview," "Fill Station 1," "Fill Station 2," "Fill Station 3," "Fill Station 4," "Fill Station 5," "Statistics," "Valve Control Settings," and "Trend."

3. Tank Information:

- Four tanks are shown, each with a unique identifier (e.g., TT-401, TT-301).

- Each tank displays temperature readings (e.g., 70°F, 69°F).

- Flow rates and pressures are indicated for each tank (e.g., 21.4 PSIG, 11.861).

- Control options for adjusting speed setpoints are available for each tank.

4. Login-Logout Buttons:

- Highlighted in the image are the login-logout buttons, located in the top menu bar. These buttons are used to manage user access to the system.

5. Additional Controls and Indicators:

- Various control elements such as pumps (e.g., P-401, P-301) and valves (e.g., SV-124, SV-224) are depicted with their operational statuses.

- Indicators for different steps in the process (e.g., "Step 2: Run Pump") are shown.

The figure caption at the bottom reads: "Figure 13 The login-logout buttons on the Tank Overview Screen," emphasizing the location and function of these buttons within the interface.

Section 5.0
SAFETY

5.1 INTRODUCTION

Safety is accomplished by individual effort and group cooperation. Only informed people who respect themselves and have a high regard for the welfare of others can achieve a safe work environment.

A. Safety is Your Responsibility

It is your responsibility and obligation as the owner/user of this pH adjustment equipment to ensure that all persons who may come in contact with the equipment and chemicals are thoroughly trained and familiar with its operation, maintenance, and safety requirements. Only qualified persons should be allowed to come in contact with this equipment. Qualified persons are those knowledgeable in the operation, maintenance, and safety aspects of the equipment and chemicals used for this system.

B. Safety Precautions

All safety begins and ends with prudent, responsible personnel whose welfare is the primary concern. There is no greater safety practice than the care and common sense exercised by you.

The SAFETY section discusses the major safety aspects of the chemicals and equipment used in the system. This guide advises personnel of the major safety precautions required for safe start-up, operation, and maintenance of this system. However, no manual can cover every possible hazard. The ultimate responsibility for safety rests with you! Remember:

No work is so urgent or so important that you cannot take the time to do the job safely.

Think about what you are doing!

Safety is no joke! Be serious about safety!

This system may be potentially dangerous for those not familiar with the specific hazards involved in installing, operating and servicing this system.

Only qualified, knowledgeable people should be allowed to contact this system.

If you are going to work on or near this equipment, it is YOUR PERSONAL RESPONSIBILITY to learn as much as possible beforehand about the system and the dangers it may present. This is important for your safety and the safety of others working with you.

5.2 MAINTENANCE SAFETY

The following procedures should be followed whenever maintenance of any pump is required:

A. The HAND/OFF/AUTOMATIC (HOA) switch on the control panel servicing the device to be maintained should be turned to the **OFF** position.

B. The local disconnect for the equipment to be serviced should be shut off.

C. All pumps have been installed with isolating valves and/or unions to assist in their removal and maintenance. These valves should be closed before attempting to service a pump, and the material drained from the pump.

D. After all necessary maintenance has been performed, open all isolating valves. Place the pump back in service by turning the disconnect "ON" and the HOA switch on the control panel to the “AUTO” position.

5.3 PERSONAL PROTECTIVE EQUIPMENT

A. Whole body to protect, inside and outside

B. Equipment worn should vary with the exposure potential

1. Safety glasses and gloves

2. Safety glasses, goggles, gloves, rain gear, or impervious apron, boots

3. Respirator (air purifying or air supplied)

   a. Dust and mist (include asbestos and lead) instructions right on the box, check headbands, cup under chin, bottom band behind head and below ears, top band behind head above ears, adjust nosepiece, check fit for leaks around edges, readjust bands or nosepiece as required – no fit no entry – warnings on respirator limitations not for gases, fumes, vapors.

   b. Canister type of air purifying – organic vapors, spray painting, dusts, and mists. Instructions on fitting and limitations to be studied; check exhalation valve, canister seating, straps okay and properly adjusted. Test fit covering and properly adjusted. Test fit covering exhalation valve and blowing into unit, slight positive pressure inside with no leaks around edges – no fit no entry.

   c. A variety of canisters are available for different chemical exposures. Uses are listed on the side and they are color coded for easy identification.