



## System Overview

This system is an Auxiliary Fluid System (AFS) that supplies the main chemical industrial processes with Arsenic Trioxide ( $\text{As}_2\text{O}_3$ ). The system consists of a large tank with a capacity of  $65.5\text{m}^3$ , supplied by <PUMP A> and drained by <PUMP B>. The flow rate of <PUMP A> is fixed, and the flow rate of <PUMP B> is limited by <VALVE B>. If <VALVE B> is closed (0%) then <PUMP B> is automatically shut off. Pressure Operated Relief Valves (PORV) exist to relieve tank of fluid if system is overfilled. This is dangerous - see **Safety**.

## System Limits

Tank Volume	65.5m <sup>3</sup>	PORV triggered (see <b>Safety</b> )
High Level Alarm	62.3m <sup>3</sup>	Pump A auto-shutoff initiated
Low Level Alarm	06.6m <sup>3</sup>	Pump B auto-shutoff initiated
Valve B Position	100%	-

## Control and Monitoring

The system is controlled by a Phoenix Contact AXC F 2152 PLC. The PLC hosts several Modbus servers to enable HMI control, data acquisition, and manual overrides. The Modbus servers are found on the following ports:

HMI_MB_SERVER	TCP:502	Dedicated HMI connection
HIST_MB_SERVER	TCP:1502	Dedicated Historian connection
DebugOverrideSERVER	UDP:420	Multi-connect, for development only

Content in <HMI\_MB\_SERVER> and <HIST\_MB\_SERVER> are identical:

DIGITAL INPUTS (DI) / INPUTS			
DI 0	High_Level_Alarm	Binary, read-only	High level alarm
DI 1	Low_Level_Alarm	Binary, read-only	Low level alarm
DI 2	Pump_A_Status	Binary, read-only	Status of Pump A
DI 3	Pump_B_Status	Binary, read-only	Status of Pump B
DI 4	-	-	-
DI 5	PORV_ENGAGED	Binary, read-only	True if PORV engaged
ANALOG INPUTS (AI) / INPUT REGISTERS			
AI 0	Tank_Level	0-65535, read-only	Tank level, m <sup>3</sup>
DIGITAL OUTPUTS (DO) / OUTPUT COILS			
DO 0	Pump_A_Cmd	Binary, read-write	Command for Pump A
DO 1	Pump_B_Cmd	Binary, read-write	Command for Pump B
ANALOG OUTPUTS (AO) / HOLDING REGISTERS			
AI 0	Valve_B_Pstn	0-65535, read-write	Position of Valve B, max 100

Content in <DebugOverrideSERVER> is as follows:

DIGITAL INPUTS (DI) / INPUTS			
DI 5	PORV_ENGAGED	Binary, read-only	True if PORV engaged
DIGITAL OUTPUTS (DO) / OUTPUT COILS			
DO 5	DisableSafetyLimits	Binary, read-write	If true, pump shutoffs are disabled. Only for testing during maintenance activities <b>DO NOT ENGAGE DURING NOMINAL OPERATIONS</b>



### HMI Variable Watch List

The Human-Machine Interface (HMI) is implemented using Scada-LTS to monitor and control the system. The *ChemTank Watch List* contains the variables and their values, as well as the last-update time.

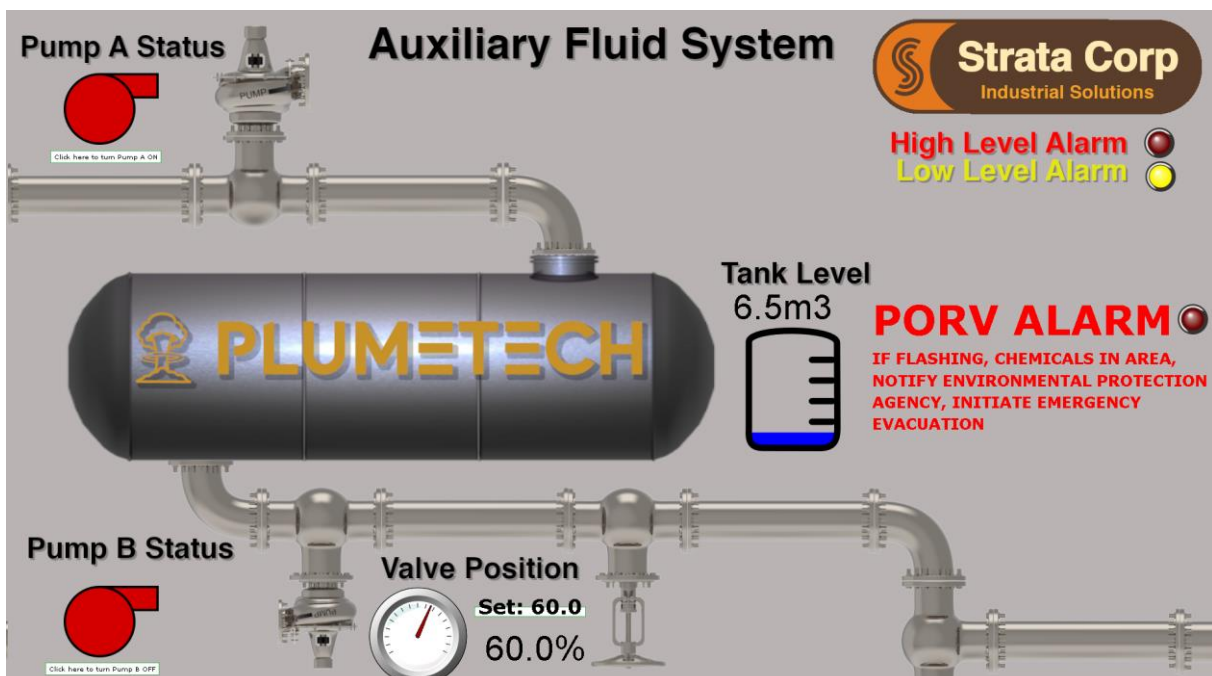
The screenshot shows the Scada-LTS interface with the following details:

- Header:** Scada-LTS Powered by Scada-LTS team, v2.7.5.2 build 4551883606, (GitHub ref: Scbf497), runs on Linux6.8.0-1021-aws, Urgent, Click and set instance description, User: admin.
- Points:** A list of variables including AF\_ChemTank\_Controller - High Level Alarm, AF\_ChemTank\_Controller - Low Level Alarm, AF\_ChemTank\_Controller - PORV Alarm, AF\_ChemTank\_Controller - Pump A Command, AF\_ChemTank\_Controller - Pump A Status, AF\_ChemTank\_Controller - Pump B Command, AF\_ChemTank\_Controller - Pump B Status, AF\_ChemTank\_Controller - Tank Level, and AF\_ChemTank\_Controller - Valve B Position.
- Watch list:** A table showing the current values and last update times for the selected variables.

Variable	Value	Last Update	Icons
AF_ChemTank_Controller - High Level Alarm	0	09:05:44	Check, Search, Up, Down, Refresh
AF_ChemTank_Controller - Low Level Alarm	1	09:05:44	Check, Search, Up, Down, Refresh
AF_ChemTank_Controller - Pump A Command	0	09:05:44	Check, Search, Up, Down, Refresh
AF_ChemTank_Controller - Pump A Status	0	09:05:44	Check, Search, Up, Down, Refresh
AF_ChemTank_Controller - Pump B Command	1	09:05:44	Check, Search, Up, Down, Refresh
AF_ChemTank_Controller - Pump B Status	0	09:05:44	Check, Search, Up, Down, Refresh
AF_ChemTank_Controller - Tank Level	6525.0	09:05:44	Check, Search, Up, Down, Refresh
AF_ChemTank_Controller - Valve B Position	60.0	09:05:44	Check, Search, Up, Down, Refresh
AF_ChemTank_Controller - PORV Alarm	0	09:05:44	Check, Search, Up, Down, Refresh

### HMI Graphical View

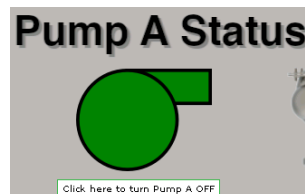
The main graphical view of the HMI enables the user to control the process using the buttons and setpoints on the screen. The HMI Graphical View looks like the following:





### Pump Control

To turn a pump on, click the button below the pump status indicator. To turn the pump off, click the same button below the status indicator. **NOTE:** <PUMP\_B> will only turn on if the position of <VALVE\_B> is greater than ZERO.



### Valve Control

To control the valve position, hover the cursor over the “Set:” input, and click the spanner icon (see red square, right). Enter in a value in the field and hit the enter key on the keyboard. Double-click the tooltip to close it.



### Standard Alarms

**High Level Alarm**  
**Low Level Alarm**



There are two visible standard alarms. These alarms will flash with the high and low limits of the process are reached. If the level of the tank reaches a high of 62.3m<sup>3</sup>, the high level alarm will flash and the system will shut off <PUMP\_A>. If the level of the system reaches a low of 6.6m<sup>3</sup>, the system will shut off <PUMP\_B>.

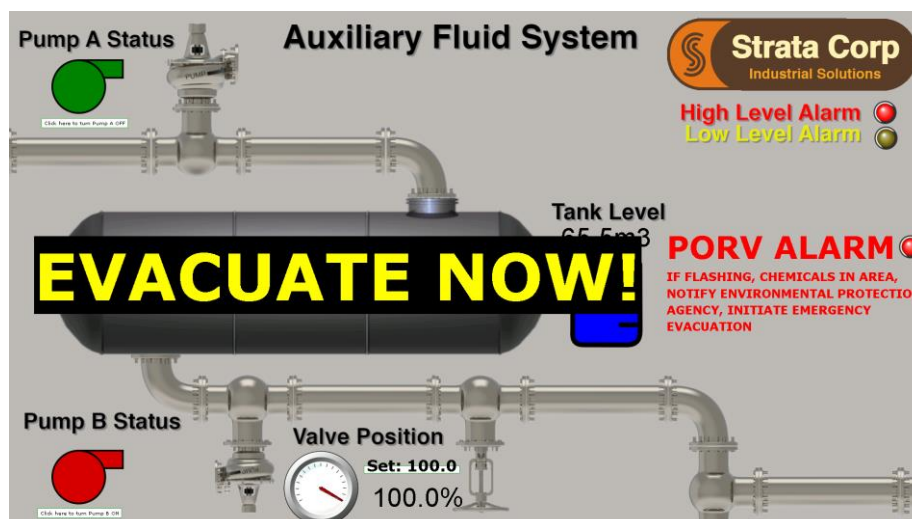
### SAFETY – PORV ALARMS

The Pressure Operated Relief Valves (PORV) have their own alarm for when the chemical liquid level reaches the maximum 65.5m<sup>3</sup>.

**PORV ALARM**  
IF FLASHING, CHEMICALS IN AREA,  
NOTIFY ENVIRONMENTAL PROTECTION  
AGENCY, INITIATE EMERGENCY  
EVACUATION

**IF THE PORV ALARM IS FLASHING RED, THERE ARE CHEMICALS IN THE ATMOSPHERE – EMERGENCY EVACUATION MUST BE INITIATED.**

You will see the following HMI Graphical View state:





### Historical Data View

A process historian – a data archiving machine – has been integrated. After navigating to the historian and logging into the interface, the “AF Chem Tank Monitoring System” will show batch historical data from the last 6 hours of operation:

