Introduction to the PlantPAx Process System for Operations and Engineering Lab

(Great Demo Format - RAOTM)

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**WARNING**

Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

**IMPORTANT**

Identifies information that is critical for successful application and understanding of the product.

**ATTENTION**

Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you:

- identify a hazard
- avoid a hazard
- recognize the consequence

**SHOCK HAZARD**

Labels may be located on or inside the drive to alert people that dangerous voltage may be present.

**BURN HAZARD**

Labels may be located on or inside the drive to alert people that surfaces may be dangerous temperatures.
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**About this Lab**

In the engineering section of the lab, we will familiarize the user with the steps necessary to start development of a PlantPAx™ Distributed Control System (DCS) project using Studio 5000 Architect and the Rockwell Automation Library of Process Objects. In the operations section we will explore the library faceplates and operate several simulated PlantPAx process applications.

PlantPAx is the modern DCS from Rockwell Automation with all the core capabilities expected from a world-class DCS. The system is built on a standard-based architecture using Integrated Architecture components that enable multi-disciplined control and Premier Integration with the Rockwell Automation Intelligent Motor Control portfolio.

The PlantPAx modern distributed control system offers process control and more:

- Plant-wide control and optimization for dynamic, demand-driven business decisions
- Scalable and modular system architectures to meet your exact needs
- Open, secure and information-enabled networking capabilities
- Flexible delivery and support options

In this lab we will do the following:

- Use Studio 5000 Architect and system templates to develop a PlantPAx application
- Leverage Controller Application templates and Process Strategies from the Rockwell Automation Library of Process Objects to configure tank level control.
- Leverage HMI Application templates to configure an HMI display with device objects.
- Configure alarms and explore the library Sequencer object
- Run a simulated waste water application

**Tools and Prerequisites**

This lab uses a VMWare Workstation® image virtualized environment. All the software tools required for this lab are installed within this image running on your lab host PC. These tools include:

- VMWare Workstation v10
- Studio 5000 Architect Application V2.0
- Studio 5000 Logix Designer Application V24
- FactoryTalk View Studio Software V8.1
- FactoryTalk View SE Client Application V8.1
- Rockwell Automation Library of Process Objects V3.5
- RSLogix Emulate 5000 Software V24

**Where to Get the Rockwell Automation Library of Process Objects**


Please STOP AND WAIT FOR INSTRUCTOR before continuing.
Initial Lab Setup

The following initial setup steps are needed before we can start the lab.

Close the open Client window by clicking on the red X.

If the controller in slot 2 is faulted ("red lighted"), Right-click on the controller in slot 2 and click on Clear Major Faults in the drop-down window.
Notice that the faults for the controller in slot 2 have cleared. Right-click again on the controller in slot 2 and this time click on Run in the drop-down window.

Notice that the controller in slot 2 is now in Run mode.
If needed, repeat the above steps for the controllers in slots 3 and 4.
Engineering - Creating a PlantPAx Project

Controller properties and code are modified using Studio 5000 Logix Designer.

Double-Click the Studio 5000 icon on the left side of the desktop to open Studio 5000.


Under the Recent Projects tab, click PAC01.

Wait while Studio 5000 Logix Designer opens.
Using Studio 5000 Logix Designer to Configure the Controller

In this section of the lab, you will learn how to organize and configure your controller using pre-configured process strategies that are imported as routines into a controller application. We will add new code for a tank, including a pump and a level transmitter, to Task D running at 500ms.

We will rename the main program in Task D from Task_D_MainProgram to Tank1.

**Double-click on Task_D_MainProgram to open the Program Properties window.**
Change the **Name** of the program to **Tank1** and click **OK**.

**Importing a Process Strategy Routine for a Pump**

In this section, we will import a pre-configured Process Strategy routine for a motor (PS_Motor) into the program named Tank1. A motor can drive a blower, conveyor, mixer, agitator or a pump. We are configuring a pump to fill the tank.

**Right-click** on the program named **Tank1**. From the menus select **Add** and then **Import Routine**.
Browse to the **Lab Files folder** and select the file for a sample motor routine named *(RA-LIB)PS_Motor_3_5-00_ROUTINE.L5X*, and click **Open**.

The **Import Configuration** window will open. From this window we can configure the new routine during the import process. First, **change** the **Final Name** for the routine from MT100 to **Pump**. **Do not click OK.** This sample motor routine can be used for various motor driven devices. Because we are adding code for a pump we also need to modify the imported tagnames by replacing the “generic motor designator” MT with PMP during the routine import.
In the **Import Content** area of the configuration window, click on the **Tags** folder to view all the tags that will be imported. We want to modify the tag names by replacing the generic MT motor designator with PMP during the routine import. The MT is a default tag designator for any type of motor. A motor can drive a blower, conveyor, mixer, agitator or a pump. In this case we are designating a pump using PMP in the tag names. **Click on the Find/Replace button.**

**Find** all the instances of **MT** in the tag references and **replace** with **PMP**. Confirm that only **Final Name** is checked in the **Find Within** options. Then **click** the **Replace All** button. Confirm that seven occurrences of MT were found and replaced with PMP. **Now click OK.**
Wait for the import to complete. Once the import completes, a new routine named Pump is added to the Tank1 program. **Double-click** on the **Pump** routine to open the function-block editor and view the new code.

Verify that all the instances of MT have been replaced with **PMP** in the tagnames and input/output reference connectors with no errors. The pump control routine is done.
Close the Logix Designer window.

Click on Yes to save the changes.

Section Summary

Application templates are included in the RA Library of Process Objects for both controller applications (Logix Controller Templates) and HMI applications (HMI Project Templates) to provide a consistent starting point for system implementation. Starting with library version 3.5, process strategies are provided with the library as sample code (named Process Strategies from the RA Library of Process Objects).

Please STOP AND WAIT FOR INSTRUCTOR before continuing.
Using FactoryTalk View Studio to Configure a Graphic

FactoryTalk View Studio is configuration software for developing PlantPAx HMI applications. With FactoryTalk View Studio, you can create displays and faceplates using a full-featured graphics editor.

Again, Double-Click the Studio 5000 icon on the left side of the desktop to open Studio 5000.


This time under the Recent Projects tab click PlantPAx. This will open an existing HMI project in the HMI designer software named FactoryTalk View Studio.

Wait a short time while the FactoryTalk View Studio application opens.
Using Library Global Objects to Configure HMI Displays

Expand the Displays folder and scroll down (the displays are listed alphabetically) until you find the display named "P1f Home" (where the P1 stands for Process Area 1 and the f means this graphic is configured for full 1920x1080 resolution screens). Double-click on the display named "P1f Home" to open the display editor.

This is the blank “P1f Home” display. We will start with this display because navigation to it is already configured on the template navigation button bars. The next step will be to add a pump object for Tank1 to the display and then link the objects to tags in the controller. The easiest way to do this will be to use Global Objects.

Global Objects

A global object is an HMI display element that is created once and referenced multiple times on multiple displays in an application. When changes are made to the original (base) object, the instantiated copies are automatically updated.

In the Explorer window, expand the Global Objects folder. Scroll down until you find the global object named "(RA-BAS) P_Motor Graphics Library". The RA-BAS stands for Rockwell Automation Base library and the P_Motor means this screen contains motor objects for process control.
Double-click on the Global Object “(RA-BAS) P_Motor Graphics Library” to open the display editor.

For rapid development of information-rich operator displays, the Rockwell Automation Library of Process Objects provides a collection of **Global Objects** that are linked to the Add-On Instructions with a drag and drop wizard. Display elements include motors, valves, analog and digital indicators and even a sequencer. Together with the HMI Project Templates they allow for rapid development of display graphics.
Drag-and-Drop a **Pump** object from the Global Objects display to the blank “P1f Home” graphic.

Right-click on the new pump object in the Main graphic window and select **Global Object Parameter Values** from the selection menu.

The **Global Object Parameter Values** window opens. We need to enter the tag Value for the Motor into parameter 1. This parameter links the tag PMP100 (that we created earlier in the Logix code) to this instance of the pump object. For **parameter 1**, **click on the ellipsis button** in the column named Tag to open a Tag Browser window.
The Tag Browser window allows you to access controller tags via a browser window that presents the controller tags in a logical hierarchy. **Click** the **Refresh All Folders** button.

**Expand** the directory named **PlantPAX/Area/Data/PAC01** (“PAC01” is the data server shortcut name for the controller in slot 2 in the Emulator). Then **expand** the subdirectory named **Online**.

**Scroll-down** the list and select the tag **PMP100**. **Verify** that the Selected Tag is **/Area/Data::[PAC01]PMP100**.
Click OK.

Click OK once more to accept the updated parameter.
The display is functional but can be customized with tanks, piping, and more using the included Symbol Factory HMI library. Due to time constraints in the lab, we will not customize the display at this time.

The configuration for the pump object is complete, you can click on the Save button to save the updates to the “P1f Home” display.

Close the Studio Designer window.

Click No to close the Studio application.
Section Summary

The Rockwell Automation Library of Process Objects™ is a collection of Application Templates, Application Code, Graphic Objects, Faceplates and Process Control Strategies that let you quickly configure a device from I/O to operator.

The Studio 5000® templates and libraries can help reduce the engineering time to assemble your integrated architecture and process application.

With PlantPAx, engineering your modern DCS has never been easier.

Please STOP AND WAIT FOR INSTRUCTOR before continuing.
Operations - Device Faceplates and Operating the Plant

Using FactoryTalk View SE Client to View the HMI Application
The application (code and HMI) is finished; test it by running the FactoryTalk View SE Client. FactoryTalk View SE Client is software for viewing and interacting with the FactoryTalk View SE application at run time. Operators can use the client to view and interact with multiple graphic displays, manage alarms, view trends and adjust set points.

Click on the Lab 3.5.cli Client Icon on the desk top.

After the Client window opens, click on the lab button on the button bar.

Note: The header, button bar, and alarm banner are samples included in the Framework templates.

Click on the MT100 pump object to open the pump control operator faceplate.
From the operator faceplate Home tab, **click** on the green **start button** to start the pump.

When the discharge pump starts running, the tank empties. Note the tank will automatically reset to 100% once it empties to below 1%. **Close** the pump **faceplate**.

**Commissioning Devices using the Faceplates**

In this section, you will see how to configure the tag descriptions, labels, and alarms from the faceplates.
**Click** on the **Tank Level** indicator to open the P_AIn faceplate.

The faceplate label and tag description are still at their default values from the PS_AIn Process Strategy template. We need to change this text to LT100 Tank Level. **Click** on the **Engineering Tab**.

To make changes from the Engineering and Maintenance tabs, the user must have the appropriate access rights. Due to time constraints, we will not be addressing login security in this lab. The current login, "Labuser" has the highest level of security access.

This faceplate label and description text is stored in the controller tags therefore when changing text you must hit the Enter key to download the new data to the controller. Enter "Tank Level" and "LT100" as shown below, **hitting the Enter key at each field**.
Notice the description at the top of the faceplate has been updated to reflect the changes that have just been made. For a larger number of changes, the tag configuration updates would be completed off-line using Rockwell’s Tag Data Editing Tool.

**Click** on the **Maintenance tab** of the faceplate.

The alarm thresholds for the tank level can also be configured from the faceplate. **Click** on the **Low-Low alarm** threshold value to launch the numeric keypad entry window. Change the **Low-Low alarm** to a value of 80 and **click OK**.

The faceplate is convenient for configuring a small number of alarm setpoints.

Note: PlantPAx has available an Alarm Configurator tool for configuring a large number of alarms.
The low-low alarm still needs to be activated. **Click** on the **Alarm Tab** of the faceplate.

![Diagram showing the Alarm Tab](image)

**Click** on the **Low Low Alarm** indicator box.

![Diagram showing the Low Low Alarm](image)

The alarm configuration faceplate will open. **Notice** that the Low Low Alarm is not configured to exist for this device. **Click** Alarm Engineering Tab to configure the alarm to exist.
Click the box for "The alarm is configured to exist and will be scanned" then close the alarm configuration faceplate. The faceplate is convenient for activating a small number of alarms. PlantPAx has available an Alarm Configurator tool for configuring a large number of alarms.

Once the level falls below 80% the Low Low alarm will activate and the the alarm box will flash red.

If you wait for the level to reset to 100% and click on the Alarm Acknowledge button the alarm indicator will stop blinking.
The alarm clears until the level again falls below 80% again.

Close the tank level faceplate.

Section Summary

The docked Header and Footer displays are part of the Framework displays contained in the HMI template that also includes button bars and alarm history and help displays. The Rockwell Automation Library of Process Objects Faceplates let you quickly configure and control a device.

Please STOP AND WAIT FOR INSTRUCTOR before continuing.
PF755 Drive Fault Simulation and Lead Lag Standby Motor group (P_LLS)

In this section of the lab, we will simulate several faults on a PowerFlex drive and monitor the fault diagnostics that are built into the P_PF755 Process Object faceplate. We will also interact with the Lead/Lag/Standby Motor Group object.

Click on Pump Group from the button bar.

This process uses four PowerFlex 755 drives and a PID controller to maintain level in a tank. The four drives are being automatically started and stopped by a Lead/Lag/Standby Motor Group Object (P_LLS).

Click on the P801 Motor Group. This will launch the Lead/Lag/Standby motor group faceplate. Pumps 801A, 801B, 801C, and 801D are configured as pumps 1, 2, 3, and 4 respectively in the motor group.
Notice that the current motor demand is 2 pumps and pumps 2 and 3 are running.

The current pump order is shown in the lower left corner of the faceplate. Currently, pump 2 is the lead and pump 3 is the lag.
The tank inflow can be simulated using the slider in the upper left corner of the display. Drag the slider to the left to decrease the tank inflow.

As the level decreases, the PID controller will decrease the speed of the discharge pumps. When the controller output drops below 30%, the motor demand will decrease to 1 and the lag pump will be stopped.
Drag the slider to the right.

As level increases, the PID controller will increase the speed of the discharge pumps. When the controller output rises above 90%, the motor demand will increase and the lag pump will be started.
We can remove a pump from service, by simulating a fault on one of the drives. Four buttons are available on the screen, for simulating drive faults.

Click on the button to **simulate a bus overvoltage** on pump P801a (pump 1).

A drive fault alarm appears in the alarm summary, and the drive object indicates an alarm condition. Notice the P_LLs faceplate now indicates that pump 1 is not available.
The P_PF755 object has the ability to read a fault code from the drive and provide descriptive text of fault codes. To view the specific drive fault, **click on the drive** to launch the faceplate.

The specific drive fault is identified on the bottom of the home tab of the drive faceplate. In this example, a Bus Overvoltage fault is active for P801A.
Click on the **diagnostics tab** of the faceplate. This tab also indicates a Device Trip due to a Drive Fault.

Click the **alarm tab** of the faceplate. This tab also indicates a drive fault alarm and identifies the specific fault.
Click on the **acknowledge** button to acknowledge this alarm.

The alarm indicators will stop blinking.

Close the P801A faceplate.
If we trip one of the running pumps, we can see that the pump will be removed from service and the standby pump will be started. **Click** on the button to simulate a power failure on pump P801C.

Notice that pump 801D was started and pump 801C now indicates an alarm condition.

On the motor group faceplate, we can see that both pumps 1 and 3 are now out of service, and pump 4 has become the lag pump.
Click on pump 801C to launch the motor faceplate.

We can see that the faceplate indicates that a drive fault occurred due to a power failure.
Rather than acknowledging the alarm from the faceplate, we can also acknowledge the alarm from the alarm summary display. Click on the alarm bell in the main header.

In the alarm list, right-click on the P801C Drive Fault and then click Ack to acknowledge the alarm.

Right click on the P801C drive fault alarm and then click Run command.
This will return us to the pump group display. Notice the alarm indicators are no longer blinking.

Trip pump 801D by clicking the button to simulate a bus undervoltage on P801D.

When pump 4 stops, the PID controller output will increase to 100% to try to maintain the level. Pump 2 will not be able to handle the demand, so the motor group will attempt to start a second pump, but there are no pumps available. The level will eventually reach a high level.
We can configure an alarm for the motor group to alert the operator when there are not enough pumps available to meet the demand. **Click on the motor group.**

Click on the alarm tab.
Click on the No motors to start alarm button.

Click on the engineering tab.
Check the box for “The alarm is configured to exist and will be scanned” and close the alarm faceplate.

You’ll see that the motor group object and faceplate now indicate an alarm condition “No motors to start”.
We can clear the drive fault on pump1, so that the pump will become available to the motor group. **Click** on the P801A simulation button to clear the fault condition.

Pump 1 becomes the lag pump and is started. The alarm condition clears on the motor group. Acknowledge the alarm by **clicking** the **acknowledge** button on the faceplate.

The level in the tank will decrease.

**Close** all open faceplates.
Section Summary

The Premier Integration experience from Rockwell Automation represents the next level of controller and device integration. It combines the functionality of an automated control system with the resources in the field device and communication infrastructure.

Premier Integration simplifies and streamlines system design, maintenance and operation.

Please STOP AND WAIT FOR INSTRUCTOR before continuing.
**Faceplate Diagnostics and Alarm Management**

In this section of the lab we will operate and interact with a simulated reactor designed with good alarm management practices. We will see how device alarms and device diagnostics help operators and maintenance personnel trouble shoot issues.

**Click** on the **Reactor** button on the button banner.

You will be using graphic screens developed with standard library objects. For rapid development of information-rich operator displays, the Rockwell Automation Library of Process Objects provides a collection of display objects that are linked to the Add-On Instructions (example below). This allows rapid development of the plant graphics.

**Notice** that during the last batch the product temperature reached a high alarm level. The product temperature still indicates the alarms because they have not been acknowledged and reset. **Click** on the **product temperature** indication to open the faceplate.
Double-Click the button to acknowledge and reset all the alarms for this device. Then close the faceplate.

We will now run a batch of product through the reactor. In this section of the lab you will run the reactor manually to operate from the device faceplates. Later in the lab you will be running an automated process to get familiar with the Process Library Sequencer object.

First we need to empty the reactor. Click on the drain valve to open the faceplate.

Click on the green open button to open the drain valve. When the valve opens the drain pump can be started.
Click on the pump to open the pump faceplate.

Click on the green start button to run the drain pump.

When the level in the reactor reaches 0% the pump will automatically stop. Click on the red close button to close the drain valve.
**Notice** the IO Fault alarm. An operator may want to shelve the inlet valve IO Fault alarm until after the batch is complete. The operator can do this from the faceplate. **Click** on the **Premix 2 Inlet Valve** to open the faceplate.

**Click** on the **expand button** to open the full multi-tabbed valve control and configuration faceplate.

**Click** on the **alarm tab** to view and configure alarms.
Click on the yellow I/O Fault alarm status indicator to open the configuration faceplate for the IO fault alarm.

Notice that the buttons for alarm shelving are visible and available to the operator. Click the Shelve button to shelve the alarm.

Click the red X to close the alarm configuration faceplate.
Click the red X to close the alarm status faceplate.

Notice that the IO alarm in the alarm banner is cleared (shelved).

Running a Reactor with Good Alarm Management

With production running high and facilities operating with fewer people, alarm management has become a key to achieving operational excellence, increasing plant safety, and reducing loss of product and unplanned downtime.

To run the reactor again we will first need to fill it above 75%. Click on the Premix 1 Inlet Flow Totalizer FQ_101_R object to open the totalizer faceplate.
Verify the setpoint is 70 KG and **click the green start button** to start the totalizer. When the Premix 1 material inlet valve XV_101_R is opened the totalizing will start. Once the 70 KG setpoint is reached the totalizer will automatically close the inlet valve.

**Click** on the Premix 1 Inlet Valve **XV_101_R** to open the operator faceplate for the valve.
Open the Premix 1 inlet valve by clicking the green open button. When the valve opens, the totalizer will start.

Wait for the reactor to fill.

When 70KG is delivered the totalizer will close the valve.
The reactor level will be above 75%.

With the reactor level above 75%, we can now start the agitator. **Click** on the agitator to open the faceplate.

**Click** on the green **start button** to run the agitator.
As agitation begins, **notice** a high temperature alarm occurs. The alarm is correctly configured with correct priorities and setpoints. **Click** on the **Product Temp** indicator to open the **faceplate**.

The reaction continues and the operator is not overwhelmed by alarms and reacts to the temperature alarm and notices the controller is not in auto mode. **Place** the **Product Temperature controller** in **auto** mode.

The product temperature returns to normal operating range and the batch is saved.
Effective operator response to alarms saved loss of product and unplanned downtime, which has a direct financial impact on the bottom line.

Section Summary

With production running high and facilities operating with fewer people, alarm management has become a key to achieving operational excellence, increasing plant safety, and reducing loss of product and unplanned downtime.

The Library Faceplates built in device alarms and device diagnostics help operators and maintenance personnel quickly trouble shoot issues.

Please STOP AND WAIT FOR INSTRUCTOR before continuing.

Sequencer (P_Seq) Library object

Cleaning in Place (CIP) has been around for approximately 50 years, and is commonly used in industries, such as Food, Beverage and Pharmaceutical, to clean a wide range of the plant. CIP refers to the use of a mix of chemicals, heat and water to clean machinery, vessels or pipe work without dismantling the plant. This process is usually an integral part of any automated plant.

To familiarize the student with the operation of the library’s P_Seq sequencer object, we will run a sequence for performing a quick rinse cleaning cycle on a simulated storage tank.

Click the Sequencer button on the button bar.
We will be using graphic screens developed with standard library objects. For rapid development of information-rich operator displays, the Rockwell Automation Library of Process Objects provides a collection of display objects that are linked to the Add-On Instructions (shown below). This allows rapid development of the plant graphics.

**Running a simple Sequence**

The sequencer for Storage Tank 1 can perform either a “Quick Rinse” or a “Full Cycle” cleaning based on operator selection. First, we will run through the seven-step Quick Rinse sequence to get an understanding of the basic sequencer functions. Click the Sequence Control Window display button labeled “Tank 1 Full Cycle” to launch the sequencer faceplate.
From the main Sequence Control Window faceplate for the P_Seq instruction, the sequence can be started, stopped, and reset.

**Click the magnifying glass** button on the Sequencer faceplate to display the Run-Time Sequence window.

**Drag and position** the run-time sequence window to the **right** of the tank as shown below.

As the sequence is running, the run-time sequence window will provide details on the operation of the sequence.

- The Input status indicators turn blue when the input is on.
- The Step columns turn green to show the current step in progress.
- When the tip of the symbol points up the input must be on to qualify for that step. When the tip is down the input must be off to qualify. When the input condition is qualified, a black dot appears in the middle of the icon.

Output status indicators turn blue when the output is ON.
Click the green **Start Sequence** button on the run-time sequence window.

Step 1 will prompt us to select a cleaning type. An orange circle with an exclamation point will appear next to several buttons on the screen. These notify the operator of a pending prompt that needs an action. **Click** the **Prompt** button on the run-time sequence window to open the pending prompt window.

If an operator response to a prompt is required within a certain time we can configure step time alarms to alert operators. This sequence has been configured with no step time alarm.

At the prompt window, **verify** that Quick Rinse is selected and **click** the Acknowledge **check mark**.
The sequence will advance to step 2 acknowledging that quick rinse was selected. Step 3 will empty the contents of the tank to the cleaning return.

Step 4 will open the rinse valve and add rinse for a configured period of 10 seconds.
Step 5 will circulate the tank contents for 10 seconds through the recirculation valve.

Step 6 will circulate the tank contents for 10 seconds through the spray valve.
Step 7 will pump the tank contents to the cleaning return.

Once the tank is empty the sequence will jump from step 7 to step 20 where it will put all devices in a done state. Step 21 will end the sequence. This sequencer is configured with 20 steps. Steps 8 through 19 are included in the full cleaning cycle sequence. The sequence faceplate will indicate that the sequence is complete and the reset button will become available.

Click the reset button to return the sequence to the idle state.

The sequence is complete and is ready to run again.

Close the run-time sequence window by clicking on the red X.

**Configuring the Sequencer from the Faceplates**

The Sequence Control Window faceplate has tabs for Maintenance, Engineering, Diagnostics, and Alarming. Once the logical connections to devices have been made in the code, the actual configuration of the sequencer steps is done from the faceplates.

Click on the **Engineering tab** of the faceplate.
From the Engineering tab we can change the name, label, units and other properties of the sequencer such as prompts, pauses, step timers, alarms, and interlocks. Note that the box for “The sequencer has an Operator Prompt Queue” is checked enabling prompting. Click the “Display Sequence Config Window” button in the upper right.

The sequence consists of simple device control with operator prompting and no configured step timer alarms. As with other PlantPAx Library objects, the Sequencer object also has configurable Permissive and Interlock inputs and supports linking navigation to P_Perm and P_Intlk objects.

From the inputs and outputs Sequencer Configuration window, we can configure the inputs and outputs for the particular sequencer. There are three configuration tabs: discrete (BOOL) inputs, discrete (BOOL) outputs, and floating-point (REAL) outputs.

This sequence uses 13 inputs (Inputs 0 through 12). These inputs are used to configure the step changes or transitions.

Click on the Output Configuration tab.
On the Output Configuration tab, 11 outputs (commands) have been configured for this sequence. The stopped and held columns define the state of the outputs if the sequence goes to either of those states. Later in the lab, we will be using the hold state. Close the configuration window.

Click the “Display Multi-Step Config Window” button in the lower right of the engineering faceplate.

Note that from this window, we can configure what is to occur in each individual step of the sequence. From here, each step is configured with the inputs, timers and other properties for the step. Close the Multi-Step Configuration Window.
Running a Sequence with Additional Features

First, we ran the Quick Rinse cycle. In this section of the lab, we will run the Full Cleaning cycle sequence and observe several additional features of the PlantPAx Sequencer.

The full cycle sequence will perform several cycles of cleaning in the following order:
- Rinse Cycle (Add Rinse for time, Circulate, Empty Tank)
- Caustic Cycle (Add Caustic to level, Circulate, Empty Tank)
- Repeat Rinse Cycle
- Acid Cycle (Add Acid for time, Circulate, Empty Tank)
- Repeat Rinse Cycle

Click on the Home-Operator tab.

Click the magnifying glass button on the faceplate to display the Run-Time Sequence window again.

Again, Drag and position the run-time sequence window to the right of the tank as shown below. As the sequence is running, the run-time sequence window will provide details on the operation of the sequence.
Pause points are identified by a pause symbol and an arrow between two steps. In the Tank 1 cleaning sequence, a pause point has been configured between steps 5 and 6. We will choose to pause the sequence at the next pause point (between steps 5 and 6).

From the detailed sequence display, click the “Request sequence to pause at next pause point” button as shown below.

Click the Start Sequence button.

Step 1 will prompt us to select a cleaning type. Notice an orange circle with an exclamation point appears next to several buttons on the screen. These notify the operator of a pending prompt that needs an action. Click the Prompt button on the run-time sequence window to open the pending prompt window.

...
If an operator response to a prompt is required within a certain time, we can configure “step time alarms” to alert operators. This sequence has been configured with no step time alarm. At the prompt window, select **Full Cycle** and click the Acknowledge check mark.

The sequence will run through the first rinse cycle steps 1 through 5. When the sequence reaches the end of step 5, it will pause and alert the operator. The outputs that were turned on during step 5 will remain on until the operator resumes the sequence. In this example, the tank contents will be recirculated until the operator resumes the sequence.

Resume the sequence by clicking the **Resume Sequence** button.

In steps 6-10, the tank will be rinsed and emptied. When the rinse cycle completes, the sequence will continue with a caustic rinse cycle. On step 11 another operator prompt will appear. Click on the **prompt** button to launch the prompt window.
In the prompt window, **Click** on the Tank Level **setpoint** to launch the numeric entry popup.

**Enter a value of 10.**
**Click OK** and then **click** the Acknowledge **check mark** button in the prompt window.

![Prompt Window Screenshot](image)

Caustic is added until the tank level reaches the setpoint that we entered. In steps 13-15, caustic is circulated through the spray balls, the tank will be rinsed and the acid cycle started.

Anytime during the following caustic, acid or rinse cycles, place the sequence in hold mode by **clicking** the **Hold Sequence** button.
When the sequence is in the Held state, the operator will be alerted as shown below.

![Held state alert](image)

The outputs will go to the state that was configured as the Held state. In this lab, all outputs were configured to be turned off as shown on the outputs configuration window below.

![Outputs configuration](image)

The outputs will remain in their “Held” state until the sequence is restarted. Restart the sequence by clicking the **Restart Sequence** button.

![Restart button](image)

The sequence will restart at the step where it was held and will continue to perform several cycles of cleaning in the following order:

- Rinse Cycle (Add Rinse for time, Circulate, Empty Tank)
- Caustic Cycle (Add Caustic to level, Circulate, Empty Tank)
- Repeat Rinse Cycle
- Acid Cycle (Add Acid for time, Circulate, Empty Tank)
- Repeat Rinse Cycle

After the full cycle concludes, the sequencer will indicate **complete**. Click the **Reset** button to return the sequence to idle mode and **close** the Tank 1 Full Cycle Cleaning sequencer faceplates.
Section Summary

The Sequencer Object (P_Seq) provides a flexible controller-based step sequencing solution that reduces engineering time by automating common operator procedures. The step-by-step configuration makes it easy to adjust procedures directly from the HMI.

Please STOP AND WAIT FOR INSTRUCTOR before continuing.

Running a Waste Water Plant Application

The Wastewater application in this section of the lab, provides several examples of wastewater processes that have been configured using the PlantPAx® Library objects as building blocks.

Click on the Waste Water Influent button in the menu bar.

In this process, raw influent enters a wet well basin where bar screens are used to remove solid pieces of waste from the wastewater. Variable speed pumps transfer the contents of the wet well basin to a primary clarifier.

The pump speed is controlled either by a wet well level controller, a forward flow controller, or the higher, the lower, or the average demand of the two. The operator selects the control mode by clicking a radio button at the bottom of the display. Notice that currently, the forward flow controller is setting the speed demand for the pumps.
Click on the flow controller, **FIC1056**, to launch the quick faceplate for the P_PID controller.

**Click on the setpoint entry box.**

Enter '20' as the new setpoint and **click OK**.
The speed of the pumps will increase to increase the forward flow.

Change the control mode to Wet Well level control by clicking on the radio button shown below.

Click on the level controller, LIC1036, to launch the quick faceplate for the P_PID controller.
Click on the setpoint entry box.

Enter ‘10’ as the new setpoint and click OK.

The speed of the pumps will increase again, to decrease the level in the wet well basin.

Close all open faceplates.
The raw influent pump group is managed by a P:\_LLS object (Lead/Lag/Standby). This is the standard object from the process object library, which was introduced in an earlier section of the lab. Click on Influent Pump Group object to launch the P:\_LLS faceplate.

Expand the faceplate to display the full faceplate.

Move the faceplate to the right, so it is not covering the pumps. The pump group is in program mode by default for this demo. Click the button to request operator mode.
We can manually change the pump demand from 3 motors to 1. **Click** on the **Number of Motors to Run** entry box.

![Image]

Enter ‘1’ and **click OK**.
Pump 2 will decelerate and stop, followed by pump 1. The lead pump, pump number 3, remains running. The level in the wet well basin will start to increase, since one pump is not able to handle the level demand. The influent gates will also start to close off.

Click the Request Program Mode button to return the pump demand to program control and all three pumps will be started.

Close the P_LL3 faceplate.
The pump demand is based on configurable set points for speed and/or level. **Click** on the **configuration button** to launch the configuration window.

**Notice** that the first pump is configured to shut off at 9 feet and the second pump at 7 feet.

For sake of time in the lab, **change the 2nd Pump Off setpoint to 8.5 FT**.

**Close** the configuration window.
We can decrease the demand, by lowering the flow of influent coming into the tank. The raw influent flow can be simulated using the slider. **Drag the slider to the left** to reduce the influent flow to zero.

When the level drops below 9 feet, the motor demand will decrease to 2 and one of the pumps will be stopped.

As the level continues to drop, the second pump will be stopped once the level drops below 8.5 feet.

**Drag the slider to the right** to increase the raw influent flow. Eventually, all three pumps will turn back on to keep up with the demand. If time allows, return to this display later in the lab to observe the status of the pumps.
Click on the Waste Water Aeration button in the menu bar.

In the aeration process, cascaded controllers are used to control the amount of air flow into the aeration basins in order to maintain the dissolved oxygen (DO) at a configurable setpoint.

Notice for Aeration Basin 1, the current setpoint for DO is 5.0 PPM and the air flow setpoint is approximately 100 SCFM.
Click on AIC2013, to launch the P_PID controller faceplate. Enter a setpoint of 6.0 PPM.

Watch the air flow into the tank increase, in order to increase the amount of DO in the aeration tank.

Click on the Waste Water Sludgepumping button in the menu bar.
Notice the interlocks, as indicated by the stop sign symbol, on the WAS (Waste Activated Sludge) pumps.

Click on one of the WAS pumps to launch the P_VSD faceplate.
Click the red **Interlock button** to launch the P_Intlk interlock faceplate. The interlock faceplate indicates that the Belt thickening valve is closed. We must open the valve to start the pump.

Click on the belt thickening valve, **XV8112** to open the P_ValveSO faceplate.

Click the **open** valve button. The interlocks on the WAS pumps will clear.

Close the open faceplates
Click on the flow controller, FIC7024, to launch the P_PID faceplate.

Click the setpoint entry button and enter a setpoint of ‘10’.

The WAS pump group motor demand increases, and the WAS pumps are started by the pump group.
Click on Waste Water Digesters in the menu bar.

The P_Seq process object is used to fill and drain the digesters.

Click the Digester 1 Sequencer button.
Click the **start** button.

Click the **operator prompt** button.

Select **Fill**, enter '10' for the level setpoint, and '50' for the flow setpoint. **Click Acknowledge.**
The flow control valve will open and the digester tank will be filled to 10 feet.

When the digester level reaches 10 feet, the flow valve will close and the sequence completes. Click the reset button.
Drag the P_Seq faceplate to the right and click start again.

This time we will drain the tank. Click operator prompt.

Select Drain, enter a level setpoint of 2, and enter 20 as the flow setpoint. Click the acknowledge checkmark.
The discharge valve will open, and the digester pump will pump contents to the sludge storage tank. When the level reaches 2 ft. the sequence will complete.

Click reset.

Section Summary

Water companies using an integrated control and visualization system for wastewater treatment, and other process industries, can expect reductions in design time and enhanced process control. Rockwell's portfolio of products, systems, templates and libraries provide you with the tools you require to engineer and maintain your plant.
Lab Summary

PlantPAx™ is the process automation system from Rockwell Automation with all the core capabilities expected in a world-class modern distributed control system. Configure your Integrated Architecture control system to meet the PlantPAx system guidelines and you can call it PlantPAx. The Studio 5000® application can help reduce the engineering time to assemble your integrated architecture and process application. The Rockwell Automation Library of Process Objects™ is a collection of Application Templates, Application Code, Graphic Objects, Faceplates and Process Control Strategies that let you quickly configure a device from I/O to operator.

With PlantPAx, engineering your modern DCS has never been easier.