

K Process

Control Requirements Definition

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Introduction

The control requirements definition (CRD) has three main parts: the process operation description (POD), the control concept, and the control strategy. The CRD is organized by process cell. For a process cell, the POD is done in a top-down manner, with the cell POD described first, followed by a POD for each unit in the cell. Each POD contains a description of the operating states that describe what the entity (cell or unit) is doing when that state is active. Each operating state is described with the following sub-headings:

Routine Activities

If the activities contain steps, the steps are listed and their sequence is indicated. If a unit is being described, these steps often become the operations and/or phases in the unit procedure.

Exception Handling

Abnormal conditions and the response (e. g., shutdown if temperature > 200°)

Primary Control Objectives

The control objective is the primary objective of the manual and/or automated control strategies. It is the goal of a process action in terms of physical property quantities (e. g., product composition, material amounts, molecular structure, specific gravity, etc.) and/or time domain quantities (e. g., mixing time of 1 hour, rinse for 20 minutes, etc.). Performance tolerances are sometimes used (e. g., maintain product composition of 30% A and 70% B within +/-2%). A control objective may apply to more than one operating state.

Performance Information

The key plant information quantities the indicate past, present, or future performance of an operating module. These are used to determine the process capability for the operating state or for the operating module as a whole. These include quality and production rate measurements whether taken manually or automatically.

State End Conditions

Conditions that cause a transition to the next operating state.

After the POD, the control concept is described. The control concept includes the cell-wide process management and the unit supervision for each unit. The control concept is described in a top-down manner, like the POD. However, it is usually written in a

bottom-up fashion. That is, the control concept for the units is usually developed before the control concept for the cell is complete. The control concept defines the extent of automation in terms of control requirements for the operating modules (units, cells). The control concept for a cell or unit is described in outline form with the following subheadings:

Extent of Automation

Operating module activities and control objectives that are automated

Flexibility of Automation

Multiple products, frequent equipment changes, etc.

Control Activity Coordination

Concurrent operations and shared resources

Interaction with Operating Personnel

Data presentation, equipment selections, control commands, and data entry

The control strategy defines the control types and interrelationships to fulfill the control requirements. For process cells, any high-level control, such as multiple unit coordination or scheduling, is detailed. For units, any advanced control algorithms are described. Loops and devices are described in terms of how they are to be operated (e. g., start/stop in certain unit sequence steps, maintain pressure during certain sequence steps). Status and indicator devices are described. Interlocks are also documented in the control strategy. The control strategy information is organized in a top-down fashion, but may be easier to formulate bottom-up. In other words, it may be easier to start describing the control strategy in terms of the individual loops and devices and then proceed to the unit supervision.

Revision History

| | | |
|-------|-------------|--|
| Rev 0 | 2005 Jan 7 | First release |
| Rev 1 | 2007 Sep 3 | Fix typos. |
| Rev 5 | 2016 Jan 3 | Added additive cell, powder unload cell, reactor 3 unit, three ion exchanger units, product storage 2 unit, and product loadout 2 unit. Changed rev level to match major rev level of process narrative. |
| Rev 7 | 2023 Oct 22 | Added reactor 4 unit, ion exchanger 5 and 6 units, product storage 3 unit, and product loadout 3 unit. Rev level matches major rev level of process narrative |

| Site | |
|-------------|--|
| | <p>The K process is divided into loadin, production, loadout, and utility areas (Figure 1). The loadin area is further divided into four cells: a wet unload cell, with truck and rail units; and a dry unload cell, with rail dry unload, dry storage loading, and dry storage loadout units; an additive cell with wet and dry units; and a powder unload cell, with truck and rail units. The wet ingredient storage is basically a set of tanks shared between the loadin and production areas. The truck wet and rail wet unload units control the inlet side of the tanks and the blend and reactors control the outlet side of the tanks. There is no separate control of the tanks and hence it is not defined as a unit. The truck powder and rail powder unload units control the inlet side of a set of tanks and reactor 3 controls the outlet side of the tanks. The gas ingredient unload unit controls the inlet side of a set of tanks and reactor 4 controls the outlet side of the tanks. The production area is divided into a reactor cell and an ion exchange cell. In the future, the QA sample unit may also be used by the ion exchange cell and so it is considered a separate unit. The reactor cell contains a blend unit and four reactor units. The ion exchange cell contains six ion exchange units. The loadout area consists of product storage units and loadout units. The utility area contains a water treatment, steam generation, two clean-in-place (CIP) units, and regen material storage cells. Only the CIP cells are described.</p> <p>The raw ingredients are unloaded from trucks and rail cars into storage tanks in the appropriate ingredient storage units. Certain ingredients are blended to produce one of the ingredients for the reactor units. Additive ingredients are constituted and stored in storage tanks. Each reactor takes the appropriate ingredients from the blend and/or ingredient storage units and combines them to make a batch of product. The QA sampling unit samples reactor product at the appropriate point in the reactor operation and presents the result to the operator so that he/she can decide how much, if any, additional reaction time is necessary. The product is transferred though an ion exchanger to remove impurities. The ion exchanger is regenerated after a certain amount of product passes through the ion exchanger. Currently, there are three sets of ion exchangers, one for reactors 1 and 2, a set of two for reactor 3, and another set for reactor 4. The product from an ion exchanger set is initially stored in a QA tank before it is transferred to one of three storage tanks. From the storage tanks, it is transferred to a truck/rail loadout system. The CIP units have a tank and a recirculation loop that maintain the cleaning water temperature. When requested by the operator, the system directs cleaning water through the storage tank header to clean out product from the header. The system can also clean out piping in the reactors and the ion exchange units. Soda ash and hot water are used to make up the cleaning water for CIP 1 unit.</p> |
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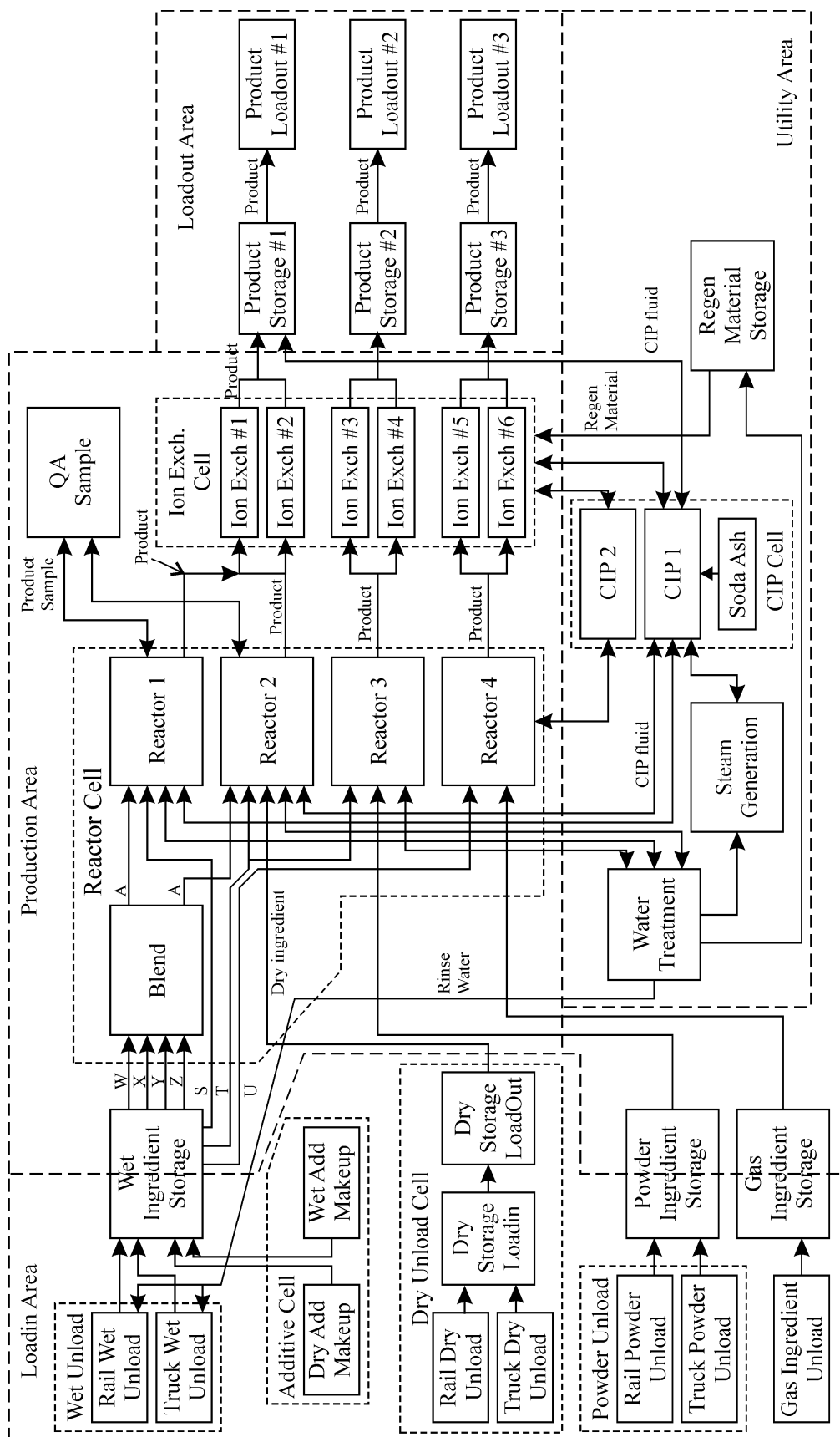
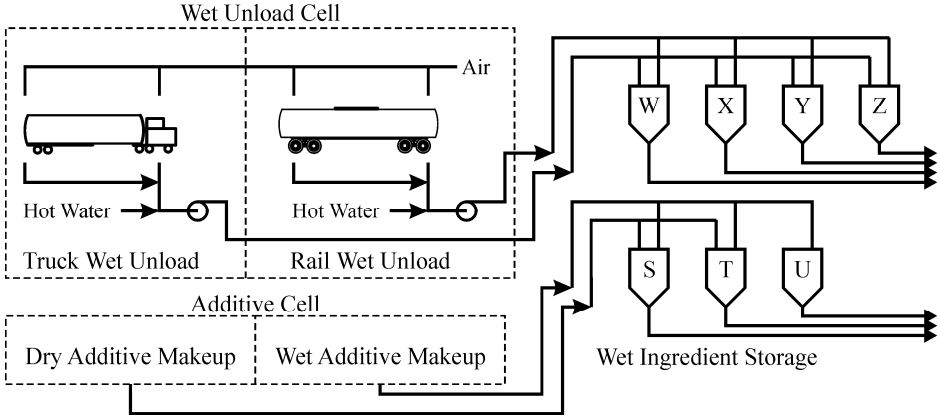
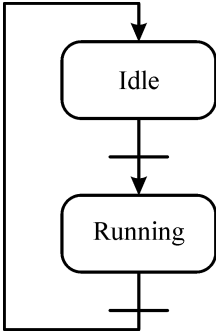


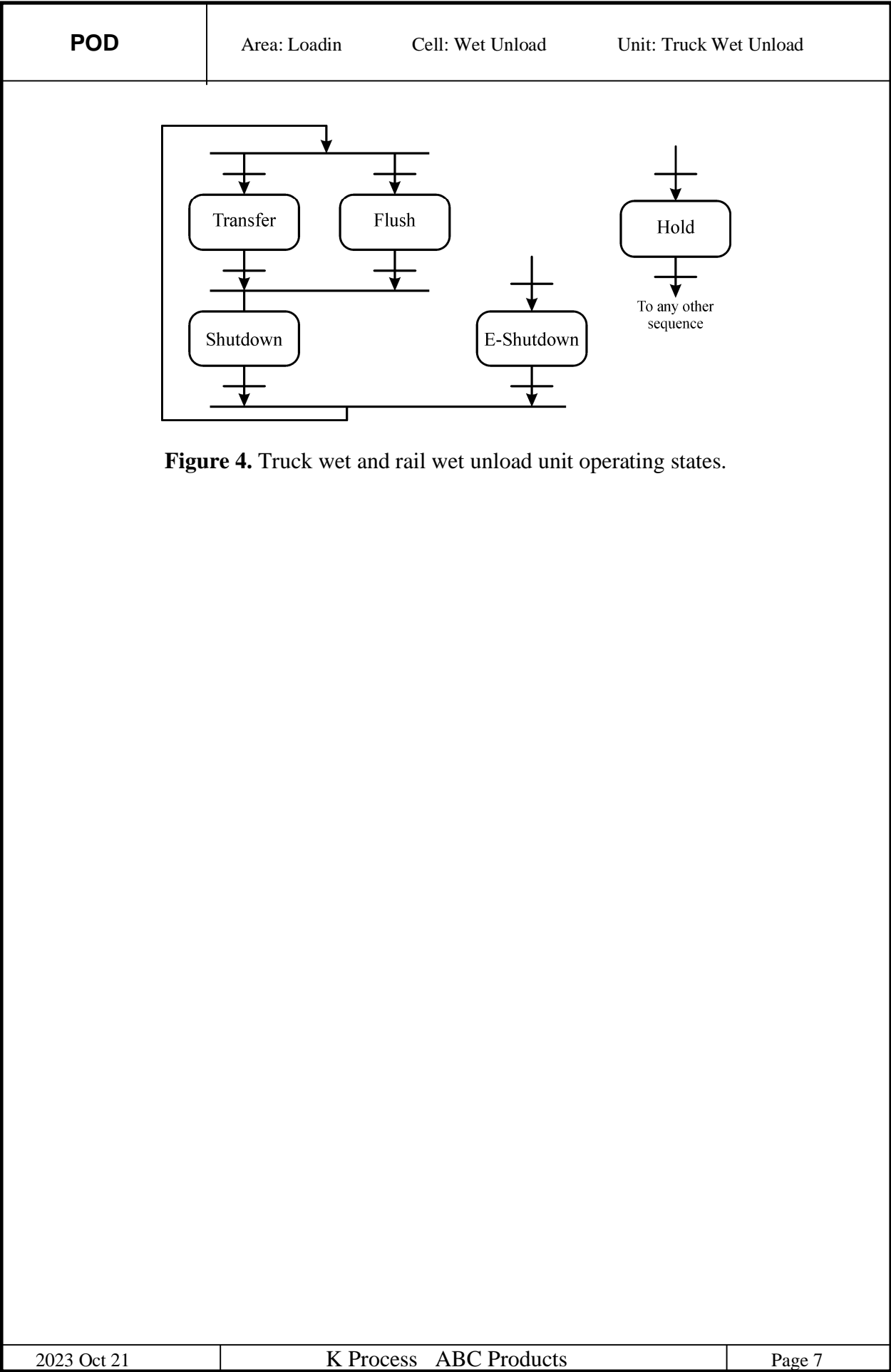
Figure 1. K chemical process overall process flow diagram.

| POD | Area: Loadin Cell: Unit: |
|-----|---|
| | <p>LOADIN AREA</p> <p>The loadin area is subdivided into wet unload, additive, dry unload, powder unload and gas ingredient unload cells. This area unloads wet and dry ingredients from trucks or rail cars and transfers them to storage tanks (Figure 1). The gas ingredient unload unit is not described.</p> |
| | |

| | |
|--|---|
| <div><div>POD</div><div><div><div>Wet Unload Cell</div><div><p>The truck wet unload unit transfers wet ingredients to one of four storage tanks and the rail wet unload unit transfers wet ingredients to one of the same four tanks (Figure 2). Note that the wet ingredient storage is shared between the loadin area and the production area.</p><p>The operating states of the wet unload cell are shown in Figure 3. The two units operate relatively autonomously and so there is no special logic to transition between states. If either the rail wet or truck wet unload units are in the transfer state, the cell is running. If both units are shut down, the cell is idle.</p></div><div></div></div></div></div> | <div><div>Area: Loadin</div><div>Cell: Wet Unload</div><div>Unit:</div></div> <div><div><div>Figure 2. Wet unload and additive cells.</div><div></div><div><div>Figure 3. Cell operating states.</div></div></div></div> <div><div>2023 Oct 21</div><div>K Process ABC Products</div><div>Page 4</div></div> |
|--|---|

| POD | Area: Loadin Cell: Wet Unload Unit: Truck Wet Unload |
|--|--|
| <p><i>Truck Wet Unload Unit.</i> Liquids unloaded from trucks are transferred to the wet ingredient storage unit. The primary control objective of this unit is to convey liquid ingredients from one of two truck unload stations to one of four destination tanks. The operating states of this unit are shown in Figure 4:</p> <p>Transfer Flush Hold Shutdown E-Shutdown</p> <p>The hold state allows manual control of devices in order to correct a problem. Normal operation is intermittent, running only when a truck needs to unload. The states are described as follows:</p> <p>Operating State Name: Transfer</p> <p><i>Routine Activities</i> Request source station and destination tank from operator. Open valves for the proper source/destination. Start pump.</p> <p><i>Exception Handling</i> Hold if: Valve or motor failure.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Transfer finished (truck trailer empty or tank full).</p> <p>Operating State Name: Flush</p> <p><i>Routine Activities</i> Open hot water source valve and drain. Start pump.</p> <p><i>Exception Handling</i> Hold if: Valve or motor failure.</p> | |
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| POD | Area: Loadin | Cell: Wet Unload | Unit: Truck Wet Unload |
|--|------------------------|------------------|------------------------|
| <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Flush time finished.</p> <p>Operating State Name: Shutdown</p> <p><i>Routine Activities</i> Stop pump and close all valves.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Transfer or flush requested.</p> <p>Operating State Name: E-Shutdown</p> <p><i>Routine Activities</i> Immediately stop pump and close all valves.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Transfer or flush requested.</p> | | | |
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| POD | Area: Loadin Cell: Wet Unload Unit: Rail Wet Unload |
|---|---|
| <p><i>Rail Wet Unload Unit.</i> Liquids unloaded from rail cars are transferred to the wet ingredient storage unit. The primary control objective of this unit is to convey liquid ingredients from one of two rail car unload stations to one of four destination tanks. The operating states of this unit are shown in Figure 4:</p> <p>Transfer Flush Hold Shutdown E-Shutdown</p> <p>The hold state allows manual control of devices in order to correct a problem. Normal operation is intermittent, running only when a rail car needs to unload. The states are described as follows:</p> <p>Operating State Name: Transfer</p> <p><i>Routine Activities</i> Request source station and destination tank from operator. Open valves for the proper source/destination. Start pump.</p> <p><i>Exception Handling</i> Hold if: Valve or motor failure.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Transfer finished (rail car empty or tank full).</p> <p>Operating State Name: Flush</p> <p><i>Routine Activities</i> Open hot water source valve and drain. Start pump.</p> <p><i>Exception Handling</i> Hold if: Valve or motor failure.</p> | |
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| POD | Area: Loadin | Cell: Wet Unload | Unit: Rail Wet Unload |
|--|------------------------|------------------|-----------------------|
| <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Flush time finished.</p> <p>Operating State Name: Shutdown</p> <p><i>Routine Activities</i> Stop pump and close all valves.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Transfer or flush requested.</p> <p>Operating State Name: E-Shutdown</p> <p><i>Routine Activities</i> Immediately stop pump and close all valves.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Transfer or flush requested.</p> | | | |
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| Control Concept | Area: Loadin | Cell: Wet Unload | Unit: |
|---|------------------------|------------------|-------|
| <p>Wet Unload Cell Process Management</p> <p><i>Extent of Automation</i> Collect performance data from units.</p> <p><i>Flexibility of Automation</i> None.</p> <p><i>Control Activity Coordination</i> Destination tanks are shared by the truck wet unload and truck wet unload units.</p> <p><i>Interaction with Operating Personnel</i> Summary information from units displayed for operator.</p> <p>Truck Wet Unload Unit Supervision</p> <p><i>Extent of Automation</i> Provide control of valves and pumps. Provide automatic startup and shutdown for the transfer of liquid from the truck trailer to a destination tank. Collect inventory data (gallons of liquid unloaded from trailer).</p> <p><i>Flexibility of Automation</i> None.</p> <p><i>Control Activity Coordination</i> Interlocks with rail wet unload unit prevent transfer from both units into same tank.</p> <p><i>Interaction with Operating Personnel</i> Operators enter source station and destination tank. Operators start transfers. Operators can stop transfer, though not normally. Display status information from control devices. Display amount transferred.</p> <p>Rail Wet Unload Unit Supervision</p> <p><i>Extent of Automation</i> Provide control of valves and pumps. Provide automatic startup and shutdown for the transfer of liquid from a rail car to a destination tank. Collect inventory data (gallons of liquid unloaded from rail car).</p> <p><i>Flexibility of Automation</i> None</p> <p><i>Control Activity Coordination</i> Interlocks with truck wet unload unit prevent transfer from both units into same tank.</p> <p><i>Interaction with Operating Personnel</i> Operators enter source station and destination tank. Operators start transfers. Operators can stop transfer, though not normally.</p> | | | |
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| | | | |
|---|------------------------|------------------|---------|
| Control Concept | Area: Loadin | Cell: Wet Unload | Unit: |
| <p>Display status information from control devices. Display amount transferred.</p> | | | |
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*Truck Wet Unload Unit***Unit Operations**

The unit operations (sequences) are the same as the operational states.

Devices**Pump**

Start/stop by unit sequence or operator.

Air pressure inlet valves (2)

Start/stop by unit sequence or operator.

Product source valves (2)

Start/stop by unit sequence or operator.

Destination tank inlet valves (4)

Start/stop by unit sequence or operator.

Hot water supply valve

Start/stop by unit sequence or operator.

Interlocks

Do not allow transfer start if destination tank too full or rail wet transferring into same destination tank.

*Rail Wet Unload Unit***Unit Operations**

The unit operations (sequences) are the same as the operational states.

Devices**Pump**

Start/stop by unit sequence or operator.

Air pressure inlet valves (2)

Start/stop by unit sequence or operator.

Product source valves (2)

Start/stop by unit sequence or operator.

Destination tank inlet valves (4)

Start/stop by unit sequence or operator.

Hot water supply valve

Start/stop by unit sequence or operator.

Interlocks

Do not allow transfer start if destination tank too full or truck wet transferring into same destination tank.

| POD | Area: Loadin Cell: Additive Unit: |
|--|---|
| <div>Additive Cell</div> <div><p>The additive cell units makeup ingredients stored in one of two storage tanks (Figure 2). Note that the wet ingredient storage is shared between the loadin area and the production area.</p></div> <div><p>The operating states of the additive cell are shown in Figure 3. The two units operate relatively autonomously and so there is no special logic to transition between states. If either the wet or dry additive units are in the transfer state, the cell is running. If both units are shut down, the cell is idle.</p></div> | |
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| POD | Area: Loadin | Cell: Additive | Unit: Dry Add Makeup |
|--|------------------------|----------------|----------------------|
| <p><i>Dry Additive Makeup Unit.</i> The primary control objective of this unit is to mix dry bagged ingredient into water and convey liquid to one of two destination tanks. The operating states of this unit are shown in Figure 5:</p> <p>Makeup Flush Hold Shutdown E-Shutdown</p> <p>The hold state allows manual control of devices in order to correct a problem. Normal operation is intermittent, running only when a truck needs to unload. The states are described as follows:</p> <p>Operating State Name: Makeup</p> <p><i>Routine Activities</i></p> <p>Request destination tank from operator. Request amount of hot water from operator Makeup chemical from dry ingredient hopper Open valves for the proper destination. Start pump.</p> <p><i>Exception Handling</i></p> <p>Hold if: Valve or motor failure.</p> <p><i>Primary Control Objectives</i></p> <p>None.</p> <p><i>Performance Information</i></p> <p>None.</p> <p><i>State End Conditions</i></p> <p>Transfer finished (makeup tank empty or destination tank full).</p> <p>Operating State Name: Flush</p> <p><i>Routine Activities</i></p> <p>Open hot water source valve and drain. Start pump.</p> <p><i>Exception Handling</i></p> <p>Hold if: Valve or motor failure.</p> | | | |
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| POD | Area: Loadin | Cell: Additive | Unit: Dry Add Makeup |
|--|------------------------|----------------|----------------------|
| <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Flush time finished.</p> <p>Operating State Name: Shutdown</p> <p><i>Routine Activities</i> Stop pump and close all valves.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Makeup or flush requested.</p> <p>Operating State Name: E-Shutdown</p> <p><i>Routine Activities</i> Immediately stop pump and close all valves.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Transfer or flush requested.</p> | | | |
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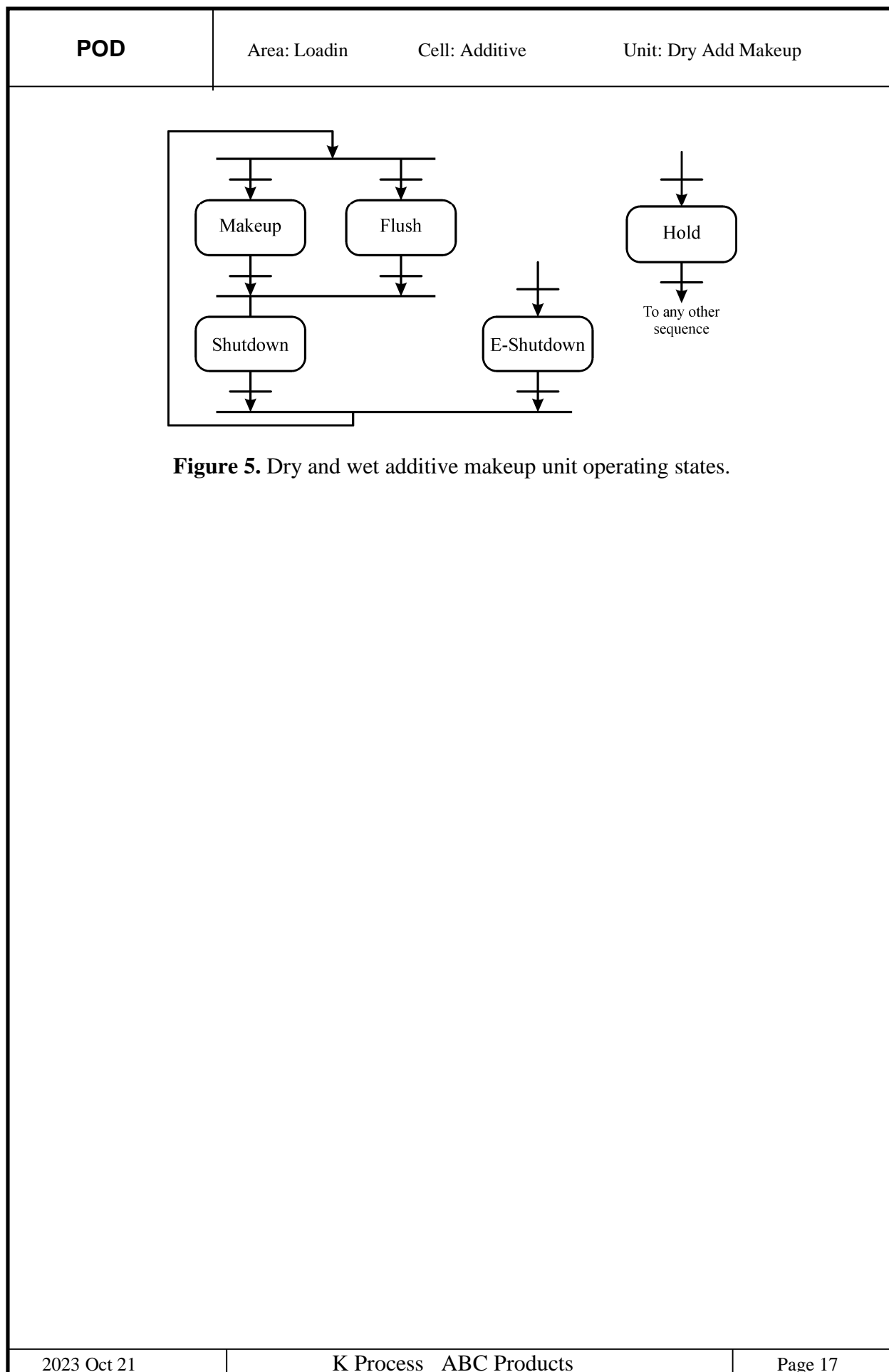


Figure 5. Dry and wet additive makeup unit operating states.

| POD | Area: Loadin Cell: Additive Unit: Wet Add Makeup |
|--|--|
| <p><i>Wet Additive Makeup Unit.</i> The primary control objective of this unit is to dilute a wet ingredient and convey liquid to one of two destination tanks. The operating states of this unit are shown in Figure 5:</p> <p>Makeup Flush Hold Shutdown E-Shutdown</p> <p>The hold state allows manual control of devices in order to correct a problem. Normal operation is intermittent, running only when a truck needs to unload. The states are described as follows:</p> <p>Operating State Name: Makeup</p> <p><i>Routine Activities</i></p> <p>Request source and destination tank from operator. Request amount of hot water from operator Makeup chemical from wet ingredient tank Open valves for the proper destination. Start pump.</p> <p><i>Exception Handling</i></p> <p>Hold if: Valve or motor failure.</p> <p><i>Primary Control Objectives</i></p> <p>None.</p> <p><i>Performance Information</i></p> <p>None.</p> <p><i>State End Conditions</i></p> <p>Transfer finished (makeup tank empty or destination tank full).</p> <p>Operating State Name: Flush</p> <p><i>Routine Activities</i></p> <p>Open hot water source valve and drain. Start pump.</p> <p><i>Exception Handling</i></p> <p>Hold if: Valve or motor failure.</p> | |
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| POD | Area: Loadin | Cell: Additive | Unit: Wet Add Makeup |
|--|------------------------|----------------|----------------------|
| <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Flush time finished.</p> <p>Operating State Name: Shutdown</p> <p><i>Routine Activities</i> Stop pump and close all valves.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Makeup or flush requested.</p> <p>Operating State Name: E-Shutdown</p> <p><i>Routine Activities</i> Immediately stop pump and close all valves.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Transfer or flush requested.</p> | | | |
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| Control Concept | Area: Loadin | Cell: Additive | Unit: |
|--|------------------------|----------------|-------|
| <p>Additive Cell Process Management</p> <p><i>Extent of Automation</i> Collect performance data from units.</p> <p><i>Flexibility of Automation</i> None.</p> <p><i>Control Activity Coordination</i> Destination tanks are shared by the dry additive and wet additive units.</p> <p><i>Interaction with Operating Personnel</i> Summary information from units displayed for operator.</p> <p>Dry Additive Unit Supervision</p> <p><i>Extent of Automation</i> Provide control of valves and pumps. Provide automatic startup and shutdown for the mixing of a dry ingredient into water and transfer of liquid to a destination tank. Collect inventory data (gallons of makeup).</p> <p><i>Flexibility of Automation</i> None.</p> <p><i>Control Activity Coordination</i> Interlocks with wet additive unit prevent transfer from both units into same tank.</p> <p><i>Interaction with Operating Personnel</i> Operators enter destination tank and amount of water. Operators start makeup. Operators can stop makeup and transfer, though not normally. Display status information from control devices. Display makeup amount.</p> <p>Wet Additive Unit Supervision</p> <p><i>Extent of Automation</i> Provide control of valves and pumps. Provide automatic startup and shutdown for the dilution of a wet ingredient into water and transfer of liquid to a destination tank. Collect inventory data (gallons of makeup).</p> <p><i>Flexibility of Automation</i> None.</p> <p><i>Control Activity Coordination</i> Interlocks with dry additive unit prevent transfer from both units into same tank.</p> <p><i>Interaction with Operating Personnel</i> Operators enter source station and destination tank and amount of water. Operators start makeup. Operators can stop makeup and transfer, though not normally. Display status information from control devices. Display makeup amount.</p> | | | |
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| | |
|---|--|
| Control Strategy | Area: Loadin Cell: Additive Unit: Dry Additive |
| <p><i>Dry Additive Unit</i></p> <p>Unit Operations</p> <p>The unit operations (sequences) are the same as the operational states.</p> <p>Devices</p> <p>Pump Start/stop by unit sequence or operator.</p> <p>Dry ingredient source gate Start/stop by unit sequence or operator.</p> <p>Dry ingredient source conveyor Start/stop by unit sequence or operator.</p> <p>Destination tank inlet valves (2) Start/stop by unit sequence or operator.</p> <p>Mix tank agitator Start/stop by unit sequence or operator.</p> <p>Hot water supply valve Start/stop by unit sequence or operator.</p> <p>Cold water supply valve Start/stop by unit sequence or operator.</p> <p>Tank outlet valves (2) Start/stop by unit sequence or operator.</p> <p>Interlocks</p> <p>Do not allow transfer start if destination tank too full or wet additive transferring into same destination tank.</p> | |
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| | | | |
|--|------------------------|----------------|--------------------|
| Control Strategy | Area: Loadin | Cell: Additive | Unit: Wet Additive |
| <p><i>Wet Additive Unit</i></p> <p>Unit Operations</p> <p>The unit operations (sequences) are the same as the operational states.</p> <p>Devices</p> <p>Pump Start/stop by unit sequence or operator.</p> <p>Wet ingredient source valves (3) Start/stop by unit sequence or operator.</p> <p>Destination tank inlet valves (2) Start/stop by unit sequence or operator.</p> <p>Mix tank agitator Start/stop by unit sequence or operator.</p> <p>Hot water supply valve Start/stop by unit sequence or operator.</p> <p>Cold water supply valve Start/stop by unit sequence or operator.</p> <p>Tank outlet valves (2) Start/stop by unit sequence or operator.</p> <p>Interlocks</p> <p>Do not allow transfer start if destination tank too full or dry additive transferring into same destination tank.</p> | | | |
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Dry Unload Cell

The dry unload cell (Figure 6) transfers grain from rail cars to one of three storage tanks. Upon request from reactor 2, grain from one of the storage tanks is transferred to the reactor.

The operating states of the dry unload cell are shown in Figure 3. The operation of the two units is coupled when transferring grain to the storage tanks. If either unit is not shut down, the cell is running. If both units are shut down, the cell is idle.

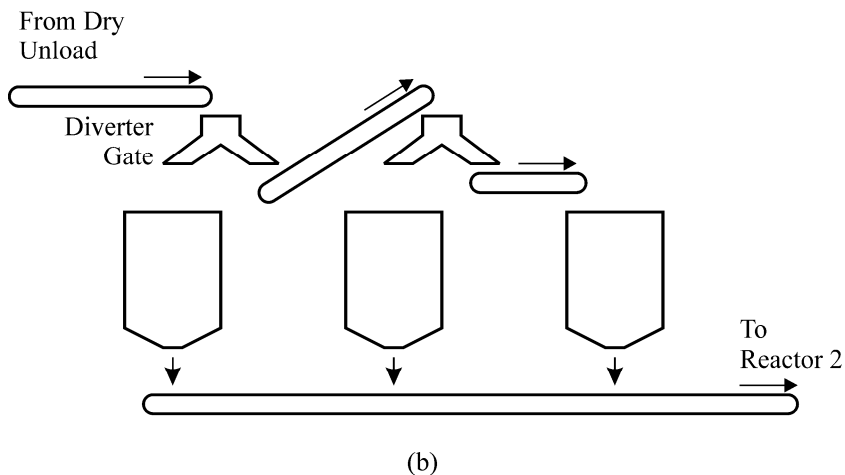
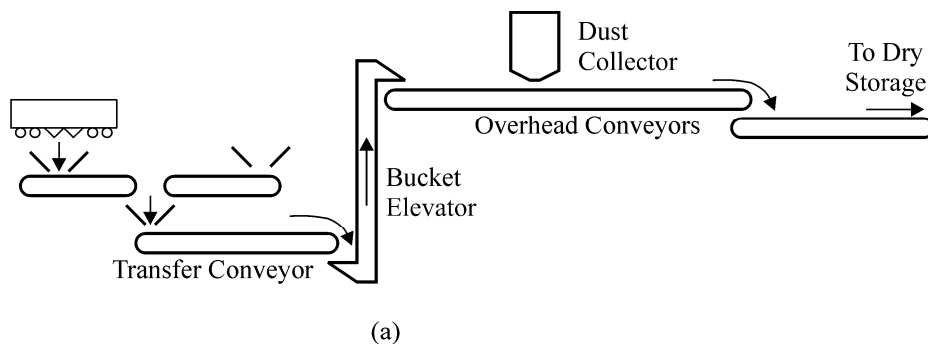


Figure 6. Dry unload cell: (a) rail dry unload unit; (b) dry storage load in and load out units.

| POD | Area: Loadin Cell: Dry Unload Unit: Rail Dry Unload |
|---|---|
| <p><i>Rail Dry Unload Unit.</i> Grain unloaded from rail cars is transferred to the dry ingredient storage unit (Figure 6a). The primary control objective of this unit is to convey dry ingredients from one of two rail car unload stations to the dry storage unit. The operating states of this unit are shown in Figure 7:</p> <p>Transfer Hold Shutdown E-Shutdown</p> <p>The hold state allows manual control of devices in order to correct a problem. Normal operation is intermittent, running only when a rail car needs to unload. The states are described as follows:</p> <p>Operating State Name: Transfer</p> <p><i>Routine Activities</i> Request source station and destination tank from operator. Start dry storage unit for proper destination. Start conveyors for the proper source. Open source slide gate.</p> <p><i>Exception Handling</i> Hold if: Dust collector failure. Shutdown if: Conveyor failure. E-Shutdown if: Dry storage shut down. .</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Tank full or operator-requested shut down.</p> <p>Operating State Name: Shutdown</p> <p><i>Routine Activities</i> Close slide gates.</p> | |
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| POD | Area: Loadin | Cell: Dry Unload | Unit: Rail Dry Unload |
|--|------------------------|------------------|-----------------------|
| <p>Stop all conveyors.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Start transfer requested.</p> <p>Operating State Name: E-Shutdown</p> <p><i>Routine Activities</i> Immediately close slide gates. Immediately stop all conveyors.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Start transfer requested.</p> <div> <pre> graph TD In1(()) --> Transfer Transfer --> Shutdown Shutdown --> Bus EShutdown[E-Shutdown] --> Bus Bus --> Transfer In2(()) --> Hold Hold --> Out[To any other sequence] </pre> </div> | | | |
| <p>Figure 7. Rail dry unload unit operating states.</p> | | | |
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| POD | Area: Loadin Cell: Dry Unload Unit: Dry Storage Loadin |
|---|--|
| <p><i>Dry Storage Loadin Unit.</i> Grain from the dry ingredient unload unit is transferred to one of three storage bins (Figure 6b). The primary control objective of this unit is to convey dry ingredients from the dry storage unload unit to one of three bins. The operating states of this unit are shown in Figure 8:</p> <p>Start Path to T-2210 Start Path to T-2230 Start Path to T-2250 Hold Shutdown E-Shutdown</p> <p>Normal operation is intermittent, running only when a rail car needs to unload. The states are described as follows:</p> <p>Operating State Name: Start Path to T-22x0</p> <p><i>Routine Activities</i> Put gates in proper position. Start conveyors.</p> <p><i>Exception Handling</i> Shutdown if: Rail dry unload shut down. E-Shutdown if: Conveyor failure.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Shut down requested by rail dry unload unit.</p> <p>Operating State Name: Shutdown</p> <p><i>Routine Activities</i> Stop all conveyors.</p> <p><i>Exception Handling</i> None.</p> | |
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| Page 26 | |

| POD | Area: Loadin | Cell: Dry Unload | Unit: Dry Storage Loadin |
|--|--------------|------------------|--------------------------|
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Figure 8. Dry storage loadin unit operating states.

| POD | Area: Loadin Cell: Dry Unload Unit: Dry Storage Loadout |
|---|---|
| <p><i>Dry Storage Loadout Unit.</i> Grain from one of the bins is transferred to reactor 2. The primary control objective of this unit is to convey dry ingredients from one of bins to the reactor 2. The operating states of this unit are shown in Figure 9:</p> <p>Start Transfer from T-2210 Start Transfer from T-2230 Start Transfer from T-2250 Hold Shutdown E-Shutdown</p> <p>Normal operation is intermittent, running only when reactor 2 needs a dry ingredient. The states are described as follows:</p> <p>Operating State Name: Start Transfer from T-22x0</p> <p><i>Routine Activities</i> Start bin rotary outlet valve. Start conveyor.</p> <p><i>Exception Handling</i> E-Shutdown if: Conveyor failure. Reactor 2 shut down.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Shut down requested by reactor 2.</p> <p>Operating State Name: Shutdown</p> <p><i>Routine Activities</i> Stop all rotary valves and conveyors.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i></p> | |
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| | | | |
|---|------------------------|------------------|---------------------------|
| POD | Area: Loadin | Cell: Dry Unload | Unit: Dry Storage Loadout |
| <div>None.</div> <div><i>Performance Information</i> None.</div> <div><i>State End Conditions</i> Start transfer requested.</div> <div>Operating State Name: E-Shutdown</div> <div><i>Routine Activities</i> Immediately stop all rotary valves and conveyors.</div> <div><i>Exception Handling</i> None.</div> <div><i>Primary Control Objectives</i> None.</div> <div><i>Performance Information</i> None.</div> <div><i>State End Conditions</i> Start transfer requested.</div> <div><pre>graph TD; In(()) --> S1(Start Transfer from T-2210); In --> S2(Start Transfer from T-2230); In --> S3(Start Transfer from T-2250); S1 --> J1(()); S2 --> J1; S3 --> J1; J1 --> Sh(Shutdown); Sh --> Out(()); ESh(E-Shutdown) --> Out; Out --> In;</pre></div> | | | |
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| Control Concept | Area: Loadin | Cell: Dry Unload | Unit: |
|---|------------------------|------------------|-------|
| <p>Dry Unload Cell Process Management</p> <p><i>Extent of Automation</i> Collect performance data from units.</p> <p><i>Flexibility of Automation</i> None.</p> <p><i>Control Activity Coordination</i> Truck dry unload transfer operation is coordinated with dry storage unit operations.</p> <p><i>Interaction with Operating Personnel</i> Summary information from units displayed for operator.</p> <p>Rail Dry Unload Unit Supervision</p> <p><i>Extent of Automation</i> Provide control of gates and conveyors. Provide automatic startup and shutdown for the transfer of grain from a rail car to the dry storage unit.</p> <p><i>Flexibility of Automation</i> None.</p> <p><i>Control Activity Coordination</i> Coordinates start of path to destination bin with dry storage loadin unit.</p> <p><i>Interaction with Operating Personnel</i> Operators enter source station and destination bin. Operators start transfers. Operators can stop transfer, though not normally. Display status information from control devices.</p> <p>Dry Storage Loadin Unit Supervision</p> <p><i>Extent of Automation</i> Provide control of diverter gates and conveyors. Provide automatic startup and shutdown for the transfer of grain from the rail dry unload unit to a destination bin.</p> <p><i>Flexibility of Automation</i> None</p> <p><i>Control Activity Coordination</i> Rail dry unload unit start/stops path to bins.</p> <p><i>Interaction with Operating Personnel</i> Operators can start transfer, though not normally. Operators can stop transfer, though not normally. Display status information from control devices.</p> <p>Dry Storage Loadout Unit Supervision</p> <p><i>Extent of Automation</i></p> | | | |
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| Control Concept | Area: Loadin Cell: Dry Unload Unit: |
|-----------------|--|
| | <p>Provide control of rotary valves and conveyor.</p> <p>Provide automatic startup and shutdown for the transfer of grain to reactor 2.</p> <p><i>Flexibility of Automation</i></p> <p>None.</p> <p><i>Control Activity Coordination</i></p> <p>Reactor 2 unit start/stops transfer.</p> <p><i>Interaction with Operating Personnel</i></p> <p>Operators can start transfer, though not normally.</p> <p>Operators can stop transfer, though not normally.</p> <p>Display status information from control devices.</p> |
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*Rail Dry Unload Unit***Unit Operations**

The unit operations (sequences) are the same as the operational states.

Devices

Rail dump gates (2)

Start/stop by unit sequence or operator.

Conveyors (5)

Start/stop by unit sequence or operator.

Bucket elevator

Start/stop by unit sequence or operator.

Dust collector

Start/stop by unit sequence or operator.

Interlocks

Do not allow transfer start if destination bin too full.

Control Strategy

Area: Loadin

Cell: Dry Unload

Unit: Dry Storage Loadin

*Dry Storage Loadin Unit***Unit Operations**

The unit operations (sequences) are the same as the operational states.

Devices

Diverter gates (2)

Start/stop by unit sequence or operator.

Conveyors (3)

Start/stop by unit sequence or operator.

Interlocks

Do not allow transfer start if destination bin too full.

Control Strategy

Area: Loadin

Cell: Dry Unload

Unit: Dry Storage Loadout

*Dry Storage Loadout Unit***Unit Operations**

The unit operations (sequences) are the same as the operational states.

Devices

Outlet rotary valves (3)

Start/stop by unit sequence or operator.

Conveyor

Start/stop by unit sequence or operator.

Interlocks

Do not allow transfer start if source bin empty.

Powder Unload Cell

The truck powder unload unit transfers powder ingredients to one of four storage tanks and the rail powder unload unit transfers wet ingredients to one of the same four tanks (Figure 10). Note that the powder ingredient storage is shared between the loadin area and the production area.

The operating states of the wet unload cell are shown in Figure 3. The two units operate relatively autonomously and so there is no special logic to transition between states. If either the rail wet or truck wet unload units are in the transfer state, the cell is running. If both units are shut down, the cell is idle.

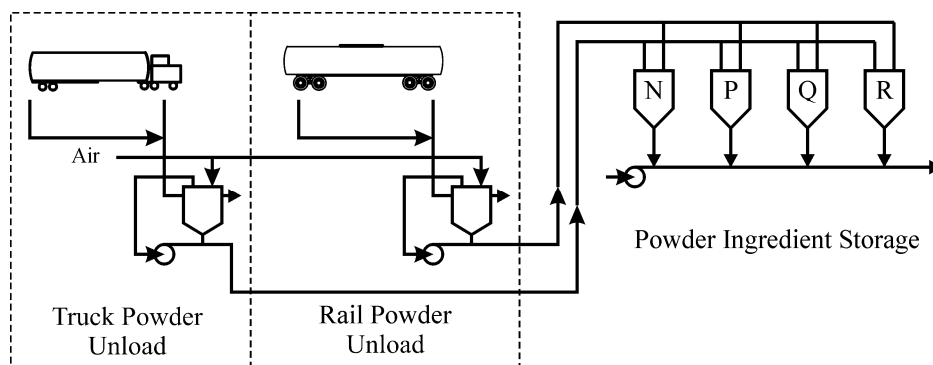
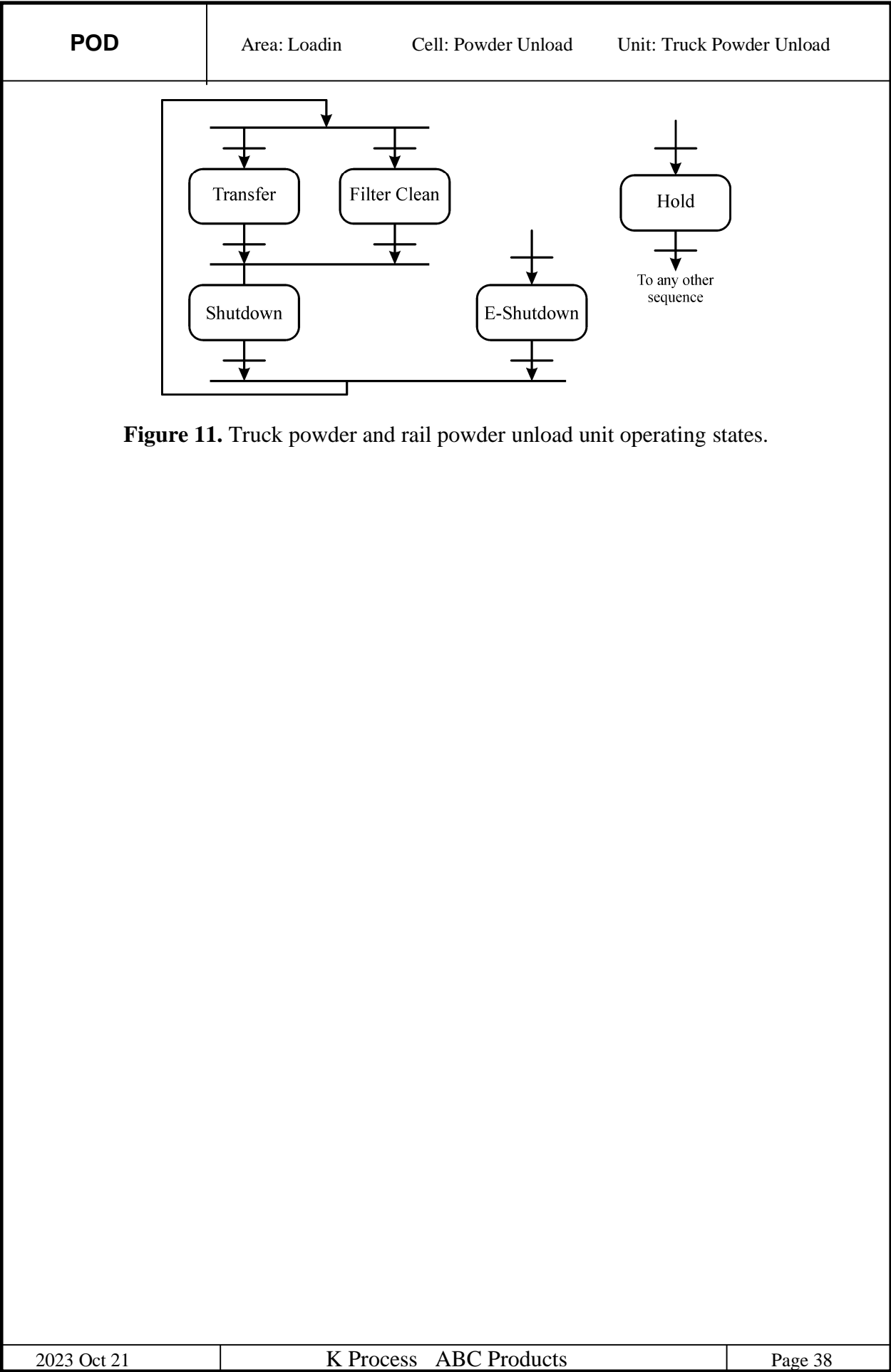


Figure 10. Powder unload cell.

| POD | Area: Loadin Cell: Powder Unload Unit: Truck Powder Unload |
|-------------|--|
| | <p><i>Truck Powder Unload Unit.</i> Powders unloaded from trucks are transferred to the powder ingredient storage unit. The primary control objective of this unit is to convey powder ingredients from one of two truck unload stations to one of four destination tanks. The operating states of this unit are shown in Figure 11:</p> <p>Transfer Filter Clean Hold Shutdown E-Shutdown</p> <p>The hold state allows manual control of devices in order to correct a problem. Normal operation is intermittent, running only when a truck needs to unload. The states are described as follows:</p> <p>Operating State Name: Transfer</p> <p><i>Routine Activities</i> Request source station and destination tank from operator. Open valves for the proper source/destination. Start blower.</p> <p><i>Exception Handling</i> Hold if: Valve or motor failure.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Transfer finished (low flow or destination tank full).</p> <p>Operating State Name: Filter Clean</p> <p><i>Routine Activities</i> Pulse backflow pressurized air to clean filter.</p> <p><i>Exception Handling</i> Hold if: Valve or motor failure.</p> <p><i>Primary Control Objectives</i></p> |
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| POD | Area: Loadin Cell: Powder Unload Unit: Truck Powder Unload |
|--|--|
| <p>None.</p> <p><i>Performance Information</i></p> <p>None.</p> <p><i>State End Conditions</i></p> <p>Pulses finished.</p> <p>Operating State Name: Shutdown</p> <p><i>Routine Activities</i></p> <p>Stop blower and close all valves.</p> <p><i>Exception Handling</i></p> <p>None.</p> <p><i>Primary Control Objectives</i></p> <p>None.</p> <p><i>Performance Information</i></p> <p>None.</p> <p><i>State End Conditions</i></p> <p>Transfer or filter clean requested.</p> <p>Operating State Name: E-Shutdown</p> <p><i>Routine Activities</i></p> <p>Immediately stop blower and close all valves.</p> <p><i>Exception Handling</i></p> <p>None.</p> <p><i>Primary Control Objectives</i></p> <p>None.</p> <p><i>Performance Information</i></p> <p>None.</p> <p><i>State End Conditions</i></p> <p>Transfer or filter clean requested.</p> | |
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| POD | Area: Loadin Cell: Powder Unload Unit: Rail Powder Unload |
|--|---|
| <p><i>Rail Powder Unload Unit.</i> Powders unloaded from rail cars are transferred to the powder ingredient storage unit. The primary control objective of this unit is to convey powder ingredients from one of two rail unload stations to one of four destination tanks. The operating states of this unit are shown in Figure 4:</p> <p>Transfer Filter Clean Hold Shutdown E-Shutdown</p> <p>The hold state allows manual control of devices in order to correct a problem. Normal operation is intermittent, running only when a truck needs to unload. The states are described as follows:</p> <p>Operating State Name: Transfer</p> <p><i>Routine Activities</i> Request source station and destination tank from operator. Open valves for the proper source/destination. Start blower.</p> <p><i>Exception Handling</i> Hold if: Valve or motor failure.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Transfer finished (low flow or destination tank full).</p> <p>Operating State Name: Filter Clean</p> <p><i>Routine Activities</i> Pulse backflow pressurized air to clean filter.</p> <p><i>Exception Handling</i> Hold if: Valve or motor failure.</p> <p><i>Primary Control Objectives</i></p> | |
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| POD | Area: Loadin Cell: Powder Unload Unit: Rail Powder Unload |
|--|---|
| <p>None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Pulses finished.</p> <p>Operating State Name: Shutdown</p> <p><i>Routine Activities</i> Stop blower and close all valves.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Transfer or filter clean requested.</p> <p>Operating State Name: E-Shutdown</p> <p><i>Routine Activities</i> Immediately stop blower and close all valves.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Transfer or filter clean requested.</p> | |
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| Control Concept | Area: Loadin Cell: Powder Unload Unit: |
|-----------------|--|
| | <p>Powder Unload Cell Process Management</p> <p><i>Extent of Automation</i> Collect performance data from units.</p> <p><i>Flexibility of Automation</i> None.</p> <p><i>Control Activity Coordination</i> Destination tanks are shared by the truck powder unload and truck powder unload units.</p> <p><i>Interaction with Operating Personnel</i> Summary information from units displayed for operator.</p> <p>Truck Powder Unload Unit Supervision</p> <p><i>Extent of Automation</i> Provide control of valves and blower. Provide automatic startup and shutdown for the transfer of powder from the truck trailer to a destination tank. Collect inventory data (pounds of powder unloaded from trailer).</p> <p><i>Flexibility of Automation</i> None.</p> <p><i>Control Activity Coordination</i> Interlocks with rail powder unload unit prevent transfer from both units into same tank.</p> <p><i>Interaction with Operating Personnel</i> Operators enter source station and destination tank. Operators start transfers. Operators can stop transfer, though not normally. Display status information from control devices. Display amount transferred.</p> <p>Rail Powder Unload Unit Supervision</p> <p><i>Extent of Automation</i> Provide control of valves and blower. Provide automatic startup and shutdown for the transfer of powder from a rail car to a destination tank. Collect inventory data (pounds of powder unloaded from rail car).</p> <p><i>Flexibility of Automation</i> None</p> <p><i>Control Activity Coordination</i> Interlocks with truck powder unload unit prevent transfer from both units into same tank.</p> <p><i>Interaction with Operating Personnel</i> Operators enter source station and destination tank. Operators start transfers.</p> |
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Control Concept

Area: Loadin

Cell: Powder Unload

Unit:

Operators can stop transfer, though not normally.
Display status information from control devices.
Display amount transferred.

*Truck Powder Unload Unit***Unit Operations**

The unit operations (sequences) are the same as the operational states.

Devices

Blower

Start/stop by unit sequence or operator.

Product source valves (2)

Start/stop by unit sequence or operator.

Filter/Receiver valves (2)

Start/stop by unit sequence or operator.

Outlet valve

Start/stop by unit sequence or operator.

Destination tank inlet valves (4)

Start/stop by unit sequence or operator.

Pressurized air inlet valve

Start/stop by unit sequence or operator.

Interlocks

Do not allow transfer start if destination tank too full or rail powder transferring into same destination tank.

*Rail Powder Unload Unit***Unit Operations**

The unit operations (sequences) are the same as the operational states.

Devices

Blower

Start/stop by unit sequence or operator.

Product source valves (2)

Start/stop by unit sequence or operator.

Filter/Receiver valves (2)

Start/stop by unit sequence or operator.

Outlet valve

Start/stop by unit sequence or operator.

Destination tank inlet valves (4)

Start/stop by unit sequence or operator.

Pressurized air inlet valve

Start/stop by unit sequence or operator.

Interlocks

Do not allow transfer start if destination tank too full or truck powder transferring into same destination tank.

| | | | |
|--|------------------------|-------|---------|
| POD | Area: Production | Cell: | Unit: |
| <p>PRODUCTION AREA</p> <p>The production area is subdivided into reactor and ion exchange cells (Figure 1). This area also contains the QA sample unit, which is used by the two of the reactors.</p> | | | |
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Reactor Cell

The reactor cell has a blending unit and three reactors, two of which are shown in Figure 12. The blending unit blends up to four wet ingredients from the wet storage tanks into one of the reactor ingredients for reactors 1 and 2.

The operating states of the reactor cell are shown in Figure 3. The four reactor units operate relatively autonomously and so there is no special logic to transition between states. If any reactor is not shut down, the cell is running. If all units are shut down, the cell is idle.

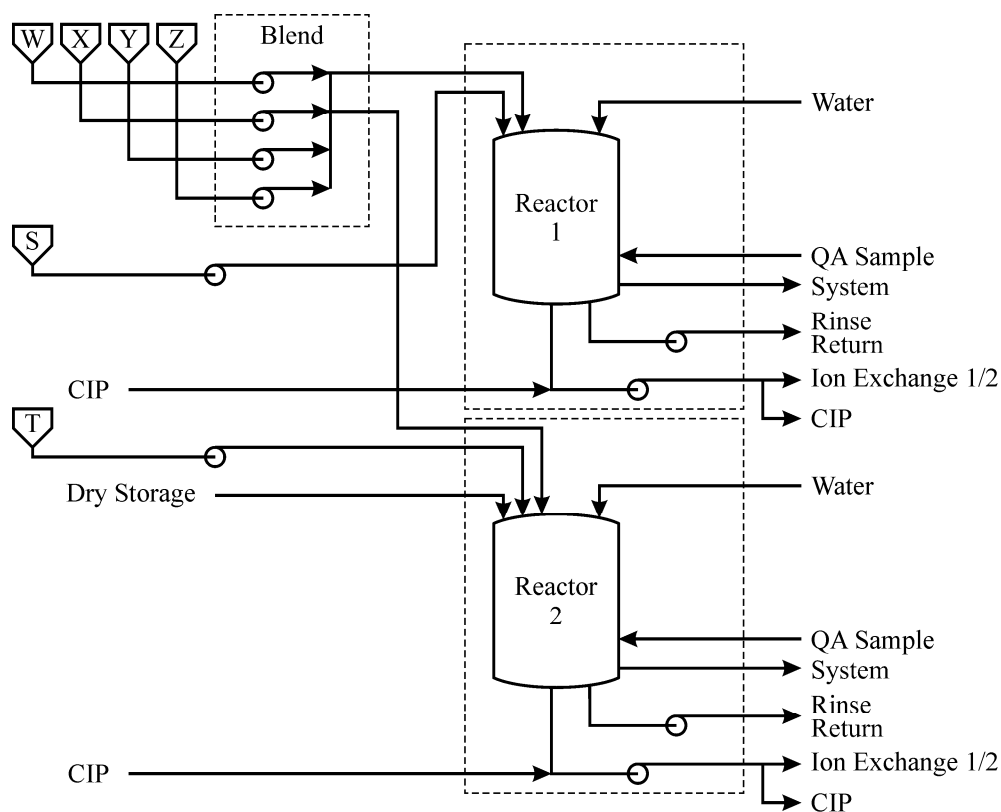


Figure 12. Reactors 1 and 2 in reactor cell.

| POD | Area: Production Cell: Reactor Unit: Blend |
|--|--|
| <p><i>Blend Unit.</i> Four ingredients are blended into one stream that is transferred to reactor 1 or 2 (Figure 12). The primary control objective of this unit is to blend the four ingredients in the proper proportion for the reactor. The operating states of this unit are shown in Figure 13:</p> <p>Blend for Reactor 1 Blend for Reactor 2 Hold Shutdown E-Shutdown</p> <p>The hold state allows manual control of devices in order to correct a problem. Normal operation is intermittent, running only when needed by a reactor. The states are described as follows:</p> <p>Operating State Name: Blend for Reactor 1</p> <p><i>Routine Activities</i> Verify blend ratios. Open appropriate valves. Start appropriate pumps. Initialize loops.</p> <p><i>Exception Handling</i> Hold if: Any valve failure. Shutdown if: Low ingredient tank level. E-Shutdown if: Reactor 1 not in Make Batch.</p> <p><i>Primary Control Objectives</i> Target blend ratios.</p> <p><i>Performance Information</i> Ingredients consumed.</p> <p><i>State End Conditions</i> Shut down requested by reactor 1 unit.</p> <p>Operating State Name: Blend for Reactor 2</p> <p><i>Routine Activities</i> Verify blend ratios.</p> | |
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| POD | Area: Production Cell: Reactor Unit: Blend |
|---|--|
| <p>Open appropriate valves. Start appropriate pumps. Initialize loops.</p> <p><i>Exception Handling</i> Hold if: Any valve failure. Shutdown if: Low ingredient tank level. E-Shutdown if: Reactor 2 not in Make Batch.</p> <p><i>Primary Control Objectives</i> Target blend ratios.</p> <p><i>Performance Information</i> Ingredients consumed.</p> <p><i>State End Conditions</i> Shut down requested by reactor 2 unit.</p> <p>Operating State Name: Shutdown</p> <p><i>Routine Activities</i> Stop all pumps. Stop all loops. Close all valves.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Blend for a reactor requested.</p> <p>Operating State Name: E-Shutdown</p> <p><i>Routine Activities</i></p> | |
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| | |
|--|--|
| POD | Area: Production Cell: Reactor Unit: Blend |
| <p>Immediately stop all pumps and close all valves. Stop all loops.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Blend for a reactor requested.</p> <div><pre>graph TD; Start(()) --> B1[Blend for Reactor 1]; Start --> B2[Blend for Reactor 2]; B1 --> S[Shutdown]; B2 --> S; S --> ES[E-Shutdown]; ES --> Start; Hold[Hold] --> ToSeq[To any other sequence];</pre></div> | |
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| | |
|---|--|
| POD | Area: Production Cell: Reactor Unit: Reactor 1 |
| <p><i>Reactor 1 Unit.</i> Takes appropriate ingredients from the blend unit and wet ingredient storage and produces a product (Figure 12). The primary control objective of this unit is to produce the product according to the recipe. The operating states of this unit are shown in Figure 14:</p> <p>Make Batch Rinse Flush Hold Shutdown E-Shutdown</p> <p>The hold state allows manual control of devices in order to correct a problem. Normal operation is intermittent, running only when product is needed. The states are described as follows:</p> <p>Operating State Name: Make Batch</p> <p><i>Routine Activities</i></p> <p>Prestart checks: reactor level (empty) and temperature. Add desired amount of water. Start agitator. Add desired amount of ingredient A (from blend). Add desired amount of S. Agitate desired time. Get QA sample results. Agitate additional time. Lock QA sampling system. Verify ion exchange unit online. Transfer product to ion exchange unit. Initiate rinse.</p> <p><i>Exception Handling</i></p> <p>Hold if: Any valve or pump failure. Shutdown if: Tank level too high Product pH outside range. Product temperature too high.</p> <p><i>Primary Control Objectives</i></p> <p>Target QA value.</p> <p><i>Performance Information</i></p> <p>Batch pH trend.</p> | |
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| | |
|--|--|
| POD | Area: Production Cell: Reactor Unit: Reactor 1 |
| <p>Batch temperature trend. Batch QA value.</p> <p><i>State End Conditions</i> Rinse initiated after correct end of batch.</p> <p>Operating State Name: Rinse</p> <p><i>Routine Activities</i> Prestart check: reactor level (empty). Open water inlet valve. Start agitator. Close rinse water inlet valve. Agitate certain time. Open rinse water outlet valve. Drain reactor tank.</p> <p><i>Exception Handling</i> Hold if: Any valve or pump failure.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Reactor tank drained.</p> <p>Operating State Name: Flush</p> <p><i>Routine Activities</i> Verify ion exchange unit online. Request CIP system to start reactor 1 outlet path. Flush product into ion exchange. Close valve to ion exchange. Flush CIP fluid through path. Request CIP system to go online/recycle.</p> <p><i>Exception Handling</i> Hold if: Any valve or pump failure.</p> | |
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| | |
|---|--|
| POD | Area: Production Cell: Reactor Unit: Reactor 1 |
| <p>E-Shutdown if: CIP system not in reactor 1 path.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> CIP system online/recycle.</p> <p>Operating State Name: Shutdown</p> <p><i>Routine Activities</i> Stop all pumps. Close all valves.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Make batch or flush requested.</p> <p>Operating State Name: E-Shutdown</p> <p><i>Routine Activities</i> Immediately stop all pumps and close all valves.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> | |
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State End Conditions

Make batch or flush requested.

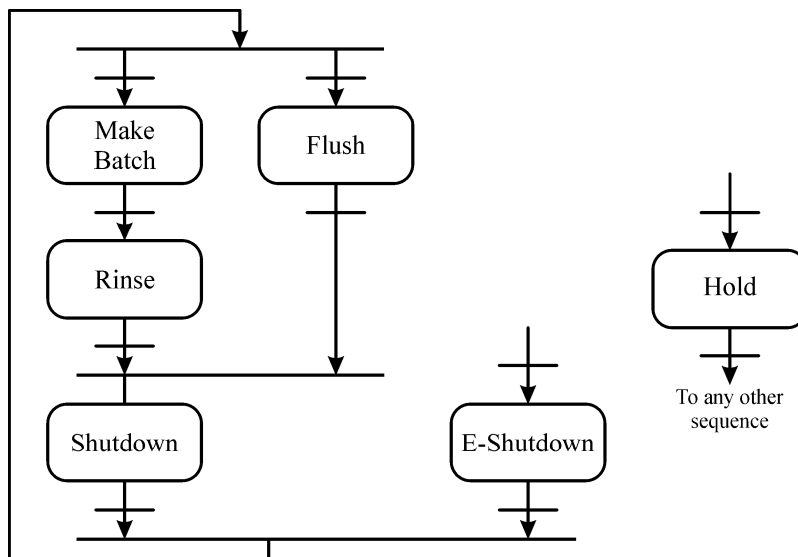


Figure 14. Reactor 1 unit operating states.

| | |
|--|--|
| POD | Area: Production Cell: Reactor Unit: Reactor 4 |
| <p><i>Reactor 2 Unit.</i> Takes appropriate ingredients from the blend unit, wet ingredient storage, and dry ingredient storage and produces a product (Figure 12). The primary control objective of this unit is to produce the product according to the recipe. The operating states of this unit are the same as for reactor 1 (Figure 14):</p> <p>Make Batch Rinse Flush Hold Shutdown E-Shutdown</p> <p>The hold state allows manual control of devices in order to correct a problem. Normal operation is intermittent, running only when product is needed. The states are described as follows:</p> <p>Operating State Name: Make Batch</p> <p><i>Routine Activities</i></p> <p>Prestart checks: reactor level (empty) and temperature. Add desired amount of water. Start agitator. Add desired amount of ingredient A (from blend). Add desired amount of dry ingredient (from dry storage loadout). Add desired amount of T. Agitate desired time. Get QA sample results. Agitate additional time. Lock QA sampling system. Verify ion exchange unit online. Transfer product to ion exchange unit. Initiate rinse.</p> <p><i>Exception Handling</i></p> <p>Hold if: Any valve or pump failure. Shutdown if: Tank level too high. Product pH outside range. Product temperature too high.</p> <p><i>Primary Control Objectives</i></p> <p>Target QA value.</p> <p><i>Performance Information</i></p> | |
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| POD | Area: Production Cell: Reactor Unit: Reactor 4 |
|---|--|
| <p>Batch pH trend. Batch temperature trend. Batch QA value.</p> <p><i>State End Conditions</i> Rinse initiated after correct end of batch.</p> <p>Operating State Name: Rinse</p> <p><i>Routine Activities</i> Prestart check: reactor level (empty). Open water inlet valve. Start agitator. Close rinse water inlet valve. Agitate certain time. Open rinse water outlet valve. Drain reactor tank.</p> <p><i>Exception Handling</i> Hold if: Any valve or pump failure.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Reactor tank drained.</p> <p>Operating State Name: Flush</p> <p><i>Routine Activities</i> Verify ion exchange unit online. Request CIP system to start reactor 2 outlet path. Flush product into ion exchange. Close valve to ion exchange. Flush CIP fluid through path. Request CIP system to go online/recycle.</p> <p><i>Exception Handling</i> Hold if:</p> | |
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| | |
|--|--|
| POD | Area: Production Cell: Reactor Unit: Reactor 4 |
| <p>Any valve or pump failure. E-Shutdown if: CIP system not in reactor 2 path.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> CIP system online/recycle.</p> <p>Operating State Name: Shutdown</p> <p><i>Routine Activities</i> Stop all pumps. Close all valves.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Make batch or flush requested.</p> <p>Operating State Name: E-Shutdown</p> <p><i>Routine Activities</i> Immediately stop all pumps and close all valves.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i></p> | |
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| | |
|---|--|
| POD | Area: Production Cell: Reactor Unit: Reactor 4 |
| <p>None.</p> <p><i>State End Conditions</i></p> <p>Make batch or flush requested.</p> | |
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| | |
|--|--|
| POD | Area: Production Cell: Reactor Unit: Reactor 4 |
| <p><i>Reactor 3 Unit.</i> Takes appropriate ingredients from the wet ingredient storage and powder ingredient storage and produces a product. The primary control objective of this unit is to produce the product according to the recipe. The operating states of this unit are the same as for reactor 1 (Figure 14):</p> <p>Make Batch Rinse Flush Hold Shutdown E-Shutdown</p> <p>The hold state allows manual control of devices in order to correct a problem. Normal operation is intermittent, running only when product is needed. The states are described as follows:</p> <p>Operating State Name: Make Batch</p> <p><i>Routine Activities</i></p> <p>Prestart checks: reactor level (empty) and temperature. Add desired amount of water. Start agitator. Add desired amount of powder (from powder storage). Add desired amount of T. Agitate desired time. Get QA sample results (manually). Agitate additional time. Verify ion exchange unit online. Transfer product to ion exchange unit. Initiate rinse.</p> <p><i>Exception Handling</i></p> <p>Hold if: Any valve or pump failure. Shutdown if: Tank level too high. Product pH outside range. Product temperature too high.</p> <p><i>Primary Control Objectives</i></p> <p>Target QA value.</p> <p><i>Performance Information</i></p> <p>Batch pH trend. Batch temperature trend.</p> | |
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| | |
|--|--|
| POD | Area: Production Cell: Reactor Unit: Reactor 4 |
| <p>Batch QA value.</p> <p><i>State End Conditions</i> Rinse initiated after correct end of batch.</p> <p>Operating State Name: Rinse</p> <p><i>Routine Activities</i> Prestart check: reactor level (empty). Open water inlet valve. Start agitator. Close rinse water inlet valve. Agitate certain time. Open rinse water outlet valve. Drain reactor tank.</p> <p><i>Exception Handling</i> Hold if: Any valve or pump failure.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Reactor tank drained.</p> <p>Operating State Name: Flush</p> <p><i>Routine Activities</i> Verify ion exchange unit online. Start rinse water path. Flush product into ion exchange. Close valve to ion exchange. Flush rinse water through path. Initiate shutdown.</p> <p><i>Exception Handling</i> Hold if: Any valve or pump failure. E-Shutdown if:</p> | |
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| POD | Area: Production Cell: Reactor Unit: Reactor 4 |
|--|--|
| <p>None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Shutdown</p> <p>Operating State Name: Shutdown</p> <p><i>Routine Activities</i> Stop all pumps. Close all valves.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Make batch or flush requested.</p> <p>Operating State Name: E-Shutdown</p> <p><i>Routine Activities</i> Immediately stop all pumps and close all valves.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> | |
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| | |
|---|--|
| POD | Area: Production Cell: Reactor Unit: Reactor 4 |
| <i>State End Conditions</i> Make batch or flush requested. | |
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| POD | Area: Production Cell: Reactor Unit: Reactor 4 |
|-------------|---|
| | <p><i>Reactor 4 Unit.</i> Takes appropriate ingredients from the wet ingredient storage and gas ingredient storage and produces a product. The primary control objective of this unit is to produce the product according to the recipe. The operating states of this unit are the same as for reactor 1 (Figure 14), except that there is no rinse:</p> <p>Make Batch Flush Hold Shutdown E-Shutdown</p> <p>The hold state allows manual control of devices in order to correct a problem. Normal operation is intermittent, running only when product is needed. The states are described as follows:</p> <p>Operating State Name: Make Batch</p> <p><i>Routine Activities</i></p> <ul style="list-style-type: none"> Prestart checks: reactor level (empty) and temperature. Add desired amount of water. Start agitator. Add desired amount of U. Bubble gas through mixture Agitate desired time. Verify ion exchange unit online. Transfer product to ion exchange unit. Initiate flush. <p><i>Exception Handling</i></p> <ul style="list-style-type: none"> Hold if: <ul style="list-style-type: none"> Any valve or pump failure. Shutdown if: <ul style="list-style-type: none"> Tank level too high. Product pH outside range. Product temperature too high. <p><i>Primary Control Objectives</i></p> <ul style="list-style-type: none"> Target QA value. <p><i>Performance Information</i></p> <ul style="list-style-type: none"> Batch pH trend. Batch temperature trend. <p><i>State End Conditions</i></p> <ul style="list-style-type: none"> Flush initiated after correct end of batch. |
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| | | | |
|---|------------------------|---------------|-----------------|
| POD | Area: Production | Cell: Reactor | Unit: Reactor 4 |
| <p>Operating State Name: Flush</p> <p><i>Routine Activities</i> Verify CIP_2 unit online. Start flush path. Flush system Request CIP_2 to go online/recycle Initiate shutdown.</p> <p><i>Exception Handling</i> Hold if: Any valve or pump failure. E-Shutdown if: None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Shutdown</p> <p>Operating State Name: Shutdown</p> <p><i>Routine Activities</i> Stop all pumps. Close all valves.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Make batch or flush requested.</p> <p>Operating State Name: E-Shutdown</p> | | | |
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| | |
|---|--|
| POD | Area: Production Cell: Reactor Unit: Reactor 4 |
| <p><i>Routine Activities</i> Immediately stop all pumps and close all valves.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Make batch or flush requested.</p> | |
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Reactor Cell Process Management*Extent of Automation*

Collect performance data from units.

Flexibility of Automation

Multiple products may be made by reactors.

Control Activity Coordination

Reactors share ion exchange and cannot transfer to it at the same time.

Interaction with Operating Personnel

Summary information from units displayed for operator.

Blend Unit Supervision*Extent of Automation*

Provide control of loops, valves, and pumps.

Provide automatic startup and shutdown for the blending of ingredient for reactors.

Flexibility of Automation

Blend ratios may be different for each batch.

Control Activity Coordination

Blending coordinated with reactor operations.

Interaction with Operating Personnel

Operators may enter blend ratios.

Operators can start blend, though not normally.

Operators can stop blend, though not normally.

Display status information from control devices.

Reactor 1 Unit Supervision*Extent of Automation*

Provide control of loops, valves, and pumps.

Provide automatic making of a batch.

Provide automatic handling of flush.

Flexibility of Automation

Recipe that defines:

Blend ratios.

Amount of ingredient A.

Amount of ingredient S.

Agitate times.

Desired QA value.

Control Activity Coordination

Blending coordinated with reactor operations.

Batching coordinated with ion exchangers.

Interaction with Operating Personnel

Operators may enter recipe values.

Operators can start make batch.

Operators can stop make batch, though not normally.
Display status information from control devices.

Reactor 2 Unit Supervision*Extent of Automation*

Provide control of loops, valves, and pumps.
Provide automatic making of a batch.
Provide automatic handling of flush.

Flexibility of Automation

Recipe that defines:
Blend ratios.
Amount of ingredient A.
Amount of ingredient T.
Storage bin and amount of dry ingredient.
Agitate times.
Desired QA value.

Control Activity Coordination

Blending coordinated with reactor operations.
Batching coordinated with ion exchangers.

Interaction with Operating Personnel

Operators may enter recipe values.
Operators can start make batch.
Operators can stop make batch, though not normally.
Display status information from control devices.

Reactor 3 Unit Supervision*Extent of Automation*

Provide control of loops, valves, and pumps.
Provide automatic making of a batch.
Provide automatic handling of flush.

Flexibility of Automation

Recipe that defines:
Amount of water.
Amount of ingredient T.
Storage bin and amount of powder ingredient.
Agitate times.
Desired QA value.

Control Activity Coordination

Batching coordinated with ion exchangers.

Interaction with Operating Personnel

Operators may enter recipe values.
Operators can start make batch.
Operators can stop make batch, though not normally.

Display status information from control devices.

Reactor 4 Unit Supervision*Extent of Automation*

Provide control of loops, valves, and pumps.

Provide automatic making of a batch.

Provide automatic handling of flush.

Flexibility of Automation

Recipe that defines:

Amount of water.

Amount of ingredient U.

Storage bin and amount of powder ingredient.

Agitate times.

Desired QA value.

Control Activity Coordination

Batching coordinated with ion exchangers.

Interaction with Operating Personnel

Operators may enter recipe values.

Operators can start make batch.

Operators can stop make batch, though not normally.

Display status information from control devices.

*Blend Unit***Unit Operations**

The unit operations (sequences) are the same as the operational states.

Loops*W Transfer Flow.*

During blending for reactor, maintain flow rate.

X Transfer Flow.

During blending for reactor, maintains desired ratio with W flow rate.

Y Transfer Flow.

During blending for reactor, maintains desired ratio with W flow rate.

Z Transfer Flow.

During blending for reactor, maintains desired ratio with W flow rate.

Devices

Pumps (4)

Start/stop by unit sequence or operator.

Blocking valves (4)

Start/stop by unit sequence or operator.

Path valves (2)

Start/stop by unit sequence or operator.

Interlocks

Do not allow blending for one reactor if blending for the other is currently in progress.

*Reactor 1 Unit***Unit Operations**

The unit operations (sequences) are the same as the operational states.

Loops*S Transfer Flow.*

During phase adding ingredient S, maintain flow rate.

Devices

Pumps (3)

Start/stop by unit sequence or operator.

Blocking valves (4)

Start/stop by unit sequence or operator.

Path valves (4)

Start/stop by unit sequence or operator.

Agitator

Start/stop by unit sequence or operator.

Interlocks

Do not start transfer to ion exchange if reactor 2 is transferring to ion exchange.

*Reactor 2 Unit***Unit Operations**

The unit operations (sequences) are the same as the operational states.

Loops*T Transfer Flow.*

During phase adding ingredient T, maintain flow rate.

Devices

Pumps (3)

Start/stop by unit sequence or operator.

Blocking valves (4)

Start/stop by unit sequence or operator.

Path valves (4)

Start/stop by unit sequence or operator.

Agitator

Start/stop by unit sequence or operator.

Conveyor

Start/stop by unit sequence or operator.

Interlocks

Do not start transfer to ion exchange if reactor 1 is transferring to ion exchange.

*Reactor 3 Unit***Unit Operations**

The unit operations (sequences) are the same as the operational states.

Loops*T Transfer Flow.*

During phase adding ingredient T, maintain flow rate.

Powder Transfer Flow.

During phase adding powder, maintain flow rate.

Rinse Water Flow.

During rinse phase, maintain flow rate.

Devices

Pumps (3)

Start/stop by unit sequence or operator.

Blocking valves (4)

Start/stop by unit sequence or operator.

Path valves (4)

Start/stop by unit sequence or operator.

Path blower

Start/stop by unit sequence or operator.

Agitator

Start/stop by unit sequence or operator.

Interlocks

None.

*Reactor 4 Unit***Unit Operations**

The unit operations (sequences) are the same as the operational states.

Loops**Devices**

Pumps (2)

Start/stop by unit sequence or operator.

Blocking valves (4)

Start/stop by unit sequence or operator.

Path valves (6)

Start/stop by unit sequence or operator.

Agitator

Start/stop by unit sequence or operator.

Interlocks

None.

Ion Exchange Cell

The ion exchange removes impurities from the product. Currently, the ion exchange cell has six ion exchanger units, of which one is shown in Figure 15.

The operating states of this cell are shown in Figure 3. The ion exchangers units operate relatively autonomously and so there is no special logic to transition between states. If any ion exchanger is not shut down, the cell is running. If all units are shut down, the cell is idle.

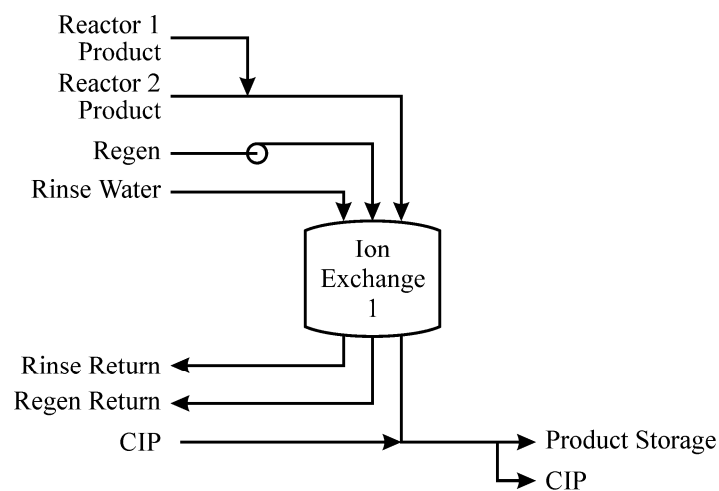


Figure 15. Ion exchange cell.

| | |
|---|--|
| POD | Area: Production Cell: Ion Exchange Unit: Ion Exchange 1 - 6 |
| <p><i>Ion Exchange 1,2,3,4,5,6 Units.</i> The primary control objective of this unit is to remove impurities from the reactor product. The operating states of this unit are (Figure 16):</p> <p>Startup Online Regenerate Flush Hold Shutdown E-Shutdown</p> <p>The hold state allows manual control of devices in order to correct a problem. Normal operation is online. The steps for the Flush state varies among the six units. Ion Exchange 1 and 2 interact with CIP_1; Ion Exchange 5 and 6 interact with CIP_2; Ion Exchange 3 and 4 use rinse water. The states are described as follows:</p> <p>Operating State Name: Startup</p> <p><i>Routine Activities</i> Prestart checks: conductivity. Reset accumulator. Open valves. Initiate online.</p> <p><i>Exception Handling</i> Hold if: Any valve or pump failure.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Online initiated.</p> <p>Operating State Name: Online</p> <p><i>Routine Activities</i> Monitor conductivity.</p> <p><i>Exception Handling</i> Hold if:</p> | |
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| POD | Area: Production Cell: Ion Exchange Unit: Ion Exchange 1 - 6 |
|-------------|---|
| | <p>Any valve or pump failure. Shutdown if: Conductivity too high</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Gallons of product processed.</p> <p>Operating State Name: Regenerate</p> <p><i>Routine Activities</i> Regenerate bed with regeneration material. Rinse bed with water.</p> <p><i>Exception Handling</i> Hold if: Any valve or pump failure.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Bed rinsed.</p> <p>Operating State Name: Flush</p> <p><i>Routine Activities</i> Request CIP system online (Ion Exchange 1,2,5,6). Request CIP system to start ion exchange outlet path (Ion Exchange 1,2,5,6). Flush product into QA tank. Close valve to QA tank. Flush CIP fluid through path. Request CIP system to go online/recycle (Ion Exchange 1,2,5,6).</p> <p><i>Exception Handling</i></p> |
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| POD | Area: Production Cell: Ion Exchange Unit: Ion Exchange 1 - 6 |
|--|--|
| <p>Hold if: Any valve or pump failure.</p> <p>E-Shutdown if: CIP system not in ion exchange path.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> CIP system online/recycle.</p> <p>Operating State Name: Shutdown</p> <p><i>Routine Activities</i> Stop all pumps. Close all valves.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Startup or flush requested.</p> <p>Operating State Name: E-Shutdown</p> <p><i>Routine Activities</i> Immediately stop all pumps and close all valves.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> | |
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Performance Information

None.

State End Conditions

Startup or flush requested.

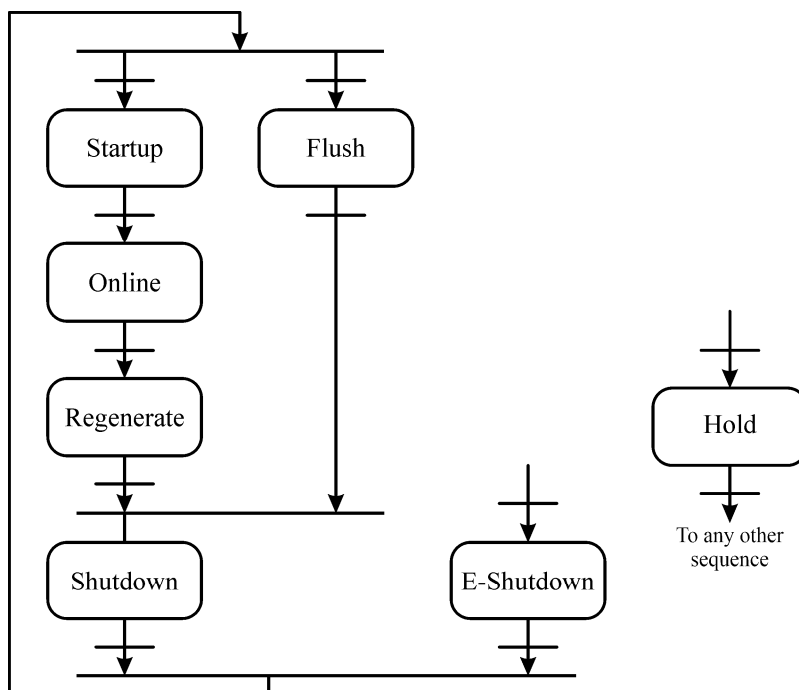


Figure 16. States of ion exchange unit.

| | |
|---|---|
| Control Concept | Area: Production Cell: Ion Exchange Unit: |
| <p>Ion Exchange Process Management</p> <p><i>Extent of Automation</i> Collect performance data from units.</p> <p><i>Flexibility of Automation</i> None.</p> <p><i>Control Activity Coordination</i> Only one ion exchange unit can regenerate at the same time.</p> <p><i>Interaction with Operating Personnel</i> Summary information from units displayed for operator.</p> <p>Ion Exchange 1 Unit Supervision</p> <p><i>Extent of Automation</i> Provide control of loops, valves, and pumps. Provide automatic startup and shutdown for the ion exchanger.</p> <p><i>Flexibility of Automation</i> None.</p> <p><i>Control Activity Coordination</i> None.</p> <p><i>Interaction with Operating Personnel</i> Operators can initiate startup, though not normally. Operators can shut down, though not normally. Display status information from control devices.</p> <p>Ion Exchange 2 Unit Supervision Same as for Ion Exchange 1 Unit.</p> <p>Ion Exchange 3 Unit Supervision Same as for Ion Exchange 1 Unit.</p> <p>Ion Exchange 4 Unit Supervision Same as for Ion Exchange 1 Unit.</p> <p>Ion Exchange 5 Unit Supervision Same as for Ion Exchange 1 Unit.</p> <p>Ion Exchange 6 Unit Supervision Same as for Ion Exchange 1 Unit.</p> | |
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*Ion Exchange 1 - 6 Units***Unit Operations**

The unit operations (sequences) are the same as the operational states.

Loops*Regenerate Material Flow.*

During regenerate bed phase of regenerate operation, maintain flow rate.

Rinse Water Flow.

During rinse phase of regenerate operation, maintain flow rate.

Devices

Pump

Start/stop by unit sequence or operator.

Blocking valves (6)

Start/stop by unit sequence or operator.

Path valves (2)

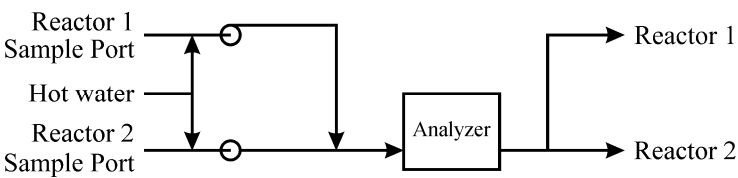
Start/stop by unit sequence or operator.

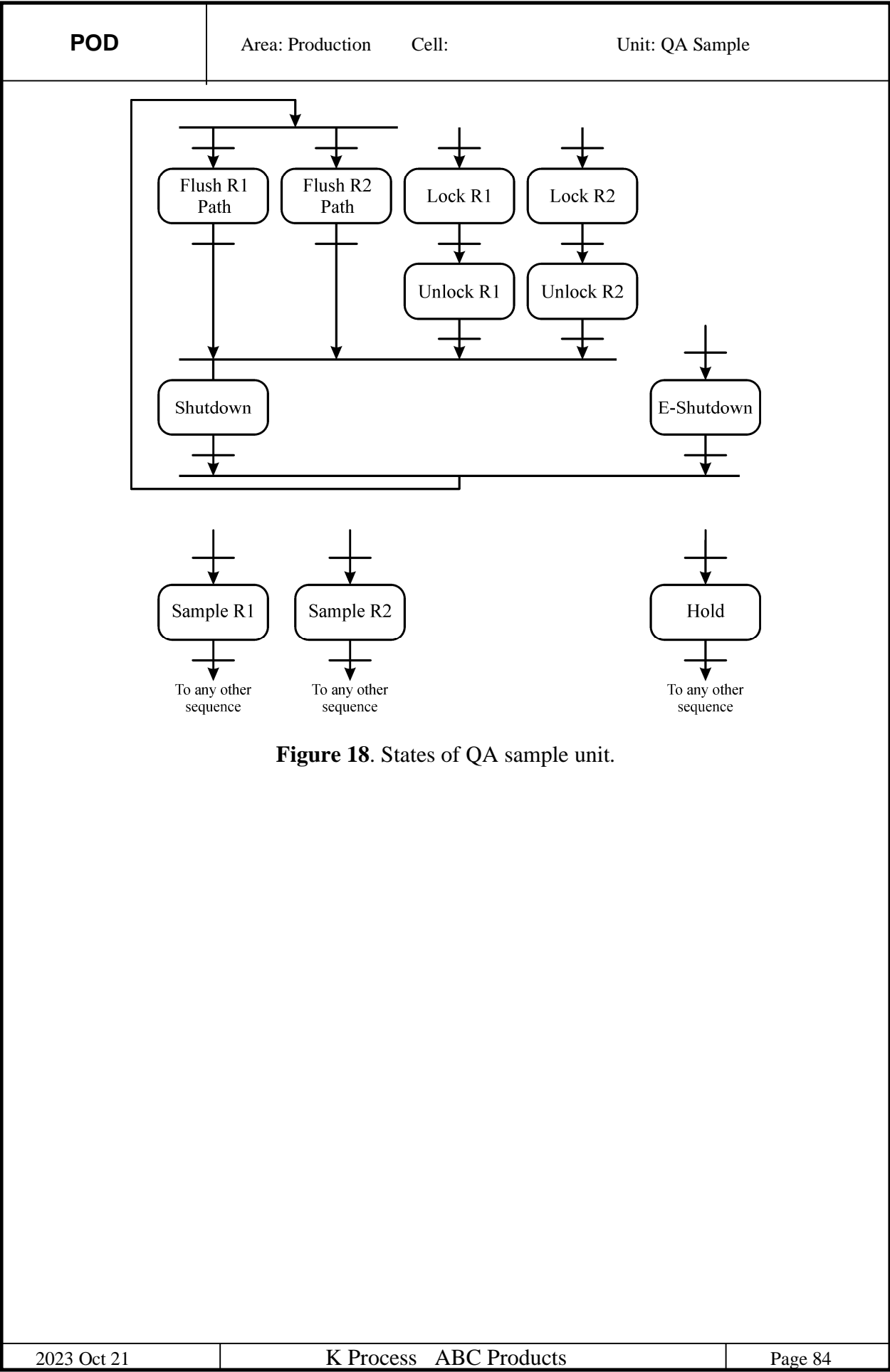
Interlocks

| POD | Area: Production Cell: Unit: QA Sample |
|--|--|
| <p><i>QA Sample Unit.</i> The primary control objective of this unit (Figure 17) is to provide a QA value while making a batch. This unit is shared by the reactors and returns product to the reactors. The operating states of this unit are (Figure 18):</p> <p>Sample R1 Lock R1 Unlock R1 Sample R2 Lock R2 Unlock R2 Flush R1 Path Flush R2 Path Hold Shutdown E-Shutdown</p> <p>The hold state allows manual control of devices in order to correct a problem. Normal operation is intermittent, running only when commanded by a reactor. The states are described as follows:</p> <p>Operating State Name: Sample R1</p> <p><i>Routine Activities</i> Open appropriate valves. Start pump. Wait for QA value to stabilize. Return sample to reactor 1.</p> <p><i>Exception Handling</i> Hold if: Any valve or pump failure. Shutdown if: Low flow when pump running.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Reading stabilized and another state requested.</p> <p>Operating State Name: Lock R1</p> | |
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| | | |
|--|-----------------------------|-----------------|
| POD | Area: Production Cell: | Unit: QA Sample |
| <p>Same as Sample R1, except that sampling locked to reactor 1 and Sample R2 and Lock R2 cannot be requested.</p> <p>Operating State Name: Unlock R1 Cancels lock to R1 and initiates shutdown.</p> <p>Operating State Name: Sample R2</p> <p><i>Routine Activities</i> Open appropriate valves. Start pump. Wait for QA value to stabilize. Return sample to reactor 2.</p> <p><i>Exception Handling</i> Hold if: Any valve or pump failure. Shutdown if: Low flow when pump running.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Reading stabilized and another state requested.</p> <p>Operating State Name: Lock R2 Same as Sample R2, except that sampling locked to reactor 2 and Sample R1 and Lock R1 cannot be requested.</p> <p>Operating State Name: Unlock R2 Cancels lock to R2 and initiates shutdown.</p> <p>Operating State Name: Flush R1 Path</p> <p><i>Routine Activities</i> Open appropriate valves.</p> | | |
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| POD | Area: Production Cell: Unit: QA Sample |
|--|--|
| <p>Start pump. Flush.</p> <p><i>Exception Handling</i> Hold if: Any valve or pump failure.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> End of flush time.</p> <p>Operating State Name: Flush R2 Path</p> <p><i>Routine Activities</i> Open appropriate valves. Start pump. Flush.</p> <p><i>Exception Handling</i> Hold if: Any valve or pump failure.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> End of flush time.</p> <p>Operating State Name: Shutdown</p> <p><i>Routine Activities</i> Stop pump. Close all valves.</p> <p><i>Exception Handling</i></p> | |
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| | | |
|--|-----------------------------|-----------------|
| POD | Area: Production Cell: | Unit: QA Sample |
| <p>None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Sample R1, sample R2, lock R1, lock R2, or flush requested.</p> <p>Operating State Name: E-Shutdown</p> <p><i>Routine Activities</i> Immediately stop pump and close all valves.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Sample R1, sample R2, lock R1, lock R2, or flush requested.</p> <div></div> <p>Figure 17. QA sample unit.</p> | | |
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QA Sample Unit Supervision*Extent of Automation*

Provide control of valves and pumps.

Provide automatic startup and shutdown for the sampling system.

Flexibility of Automation

None.

Control Activity Coordination

None.

Interaction with Operating Personnel

Operators can initiate sampling, though not normally.

Operators can shut down, though not normally.

Display status information from control devices.

*QA Sample Unit***Unit Operations**

The unit operations (sequences) are the same as the operational states.

Devices

Pumps (2)

Start/stop by unit sequence or operator.

Valves (13)

Start/stop by unit sequence or operator.

Interlocks

Sample R1 operation is not allowed to start if sampling for reactor 2 and indication to reactor 2 has not been sent or if sampling system is locked to reactor 2.

Sample R2 operation is not allowed to start if sampling for reactor 1 and indication to reactor 1 has not been sent or if sampling system is locked to reactor 1.

| | | | |
|-----|---------------|-------|-------|
| POD | Area: Loadout | Cell: | Unit: |
|-----|---------------|-------|-------|

LOADOUT AREA

The loadout area is subdivided into three product storage and three product loadout units. This area transfers the product to storage tanks and also transfers the product from the storage tanks to truck trailers or rail cars. One product storage unit and associated product loadout unit is shown in Figure 19.

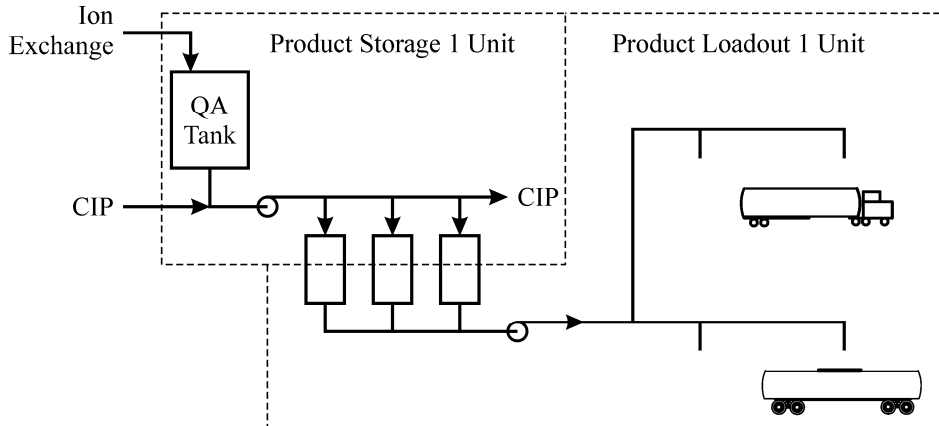


Figure 19. Product loadout area.

| | | |
|-------------|--------------------------|---------|
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|-------------|--------------------------|---------|

| | |
|---|---|
| POD | Area: Loadout Cell: Unit: Product Storage 1,2,3 |
| <p><i>Product Storage 1,2,3 Unit.</i> The primary control objective of this unit is to convey liquid product from the QA tank to one of three destination tanks. The operating states of these units are shown in Figure 20:</p> <p>Transfer Flush Hold Shutdown E-Shutdown</p> <p>The hold state allows manual control of devices in order to correct a problem. Normal operation is intermittent, running only when the QA tank contents needs to be transferred. The states are described as follows:</p> <p>Operating State Name: Transfer</p> <p><i>Routine Activities</i> Request destination tank from operator. Open valves for the proper destination. Start pump.</p> <p><i>Exception Handling</i> Hold if: Valve or motor failure. Shutdown if: High level on tank level while transfer.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Transfer finished (QA tank empty or destination tank full).</p> <p>Operating State Name: Flush</p> <p><i>Routine Activities</i> Verify ion exchange unit online. Request CIP system to start product storage path (Product Storage 1, 3). Flush product into storage tank 3. Close valve to storage tank 3. Flush CIP fluid through path.</p> | |
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| | |
|--|---|
| POD | Area: Loadout Cell: Unit: Product Storage 1,2,3 |
| <p>Request CIP system to go online/recycle (Product Storage 1, 3).</p> <p><i>Exception Handling</i> Hold if: Any valve or pump failure. E-Shutdown if: CIP system not in product storage path.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> CIP system online/recycle.</p> <p>Operating State Name: Shutdown</p> <p><i>Routine Activities</i> Stop pump and close all valves.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Transfer or flush requested.</p> <p>Operating State Name: E-Shutdown</p> <p><i>Routine Activities</i> Immediately stop pump and close all valves.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> | |
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Performance Information

None.

State End Conditions

Transfer or flush requested.

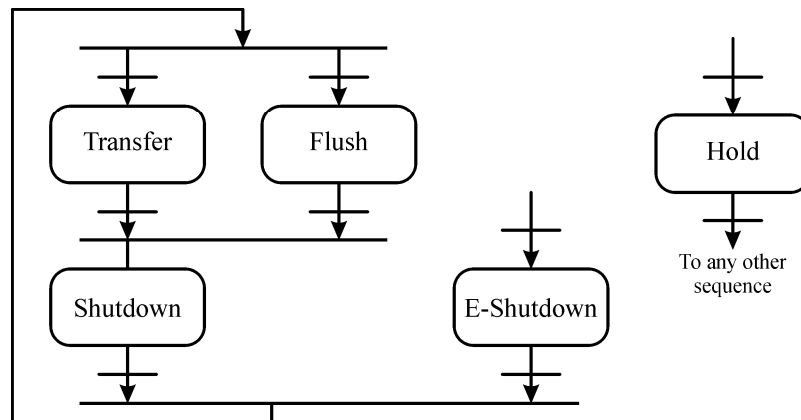


Figure 20. Product storage unit operating states.

| POD | Area: Loadout Cell: Unit: Product Loadout 1, 2, 3 |
|---|---|
| <p><i>Product Loadout 1, 2, 3 Unit.</i> The primary control objective of this unit is to convey liquid product from one of the storage tanks to one of four loadout stations. The operating states of these units are shown in Figure 21:</p> <p>Transfer Hold Shutdown E-Shutdown</p> <p>The hold state allows manual control of devices in order to correct a problem. Normal operation is intermittent, running only when a truck trailer or rail car needs to be loaded. The states are described as follows:</p> <p>Operating State Name: Transfer</p> <p><i>Routine Activities</i></p> <ul style="list-style-type: none"> Request source tank and destination station from operator. Request amount to transfer from operator. Open valves for the proper destination. Start pump. Initialize flow loop. <p><i>Exception Handling</i></p> <p>Hold if:</p> <ul style="list-style-type: none"> Valve or motor failure. <p>Shutdown if:</p> <ul style="list-style-type: none"> Low level on source tank level while transfer. Flow deviation from setpoint <p>E-Shutdown if:</p> <ul style="list-style-type: none"> Low flow and fully open control valve. <p><i>Primary Control Objectives</i></p> <p>None.</p> <p><i>Performance Information</i></p> <p>None.</p> <p><i>State End Conditions</i></p> <p>Transfer finished (source tank empty or amount transferred).</p> <p>Operating State Name: Shutdown</p> <p><i>Routine Activities</i></p> <ul style="list-style-type: none"> Stop flow loop. | |
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| POD | Area: Loadout Cell: Unit: Product Loadout 1, 2, 3 |
|---|---|
| <p>Stop pump and close all valves.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Transfer requested.</p> <p>Operating State Name: E-Shutdown</p> <p><i>Routine Activities</i> Immediately stop flow loop, stop pump, and close all valves.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Transfer requested.</p> | |
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| | |
|-------------|---|
| POD | Area: Loadout Cell: Unit: Product Loadout 1, 2, 3 |
| | <div><pre>graph TD; In1(()) --> Transfer[Transfer]; Transfer --> Shutdown[Shutdown]; Shutdown --> Out1(()); In2(()) --> EShutdown[E-Shutdown]; EShutdown --> Out2(()); In3(()) --> Hold[Hold]; Hold --> Out3[To any other sequence]; Out1 --- Out2; Out2 --- Out3;</pre><p>The flowchart illustrates the operating states of the Product Loadout Unit. It features three main vertical sequences of states. The first sequence starts with an entry arrow pointing to a rounded rectangle labeled 'Transfer'. An arrow points down to another rounded rectangle labeled 'Shutdown'. From 'Shutdown', an arrow points down to a horizontal line, which then connects to a common horizontal line at the bottom. The second sequence starts with an entry arrow pointing to a rounded rectangle labeled 'E-Shutdown'. An arrow points down from 'E-Shutdown' to the same common horizontal line at the bottom. The third sequence starts with an entry arrow pointing to a rounded rectangle labeled 'Hold'. An arrow points down from 'Hold' to the text 'To any other sequence'. The common horizontal line at the bottom serves as a junction point for the 'Shutdown' and 'E-Shutdown' paths, leading to the right edge of the diagram area.</p></div> |
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| Control Concept | Area: Loadout | Cell: | Unit: |
|---|------------------------|---------|-------|
| <p>Product Storage Unit Supervision</p> <p><i>Extent of Automation</i></p> <ul style="list-style-type: none"> Provide control of valves and pumps. Provide automatic startup and shutdown for the transfer of product from QA tank to a destination tank. Collect inventory data (storage tank levels). <p><i>Flexibility of Automation</i></p> <p>None.</p> <p><i>Control Activity Coordination</i></p> <p>None.</p> <p><i>Interaction with Operating Personnel</i></p> <ul style="list-style-type: none"> Operators enter destination tank. Operators start transfers. Operators can stop transfer, though not normally. Display status information from control devices. <p>Product Loadout Unit Supervision</p> <p><i>Extent of Automation</i></p> <ul style="list-style-type: none"> Provide control of valves and pumps. Provide automatic startup and shutdown for the transfer of product from a storage tank to a rail car or truck trailer. Collect inventory data (gallons of product loaded to rail/truck). <p><i>Flexibility of Automation</i></p> <p>None.</p> <p><i>Control Activity Coordination</i></p> <p>None.</p> <p><i>Interaction with Operating Personnel</i></p> <ul style="list-style-type: none"> Operators enter source station and destination tank. Operators enter desired transfer amount. Operators enter desired loadout flow rate. Operators start transfers. Operators can stop transfer, though not normally. Display status information from control devices. Display amount transferred. | | | |
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Control Strategy

Area: Loadout

Cell:

Unit: Product Storage

*Product Storage Unit***Unit Operations**

The unit operations (sequences) are the same as the operational states.

Devices**Pump**

Start/stop by unit sequence or operator.

Path valves (5)

Open/close by unit sequence or operator.

Interlocks

Do not allow transfer start if destination tank too full or QA tank empty.

Control Strategy

Area: Loadout

Cell:

Unit: Product Loadout

*Product Loadout Unit***Unit Operations**

The unit operations (sequences) are the same as the operational states.

Loops*Loadout Transfer Flow.*

During loadout, maintains desired product flow rate.

Devices

Pump

Start/stop by unit sequence or operator.

Path valves (7)

Open/close by unit sequence or operator.

Interlocks

Do not allow transfer start if source tank empty.

| POD | Area: Utility Cell: Unit: |
|-------------|---------------------------------------|
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UTILITY AREA

The utility area is subdivided into water treatment, steam generation, clean-in-place, and regen material cells (Figure 1). Only the two clean-in-place cells are described here.

| POD | Area: Utility | Cell: CIP | Unit: |
|---|------------------------|-----------|---------|
| <div><div>CIP Cell</div><p>The CIP (clean-in-place) cell consists of the CIP_1 tank, CIP_2 tank, and soda ash units (Figure 22). The CIP_1 tank unit cleans out piping in reactors 1 and 2, associated ion exchange, and product storage units. The CIP_2 tank unit cleans out piping in reactor 4, associated ion exchange, and product storage units.</p><p>The diagram illustrates the CIP cell layout. It features two main cleaning units, CIP_1 and CIP_2, each consisting of a tank, a heat exchanger, and a soda ash unit. CIP_1 is connected to Reactors 1 and 2, Ion Exchange 1, 2, and Product Storage 1. CIP_2 is connected to Reactor 4, Ion Exchange 5, 6, and Product Storage 3. Both units receive hot water and steam for heating. Waste tanks are also shown for each unit.</p></div> | | | |
| <p>Figure 22. Clean-in-place (CIP) cell.</p> | | | |
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| POD | Area: Utility Cell: CIP Unit: CIP_2 Tank |
|--|--|
| <p><i>CIP_1 Tank Unit.</i> The primary control objective of this unit is to clean out product piping in reactors 1 & 2, ion exchange 1 & 2, and product storage 1 units. The operating states of this unit are shown in Figure 23:</p> <p>Online/Recycle Reactor 1 Path Reactor 2 Path Ion Exchange Path Product Storage Path To Waste Tank CIP Make-up Hold Shutdown E-Shutdown</p> <p>The hold state allows manual control of devices in order to correct a problem. Normal operation is online/recycle, with paths being requested by the various units or operators. The states are described as follows:</p> <p>Operating State Name: Online/Recycle</p> <p><i>Routine Activities</i> Open recycle valve. Close other path valves. Start recirculating temperature control. Start pump.</p> <p><i>Exception Handling</i> Hold if: Valve or motor failure. Shutdown if: Extremely low tank level. Extreme temperature deviation from setpoint.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Cleaning path or makeup requested.</p> <p>Operating State Name: Reactor 1 Path</p> | |
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| POD | Area: Utility | Cell: CIP | Unit: CIP_2 Tank |
|--|------------------------|-----------|------------------|
| <p><i>Routine Activities</i></p> <ul style="list-style-type: none"> Stop recirculating temperature control. Open valve to direct cleaning water to reactor 1. Close other path valves. Start pump. <p><i>Exception Handling</i></p> <ul style="list-style-type: none"> Hold if: <ul style="list-style-type: none"> Any valve or pump failure. Online/Recycle if: <ul style="list-style-type: none"> Reactor 1 not in flush. <p><i>Primary Control Objectives</i></p> <ul style="list-style-type: none"> None. <p><i>Performance Information</i></p> <ul style="list-style-type: none"> None. <p><i>State End Conditions</i></p> <ul style="list-style-type: none"> Requested to start another path, online/recycle, or makeup. <p>Operating State Name: Reactor 2 Path</p> <p><i>Routine Activities</i></p> <ul style="list-style-type: none"> Stop recirculating temperature control. Open valve to direct cleaning water to reactor 2. Close other path valves. Start pump. <p><i>Exception Handling</i></p> <ul style="list-style-type: none"> Hold if: <ul style="list-style-type: none"> Any valve or pump failure. Online/Recycle if: <ul style="list-style-type: none"> Reactor 2 not in flush. <p><i>Primary Control Objectives</i></p> <ul style="list-style-type: none"> None. <p><i>Performance Information</i></p> <ul style="list-style-type: none"> None. <p><i>State End Conditions</i></p> <ul style="list-style-type: none"> Requested to start another path, online/recycle, or makeup. | | | |
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| | | | |
|--|------------------------|-----------|------------------|
| POD | Area: Utility | Cell: CIP | Unit: CIP_2 Tank |
| <p>Operating State Name: Ion Exchange Path</p> <p><i>Routine Activities</i> Stop recirculating temperature control. Open valve to direct cleaning water to ion exchange. Close other path valves. Start pump.</p> <p><i>Exception Handling</i> Hold if: Any valve or pump failure. Online/Recycle if: Ion exchange not in flush.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Requested to start another path, online/recycle, or makeup.</p> <p>Operating State Name: Product Storage Path</p> <p><i>Routine Activities</i> Stop recirculating temperature control. Open valve to direct cleaning water to product storage. Close other path valves. Start pump.</p> <p><i>Exception Handling</i> Hold if: Any valve or pump failure. Online/Recycle if: Product storage not in flush.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> | | | |
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| | | | |
|--|------------------------|-----------|------------------|
| POD | Area: Utility | Cell: CIP | Unit: CIP_2 Tank |
| <p><i>State End Conditions</i> Requested to start another path, online/recycle, or makeup.</p> <p>Operating State Name: To Waste Tank</p> <p><i>Routine Activities</i> Stop recirculating temperature control. Open valve to direct cleaning water to waste tank. Close other path valves. Start pump. Empty tank.</p> <p><i>Exception Handling</i> Hold if: Any valve or pump failure.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Tank empty.</p> <p>Operating State Name: Make-up</p> <p><i>Routine Activities</i> Open recycle valve. Close other path valves. Fill tank to 20% with hot water. Start pump. Start recirculating temperature control. Fill tank to 90% with hot water. Start soda ash transfer to tank. Wait for pH ≥ 9. Shutdown soda ash transfer. Wait for ash to disperse in tank.</p> <p><i>Exception Handling</i> Hold if: Any valve or pump failure.</p> | | | |
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| POD | Area: Utility | Cell: CIP | Unit: CIP_2 Tank |
|---|------------------------|-----------|------------------|
| <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> End of time to disperse ash in tank.</p> <p>Operating State Name: Shutdown</p> <p><i>Routine Activities</i> Stop pump and close all valves. Stop all loops.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Online/recycle, make-up, or to waste tank requested.</p> <p>Operating State Name: E-Shutdown</p> <p><i>Routine Activities</i> Immediately stop pump and close all valves. Stop all loops.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i></p> | | | |
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Online/recycle, make-up, or to waste tank requested.

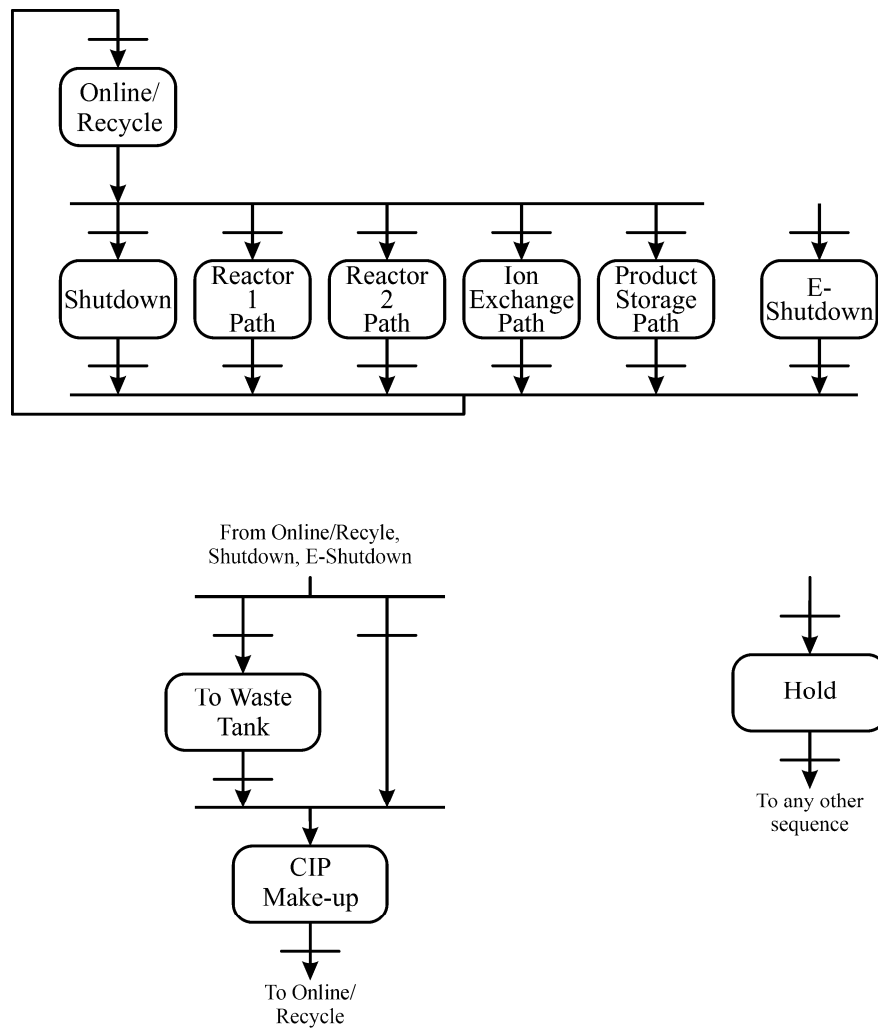


Figure 23. CIP_1 tank unit operating states.

| POD | Area: Utility Cell: CIP Unit: CIP_2 Tank |
|---|--|
| <p><i>Soda Ash Unit.</i> The primary control objective of this unit is to convey soda ash to the CIP_1 tank. The operating states of this unit are shown in Figure 24:</p> <p>Start Transfer Hold Shutdown E-Shutdown</p> <p>The hold state allows manual control of devices in order to correct a problem. Normal operation is intermittent, running only when the CIP tank unit requests soda ash to be loaded. The states are described as follows:</p> <p>Operating State Name: Start Transfer</p> <p><i>Routine Activities</i> Open tank slide gate. Start conveyor. Start rotary outlet valve.</p> <p><i>Exception Handling</i> Shutdown if: Rotary valve failure. Low level on soda ash bin while transfer. E-Shutdown if: Conveyor or slide gate failure. Low flow and fully open control valve.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Shutdown requested.</p> <p>Operating State Name: Shutdown</p> <p><i>Routine Activities</i> Stop rotary valve. Stop conveyor and close slide gate.</p> <p><i>Exception Handling</i> None.</p> | |
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| POD | Area: Utility | Cell: CIP | Unit: CIP_2 Tank |
|---|------------------------|-----------|------------------|
| <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Transfer requested.</p> <p>Operating State Name: E-Shutdown</p> <p><i>Routine Activities</i> Immediately stop rotary valve and conveyor and close slide gate.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Transfer requested.</p> | | | |
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| | | | |
|--|--------------------------|-----------|------------------|
| POD | Area: Utility | Cell: CIP | Unit: CIP_2 Tank |
| <div><div><div><div><div></div><div>Start Transfer</div><div></div></div><div><div></div><div></div><div></div></div><div><div></div><div>Shutdown</div><div></div></div><div><div></div><div></div><div></div></div><div><div></div><div></div><div></div></div></div><div><div></div><div></div><div></div></div><div><div></div><div>E-Shutdown</div><div></div></div><div><div></div><div></div><div></div></div><div><div></div><div></div><div></div></div></div><div><div></div><div></div><div></div></div><div><div></div><div>Hold</div><div></div></div><div><div></div><div></div><div></div></div><div><div></div><div></div><div></div></div><div><div></div><div></div><div></div></div><div>To any other sequence</div></div> <div><p>Figure 24. Soda ash unit operating states.</p></div> | | | |
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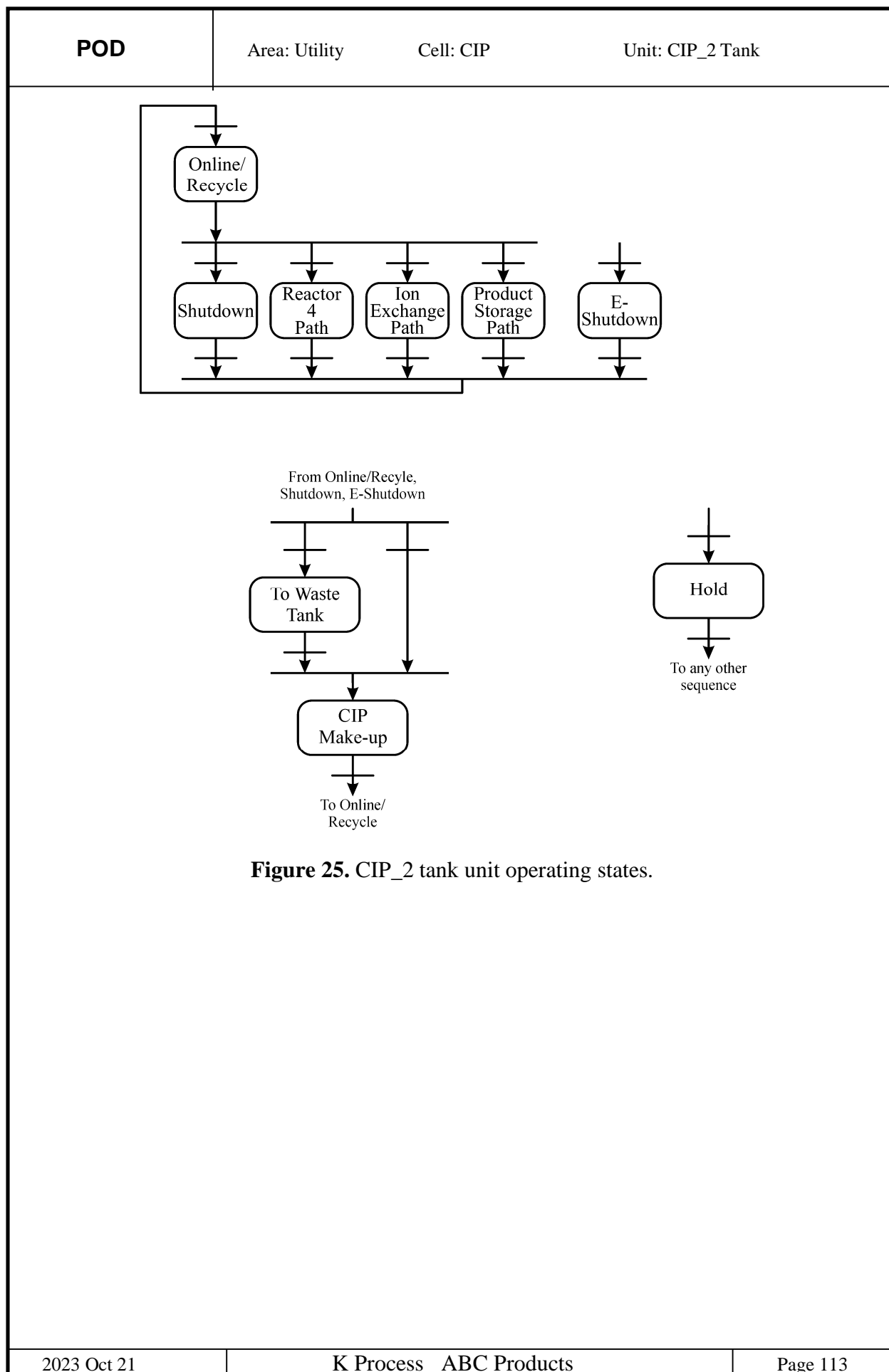
| POD | Area: Utility | Cell: CIP | Unit: CIP_2 Tank |
|---|---------------|--------------|------------------|
| <p><i>CIP_2 Tank Unit.</i> The primary control objective of this unit is to clean out product piping in reactor 4, ion exchange 5 & 6, and product storage 3 units. The operating states of this unit are shown in Figure 25:</p> <p>Online/Recycle Reactor 4 Path Ion Exchange Path Product Storage Path To Waste Tank CIP Make-up Hold Shutdown E-Shutdown</p> <p>The hold state allows manual control of devices in order to correct a problem. Normal operation is online/recycle, with paths being requested by the various units or operators. The states are described as follows:</p> <p>Operating State Name: Online/Recycle</p> <p><i>Routine Activities</i></p> <p>Open recycle valve. Close other path valves. Start recirculating temperature control. Start pump.</p> <p><i>Exception Handling</i></p> <p>Hold if: Valve or motor failure. Shutdown if: Extremely low tank level. Extreme temperature deviation from setpoint.</p> <p><i>Primary Control Objectives</i></p> <p>None.</p> <p><i>Performance Information</i></p> <p>None.</p> <p><i>State End Conditions</i></p> <p>Cleaning path or makeup requested.</p> <p>Operating State Name: Reactor 4 Path</p> | | | |
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| POD | Area: Utility | Cell: CIP | Unit: CIP_2 Tank |
|---|------------------------|-----------|------------------|
| <p><i>Routine Activities</i></p> <ul style="list-style-type: none"> Stop recirculating temperature control. Open valve to direct cleaning water to reactor 4. Close other path valves. Start pump. <p><i>Exception Handling</i></p> <ul style="list-style-type: none"> Hold if: <ul style="list-style-type: none"> Any valve or pump failure. Online/Recycle if: <ul style="list-style-type: none"> Reactor 4 not in flush. <p><i>Primary Control Objectives</i></p> <ul style="list-style-type: none"> None. <p><i>Performance Information</i></p> <ul style="list-style-type: none"> None. <p><i>State End Conditions</i></p> <ul style="list-style-type: none"> Requested to start another path, online/recycle, or makeup. | | | |
| <p>Operating State Name: Ion Exchange Path</p> <p><i>Routine Activities</i></p> <ul style="list-style-type: none"> Stop recirculating temperature control. Open valve to direct cleaning water to ion exchange. Close other path valves. Start pump. <p><i>Exception Handling</i></p> <ul style="list-style-type: none"> Hold if: <ul style="list-style-type: none"> Any valve or pump failure. Online/Recycle if: <ul style="list-style-type: none"> Ion exchange not in flush. <p><i>Primary Control Objectives</i></p> <ul style="list-style-type: none"> None. <p><i>Performance Information</i></p> <ul style="list-style-type: none"> None. <p><i>State End Conditions</i></p> <ul style="list-style-type: none"> Requested to start another path, online/recycle, or makeup. | | | |
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| | | | |
|---|------------------------|-----------|------------------|
| POD | Area: Utility | Cell: CIP | Unit: CIP_2 Tank |
| <p>Operating State Name: Product Storage Path</p> <p><i>Routine Activities</i> Stop recirculating temperature control. Open valve to direct cleaning water to product storage 3. Close other path valves. Start pump.</p> <p><i>Exception Handling</i> Hold if: Any valve or pump failure. Online/Recycle if: Product storage not in flush.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> Requested to start another path, online/recycle, or makeup.</p> <p>Operating State Name: To Waste Tank</p> <p><i>Routine Activities</i> Stop recirculating temperature control. Open valve to direct cleaning water to waste tank. Close other path valves. Start pump. Empty tank.</p> <p><i>Exception Handling</i> Hold if: Any valve or pump failure.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> | | | |
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| | | | |
|--|------------------------|-----------|------------------|
| POD | Area: Utility | Cell: CIP | Unit: CIP_2 Tank |
| <p><i>State End Conditions</i> Tank empty.</p> <p>Operating State Name: Make-up</p> <p><i>Routine Activities</i> Open recycle valve. Close other path valves. Fill tank to 20% with hot water. Start pump. Start recirculating temperature control. Fill tank to 90% with hot water. Start soda ash transfer to tank. Wait for pH ≥ 9. Shutdown soda ash transfer. Wait for ash to disperse in tank.</p> <p><i>Exception Handling</i> Hold if: Any valve or pump failure.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i> None.</p> <p><i>State End Conditions</i> End of time to disperse ash in tank.</p> <p>Operating State Name: Shutdown</p> <p><i>Routine Activities</i> Stop pump and close all valves. Stop all loops.</p> <p><i>Exception Handling</i> None.</p> <p><i>Primary Control Objectives</i> None.</p> <p><i>Performance Information</i></p> | | | |
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| POD | Area: Utility Cell: CIP Unit: CIP_2 Tank |
|---|--|
| <p>None.</p> <p><i>State End Conditions</i></p> <p>Online/recycle, make-up, or to waste tank requested.</p> <p>Operating State Name: E-Shutdown</p> <p><i>Routine Activities</i></p> <p>Immediately stop pump and close all valves. Stop all loops.</p> <p><i>Exception Handling</i></p> <p>None.</p> <p><i>Primary Control Objectives</i></p> <p>None.</p> <p><i>Performance Information</i></p> <p>None.</p> <p><i>State End Conditions</i></p> <p>Online/recycle, make-up, or to waste tank requested.</p> | |
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| Control Concept | Area: Utility | Cell: CIP | Unit: |
|---|------------------------|-----------|-------|
| <p>CIP_1 Tank Unit Supervision</p> <p><i>Extent of Automation</i></p> <ul style="list-style-type: none"> Provide control of valves and pumps. Provide automatic control of operations. <p><i>Flexibility of Automation</i></p> <ul style="list-style-type: none"> None. <p><i>Control Activity Coordination</i></p> <ul style="list-style-type: none"> None. <p><i>Interaction with Operating Personnel</i></p> <ul style="list-style-type: none"> Operators can start path changes, though not normally. Operators can initiate online/recycle and make-up. Display status information from control devices. <p>Soda Ash Unit Supervision</p> <p><i>Extent of Automation</i></p> <ul style="list-style-type: none"> Provide control of motors and slide gate. Provide automatic startup and shutdown for the transfer of soda ash to CIP tank. <p><i>Flexibility of Automation</i></p> <ul style="list-style-type: none"> None. <p><i>Control Activity Coordination</i></p> <ul style="list-style-type: none"> None. <p><i>Interaction with Operating Personnel</i></p> <ul style="list-style-type: none"> Operators can start transfer, though not normally. Operators can stop transfer, though not normally. Display status information from control devices. <p>CIP_2 Tank Unit Supervision</p> <p><i>Extent of Automation</i></p> <ul style="list-style-type: none"> Provide control of valves and pumps. Provide automatic control of operations. <p><i>Flexibility of Automation</i></p> <ul style="list-style-type: none"> None. <p><i>Control Activity Coordination</i></p> <ul style="list-style-type: none"> None. <p><i>Interaction with Operating Personnel</i></p> <ul style="list-style-type: none"> Operators can start path changes, though not normally. Operators can initiate online/recycle and make-up. Display status information from control devices. | | | |
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| | | | |
|---|------------------------|-----------|------------------|
| Control Strategy | Area: Utility | Cell: CIP | Unit: CIP_2 Tank |
| <p><i>CIP_1 Tank Unit</i></p> <p>Unit Operations</p> <p>The unit operations (sequences) are the same as the operational states.</p> <p>Loops</p> <p><i>Recirculating Temperature.</i> During online/recycle and make-up, maintains tank temperature.</p> <p><i>Hot Water Flow.</i> During make-up, maintains desired flow rate.</p> <p>Devices</p> <p>Pump Start/stop by unit sequence or operator.</p> <p>Path valves (6) Open/close by unit sequence or operator.</p> <p>Interlocks</p> | | | |
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*Soda Ash Unit***Unit Operations**

The unit operations (sequences) are the same as the operational states.

Devices

Rotary valve

Start/stop by unit sequence or operator.

Conveyor

Start/stop by unit sequence or operator.

Slide gate

Open/close by unit sequence or operator.

Interlocks

Control Strategy

Area: Utility

Cell: CIP

Unit: CIP_2 Tank

*CIP_2 Tank Unit***Unit Operations**

The unit operations (sequences) are the same as the operational states.

Loops*Recirculating Temperature.*

During online/recycle and make-up, maintains tank temperature.

Hot Water Flow.

During make-up, maintains desired flow rate.

Devices

Pumps (2)

Start/stop by unit sequence or operator.

Path valves (4)

Open/close by unit sequence or operator.

Interlocks