Industrial Control

Trade 19

SkillsCanada Alberta

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Provincial Skills Competition

Day 2

Test Project

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1 - Introduction

Contextualization

This simulated craft beer process simulates filling grain bins from a large storage hopper. After a preset number of bins are filled, the hopper must be refilled before more bins can be filled for distribution.

When in automatic mode the operator is not required to do anything as a timing and counting process will fill a preset number of bins before stopping to allow the main hopper to be refilled. (See 4 - Automatic Mode)

When in manual mode, the operator can control all parts of the process using the control panel. (See 3 - Manual Mode)

Terminology Definitions

- Light on – a light that will be continuously illuminated
- Flashing Light – Light will be cycling for 1 second ON and 1 second OFF
- Fast Flashing Light – Light will be cycling for 0.5 second ON and 0.5 second OFF
- Push Button Pressed – A pushbutton that is pressed and released
- Push and held – A pushbutton that is pressed and held

2 - Process Details

Emergency Stop Circuit

The system is equipped with a general Emergency Stop push-pull button.

The Emergency Stop button mounted on the Control Panel Door will be used in conjunction with a 24 VDC relay (non-PLC) to create a Master Control Relay (MCR)/Emergency Stop Circuit. The 24 VDC relay will be equipped with both normally-open (NO) and normally-closed (NC) contacts, as required.

When the Emergency Stop button is depressed, The Master Control Relay/Emergency Stop Circuit will de-energize all the PLC's outputs.

All the PLC's outputs shall remain de-energized until the Emergency Stop button is reset (pulled).

Input Descriptions and Assignments

The following table lists the required PLC inputs for the process. The PLC input assignments are suggested and may need changes to accommodate your PLC.

Input	Description	Symbol	Contact Type	PLC Input Assignments
Master Control Relay / Emergency Stop Circuit		MCR	NO	I0
Push Button - Green	Start Button	PB1	NO	I1
Push Button - Amber	Action Button Manual Mode – Energize SOL Automatic Mode – Pause Process	PB2	NO	I2
Selector Switch 1 (Maintained) - Left Position	Automatic Mode	SS1_1	NO	I3
Selector Switch 1 (Maintained) - Right Position	Manual Mode	SS1_3	NO	I4
Selector Switch 2 (Momentary) - Left Position	Manual - Contactor K1 Reverse	SS2_1	NO	I5
Selector Switch 2 (Momentary) - Right Position	Manual - Contactor K1 Forward	SS2_3	NO	I6
Limit Switch 1	Grain Bin Positioning Switch – Left	LS1	NO	I7
Limit Switch 2	Weight Detection Switch	LS2	NO	I8
Limit Switch 3	Grain Bin Positioning Switch – Right	LS3	NO	I9

Output Descriptions and Assignments

The following table lists the required PLC outputs for the process. The PLC Output assignments are suggested and may need changes to accommodate your PLC.

Output	Description	Symbol		PLC Output Assignments
Stack Light - Red	Manual Mode Status Light	L1		Q0
Stack Light - Amber	Manual Mode light	L2		Q1
Stack Light - Green	Automatic Mode light	L3		Q2
Panel Pilot Light - Blue	Control power on light	L4		Q3
Hopper Pilot Light - Green	M2 running light	L5		Q4
Hopper Pilot Light - Blue	Conveyor moving light	L6		Q5
Solenoid (Indicated by Pilot Light - White)		SOL		Q6
Contactor K1 Forward	Conveyor M1 – Forward Direction	K1_F		Q7
Contactor K1 Reverse	Conveyor M1 – Reverse Direction	K1_R		Q8
Contactor K2 Forward	Screw conveyor to fill hopper M2	K2		Q9

3 - Manual Mode Description

The purpose of the Manual Mode is to give the operator manual control of the process in order to empty the Process Hopper into the Grain Bins manually using SS2 to jog the Grain Bins into the correct position and PB2 to operate SOL.

Initialization and Manual Mode Process

Initialization of the Manual Mode

- There are no grain bins at ***LS1*** or ***LS3***
- **SS1** must be in the Manual position (***SS1_1***)
- ***SS2*** must be in the Off position
- ***L4*** is on
- All other outputs are deenergized
- All limit switches are deactivated

Press ***PB1*** to start the process in Manual mode:

- ***L2*** is Flashing

When in Manual mode ***SS2*** is used to jog M1 (***K1-F*** or ***K1-R***) to locate a grain bin into position under the Process bin

Operating ***SS2*** Forward and Reverse will move the Grain bin on the conveyor and operate ***LS1*** and ***LS3***

- When M1 (***K1-F*** or ***K1-R***) is operating ***L6*** will be on,
- When ***LS1*** OR ***LS3*** are activated ***L1*** will be on
- When ***LS1*** AND ***LS3*** are activated ***L1*** will flash
- ***L1*** flashing will indicate to the operator that the Grain bin is in the fill location
- Pressing and holding ***PB2*** will energize the solenoid (***SOL***)
- When ***PB2*** is released, ***SOL*** will be deenergized

Once the grain bin is at the Full weight:

- ***LS2*** is activated
- ***SOL*** will deenergize
- ***L1*** will flash fast to indicate the grain bin is full
- ***PB2*** can be released

The operator can now move the Grain bin forward and position another Grain bin to be filled.

When the Full grain bin moves forward:

- ***LS1*** is deactivated
- ***LS2*** is deactivated
- ***LS3*** is deactivated
- ***L1*** is off

There will be at least two Grain Bins to be filled manually to empty the Process hopper.

4 - Automatic Mode Description

The purpose of the Automatic mode is to allow Grain bins to be filled to the correct weight from the Process hopper and the Process hopper to be filled from the Storage hopper without operator intervention.

Initialization of the Automatic Mode

- The supply of grain in the Storage hopper is unlimited
- The Process hopper is full
- ***L4*** is on, indicating power to the control panel
- No Grain bins are located at ***LS1*** or ***LS3***
- There is an unlimited supply of Grain bins on the Conveyor operated by M1
- No faults or alarms must be detected
- ***SS1*** is in the Automatic position (***SS1_3***)
- ***SS2*** is in the Off position
- ***L3*** is on to indicate automatic mode selected
- All other outputs are deenergized

Press ***PB1*** to start the process in Automatic Mode:

- M1 (***K1-F***) operates until ***LS1*** and ***LS3*** are activated by the Grain bin
- When M1 (***K1-F***) is operating, ***L6*** is on

Grain Bin Filling Process

When ***LS1*** and ***LS2*** are activated:

- M1 (***K1-F***) is deenergized, L6 is off

A delay of 3 seconds:

- ***SOL*** is energized
- ***LS2*** is activated when the fill weight is reached
- ***SOL*** is deenergized

A delay of 5 seconds:

- M1 (***K1-F***) is energized, ***L6*** is on
- ***LS3*** is deactivated
- ***LS2*** is deactivated
- ***LS1*** is deactivated

The Grain bin is full and has been moved Forward.

The **Grain Bin Filling Process** will repeat until three (3) grain bins have been filled. Once the third Grain Bin has been filled and moved forward:

- M1 (***K1-F***) is deenergized
- ***L6*** is off

Process Hopper Refill Process

A delay of 3 seconds:

- M2 (***K2***) is energized
- ***L5*** is Flashing fast

A delay of 5 seconds: Process hopper is now full

- M2 (***K2***) is deenergized
- ***L5*** is off

Automatic Mode continues

- ***K1*** is energized
- ***L6*** is on
- Grain Bin Filling Process to fill three more bins

The Grain Bin Filling Process followed by the Process Hopper Refill Process will continue until the system is turned off, to manual mode, or ***PB2*** is pressed initiating a Conveyor Clearing Process. When automatic mode is selected again, it will begin with the Initialization of the Automatic Mode.

Conveyor Clearing Process

The conveyor clearing process is to be used while in automatic mode to clear stop the flow of grain and clear the conveyor of all bins. This can be initiated at any point in the automatic mode process.

When ***PB2*** is pressed initiating a Conveyor Clearing Process

- M1 (***K1-R***) is energized in reverse to move all bins backwards
- ***L6*** is flashing
- ***L4*** is energized

- Actuating ***LS1***, ***LS2***, ***LS3***, ***SS2***, and ***PB1*** have no effect on the system
- ***SS1*** must remain in Automatic Mode (***SS1_3***)
- All other outputs are deenergized

A delay of 8 seconds: Conveyor is cleared

- System returns to **Initialization of the Automatic Mode**

5 – Completion Checklist

- Overcurrent devices are in the closed position (on)
- Main Disconnect in the open position (off)
- Emergency Stop in the closed position (pulled out)
- SS1 and SS2 in the middle position
- Control panel door cleaned, closed, and secured
- Floor of work area clean and free of hazards
- Labels on wall mounted devices, control panel door devices, overcurrent devices, and contactors

Process testing will begin with the operator closing the disconnect, selecting the mode and pressing start.