Description of Operations (DOO)

Amazon BNA8

Revision 3

STATUS: DRAFT

1. Revision Log

Rev	Date	By	Description
1	06/26/2025	MS	Initial release
2	08/07/2025	MS	• Updated Rates • Updated MTBH • Clarified Estop Zone Behavior

Contents

Tables

Figures

2. Purpose

The purpose of this document is for the reader to:

- Gain a high-level understanding of system flow and functionality.
- Understand how and when to interact with the system.
- Gain insight that may help diagnose system issues.

This document is structured generally into two key concepts:

- How the system works
- How to interact with and diagnose the system

The following image describes which sections inform the reader of the previous two concepts. Additionally, the image is color-coded to indicate which sections are written in digestible plain language (blue) and which sections contain detailed technical descriptions (orange)

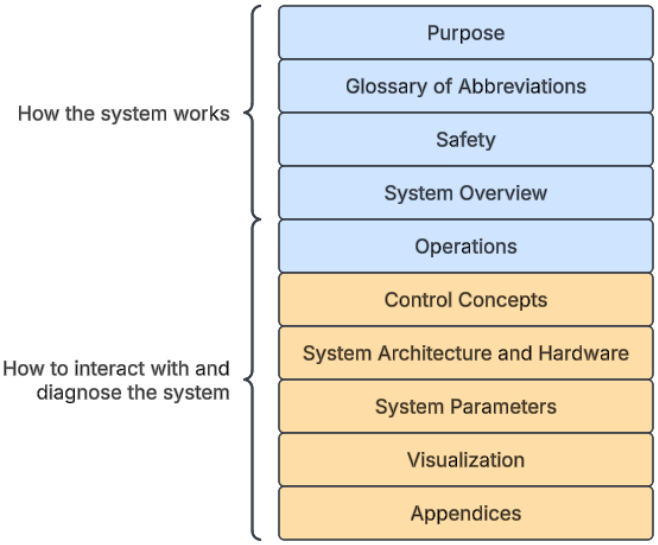


Figure 1. Document Structure

3. Glossary of Abbreviations

The following table lists common abbreviations or terminology used throughout this document.

Table 1. Abbreviations

Abbreviation	Meaning	Context
NC	Non-conveyable	Parcels that exceed the allowable MTBH for the cross-belt system.
MTBH	Material to be Handled	Defines appropriate parcel sizes for the system.
VS	Virtual Sorter	The cross-belt sorter is a continuous loop, but broken up into four virtual zones referred to as VS-A, VS-B, VS-C, VS-D.
PPH	Packages per Hour	Metric used to define flow rates of parcels.
AWCS	Amazon Warehouse Control System	Service which, among other things, dictates which sorter/destination a parcel will be routed to.
MDR	Motor Driven Rollers	Roller conveyance used to automatically accumulate parcels. Typically used wherever associates remove parcels from the system (i.e. problem solve).
MCM	Main Control Module	Small enclosure that houses the PLC, used for subsystems other than the sorter.
MCP	Motor Control Panel	Large enclosure containing control equipment including a PLC, used for the sorter subsystem.
PLC	Programmable Logic Controller	Industrial processor used to control the conveyance system.
DPM	Data Power Module	Field mounted bracket with network switch and power supply.
ARB	Activated Roller Belt	A type of conveyor consisting of a belt of arrayed rollers which can be activated to cause package movement perpendicular to the belt's direction of motion.

4. Safety

4.1. General Precautions

Be aware of the following (non-exhaustive) list of general precautions when working anywhere within the facility:

Table 2. General Precautions

Precaution	Description
Don't Stand on Moving Belts	Never stand, walk, or ride on moving conveyor belts to prevent falls and injuries.
Appropriate Platforms for Breaking Jams	Use designated platforms or tools to clear jams, never your hands or feet.
Lockout/Tagout (LOTO)	Ensure machinery is properly locked and tagged out before any maintenance or interfacing.
Wear PPE at All Times	Always wear the required Personal Protective Equipment (PPE), including safety goggles, gloves, hard hats, and steel-toed boots.
Awareness of Forklifts/Machinery	Stay alert and be aware of forklifts and other machinery operating in the area.
Machine Guards	Ensure that all machine guards and safety barriers are in place and properly maintained to prevent accidental contact with moving parts.
No Loose Clothing	Avoid wearing loose clothing or jewelry that could get caught in the conveyor system.
Emergency Stops	Be aware of the location of all emergency stop devices in the area and their functionality.
Dedicated Walking Paths	Dedicated Walking Paths: Use specified walking paths to navigate around the warehouse safely.
3-Point Contact on Ladders	Maintain three points of contact (two hands and a foot, or two feet and a hand) when using ladders.

4.2. Hazards

Be aware of the following (non-exhaustive) list of potential hazards. If you encounter a hazard, notify your supervisor immediately.

Table 3. Potential Hazards

Hazard	Description
Moving Parts	Conveyor belts and rollers can cause entanglement or crushing injuries if clothing, jewelry, or body parts get caught
Falling Objects	Improperly secured loads can fall off conveyors, posing a risk of injury to workers below.
Slips, Trips, and Falls	Poor housekeeping, spills, or obstructions around the conveyor area can lead to slips, trips, and falls.
Pinch Points	Areas where conveyor parts come together, or move can create pinch points that can crush or injure fingers and hands.
Ergonomic Hazards	Repetitive motion or awkward postures while loading or unloading conveyors can cause injuries.
Noise	High noise levels from conveyor operation can lead to hearing loss if proper hearing protection isn't used.
Dust and Debris	Accumulation of dust or debris can create slip hazards and affect the air quality, potentially causing respiratory issues.
Blocked Emergency Exits	Storing materials in pathways can block emergency exits, preventing quick evacuation during emergencies.
Forklift Traffic	Interaction between forklifts and conveyors can lead to collisions and accidents if proper traffic controls aren't in place.
Manual Handling	Lifting and moving heavy items onto or off conveyors can lead to back injuries if proper lifting techniques aren't used.

4.3. Warning Labels / Danger Labels

4.3.1. MCM Panel Labels

All MCM's have the following warning labels on their panels.

Figure 2. MCM Panel Labels

4.4. Emergency Stops

4.4.1. Estop Devices

The following table shows all devices that are used to initiate emergency stops.

Table 4. Estop Devices

Description	Part Number	Mfg.	Image
2-Position Push/Pull Illuminated Push Button, Red	800FM-LMP44	AB	
Single E-Stop pullcord switches	440E-LL5SE5	AB	

4.4.2. Estop Zones

Estop zones describe sets of conveyors that are stopped by the activation of one or more estop devices. Each zone has a selection of estop devices and conveyors associated with that zone. The activation of any estop device in this zone will stop all conveyors associated with this zone. For a complete list of devices and conveyors associated with each zone, see section 11.1. Estop Zones.

5. System Overview

This section provides a high-level overview of the entire system and subsequently each subsystem within the overall system. Reading this section provides you with a functional understanding of the system's flow and operation.

5.1. Overall System Description

The non-con sortation system at the BNA8 facility is fed by the fluid unload area located on the western end of the building. NC sized parcels are merged from two unload lanes and conveyed to an Intralox ARB conveyor sorter located on the eastern edge of the building. A parcel is determined to be NC sized by dimension limits referenced in section 9.1. MTBH.

5.1.1. System Flow Diagrams

The section shows the general flow of the system, with subsystems highlighted to indicate position within the building. The following diagrams show the entire system from above. Note that platforms are shown in the below images. Some of the subsystems described in the previous section are below the platforms. Flow underneath the platforms is indicated by dashed arrows.

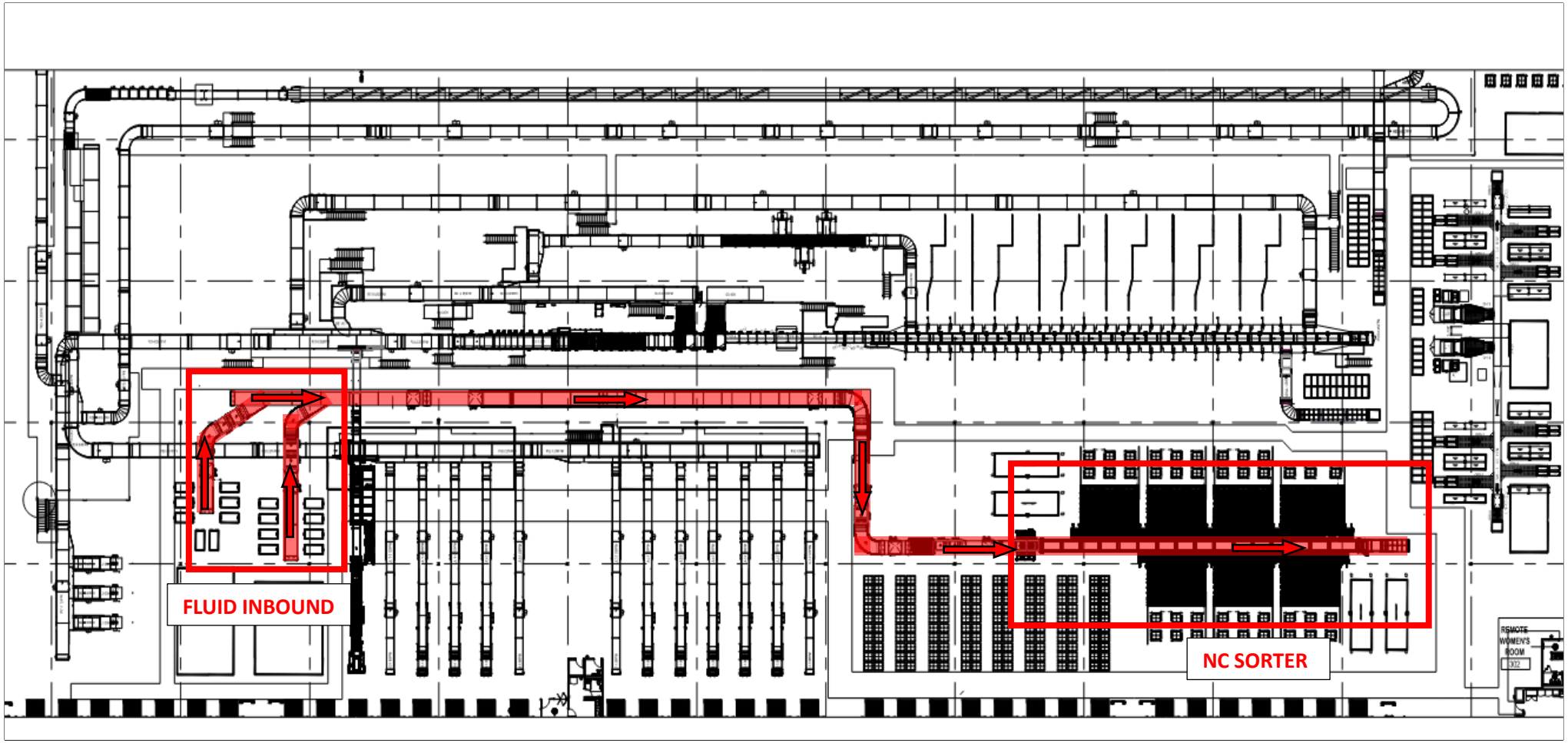


Figure 3. Parcel Flow from Fluid Inbound Lanes to Non-Con Sorter

5.2. Subsystem Overview

The following sections describe each subsystem within the system. A subsystem is a region of logical control. Each subsystem section provides a more detailed overview of that subsystem. These details include the subsystem description and layout with points of interest labelled, summary of operations within that subsystem, and the processing rates of the subsystem.

5.2.1. Fluid Inbound

5.2.1.1. Overview

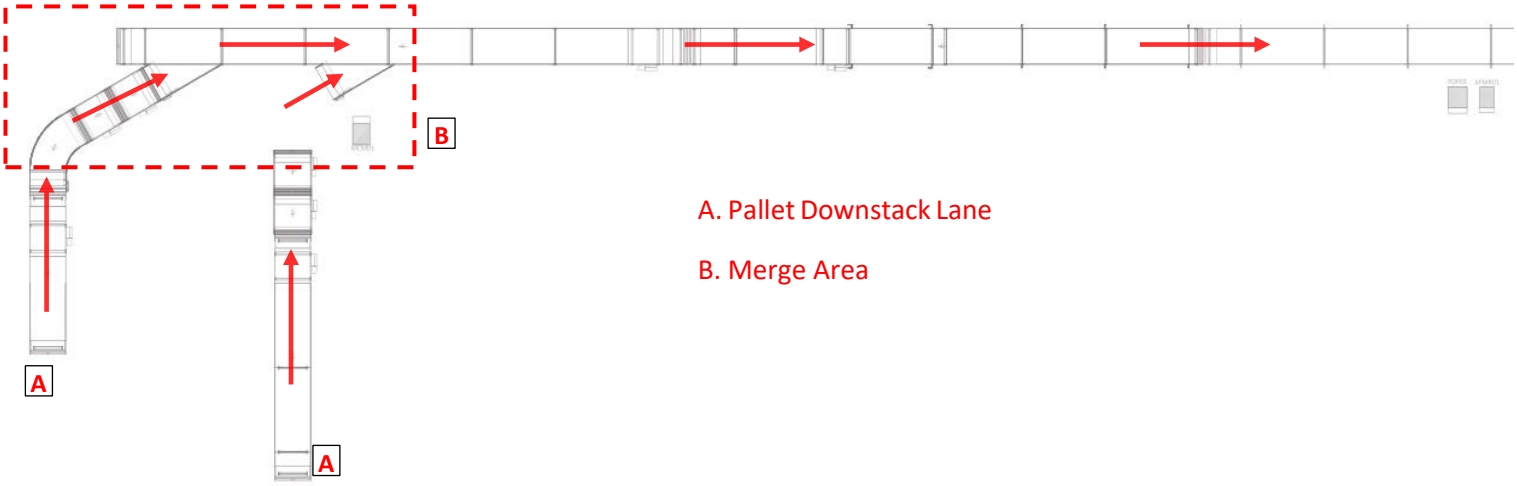


Figure 4. Fluid Inbound Overview

The fluid inbound area is where pallets are unloaded to feed volume into the system. There are two pallet downstack lanes (A). Each of these unload lanes come together at a merge area (B). The merge functionality is opportunistic, meaning that parcels will be held until there is space to merge onto the collector belt. This merged volume flows to the non-conveyable sorter subsystem (not pictured above).

5.2.1.2. Operation

Associates will be unstacking pallets and placing these parcels onto conveyors in this area. The pallet downstack conveyor has control stations for associates to start and stop the belt, to safely place larger packages on a stopped belt.

NOTE	To allow for effective merging, avoid placing parcels side-by-side or one on top of another in the unload lanes.

Conveyors in this area may appear to be slowing down or speeding up; this is normal and is the result of the merge logic optimizing the flow. Packages flowing from the upstream lane will be prioritized to minimize the effect on the speed of the collector belt.

5.2.1.3. Rates

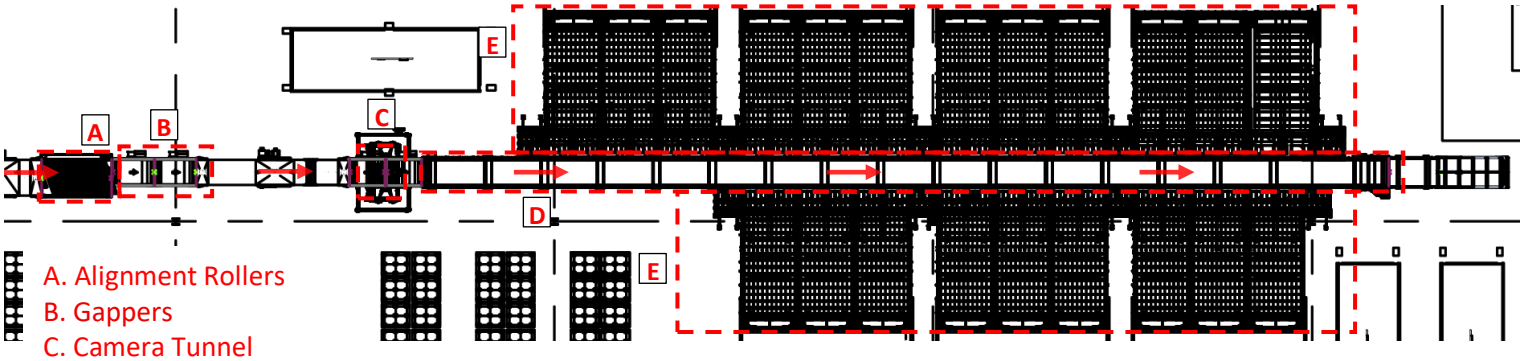
The following table shows the rates of the various sections of the fluid inbound subsystem.

Table 5. Fluid Inbound Rates

Area	Package Types		Length (in)	Width (in)	Height (in)	Weight (lbs)	Rate (pph)
Non-Con Merge Spur (each)	XL	Min	37.1	30.1	24.1	50	750
		Max	100	42	42	100	

5.2.1. Non-Conveyable Sorter

5.2.1.1. Overview



A. Alignment Rollers
B. Gappers
C. Camera Tunnel
D. Intralox ARB Conveyor
E. Sorter Chutes

Figure 5. Non-Conveyable Sorter Overview

NC-sized parcels are transported from the fluid inbound subsystem (not pictured above) to the Non-Conveyable Sorter subsystem. These parcels flow over a bank of alignment rollers (A), resulting in the flow being justified to the left of the conveyor. After justification, the parcels enter the gapping belts (B), where they will be spaced with an average gap of 20 inches.

This NC volume passes through the camera tunnel (C), which is activated when a photoeye (PS3_12_TPE1) positioned just upstream of the tunnel is flagged. The camera tunnel scans a barcode on each package and sends that information to the PLC through a direct ethernet connection. The PLC packages the barcode information and sends it to AWCS which returns the parcel's desired destination to the sorter PLC.

After passing through the camera tunnel and being assigned destinations, parcels will flow onto the Intralox ARB Conveyor (D), which transports and diverts each parcel to its desired sorter chute (E).

5.2.1.2. Operation

Associates are staffed around the NC sorter. They scan parcels that are diverted to the sorters' chutes then pick and place them on the designated pallet. Each sorter chute has an indicator beacon for associates to determine the chutes' fullness status. A solid blue beacon indicates the chute is half-full. A flashing blue beacon indicates that the chute is completely full. When a chute is completely full, the sorter will no longer divert parcels to that destination. This results in parcels needing to be re-handled, which derates the systems throughput.

During operation, the NC sorter may jam. Each chute bank has an amber beacon that will flash indicated a sorter jam on that chute bank. Once the jam sensor is clear (the jammed parcel removed), the amber beacon will be solid, indicating it is ready to be reset. Each chute bank also has a jam reset pushbutton which will clear the jam condition and restart the sorter.

5.2.1.3. Rates

The following table shows the rates of the various sections of the non-conveyable sorter subsystem.

Table 6. Non-Conveyable Sorter Rates

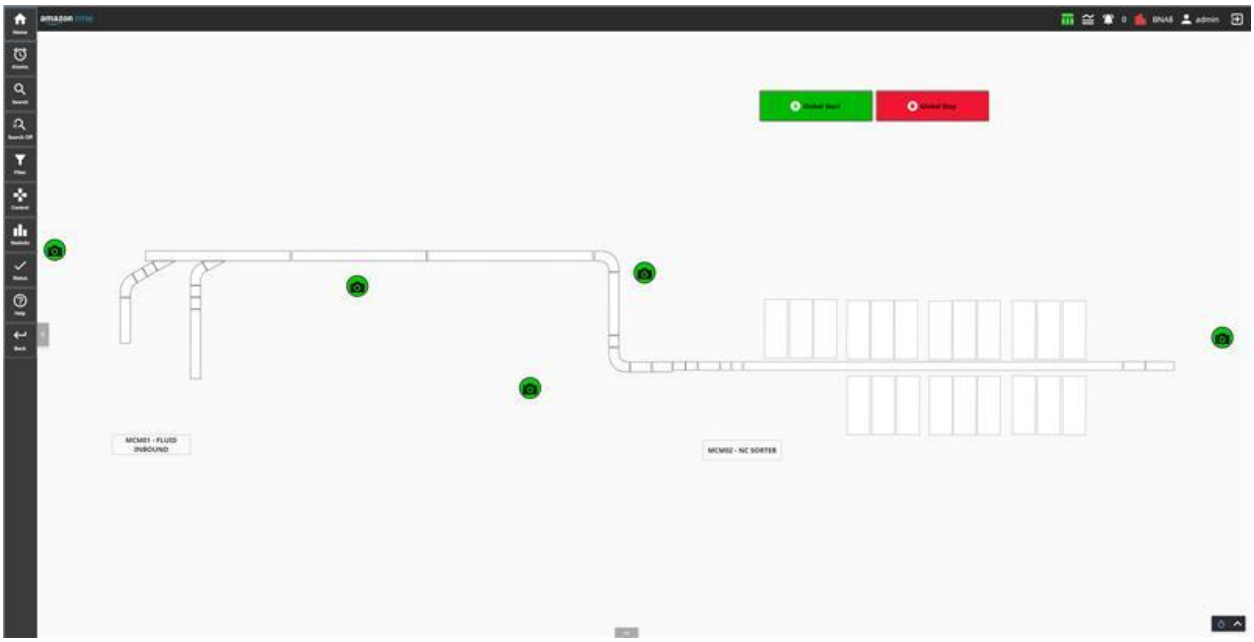
Area	Package Types		Length(in)	Width(in)	Height(in)	Weight(lbs)	Rate(pph)
All Areas	XL	Max	37.1	30.1	24.1	50	x
		Min	100	42	42	100	x
Unload Lanes		42” Package Size	x	x	x	x	1394
		100” Package Size	x	x	x	x	720
2 to 1 Merge Lanes		42” Package Size	x	x	x	x	2,323
Non-Con Primary		100” Package Size	x	x	x	x	1200

6. Operations

6.1. Startup Procedures

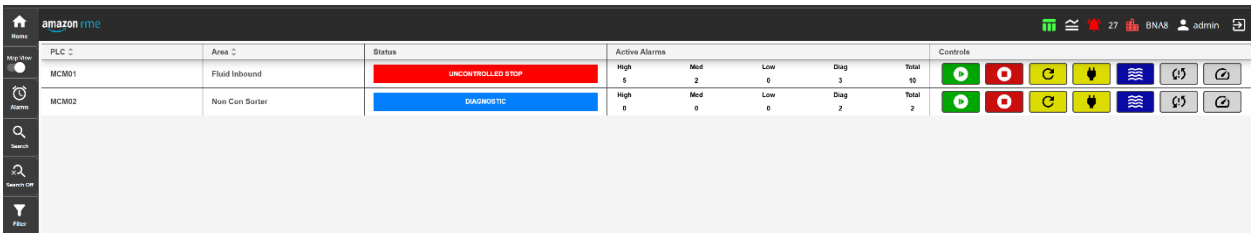
6.1.1 Global Start

To start the entire system, a global start button is provided on SCADA. This button will first command the NC sorter to start. When the sorter reaches full speed, the rest of the NC subsystem will start. The startup/restart sequence for the system will take approximately one minute to complete.



6.1.2 Subsystem Start

Each subsystem can be started or stopped individually with physical push buttons or via SCADA. Each subsystem's Main Control Module (MCM) has physical start and stop push buttons for control. SCADA has buttons that allow for starting and stopping each subsystem.



6.2. Operator Interaction

6.2.1. Controls Panels

There are multiple Main Control Modules (MCM) throughout the MHE system. The MCM houses the PLC for that subsystem and several buttons and indicators for system control and status. One MCM can control several subsystems.

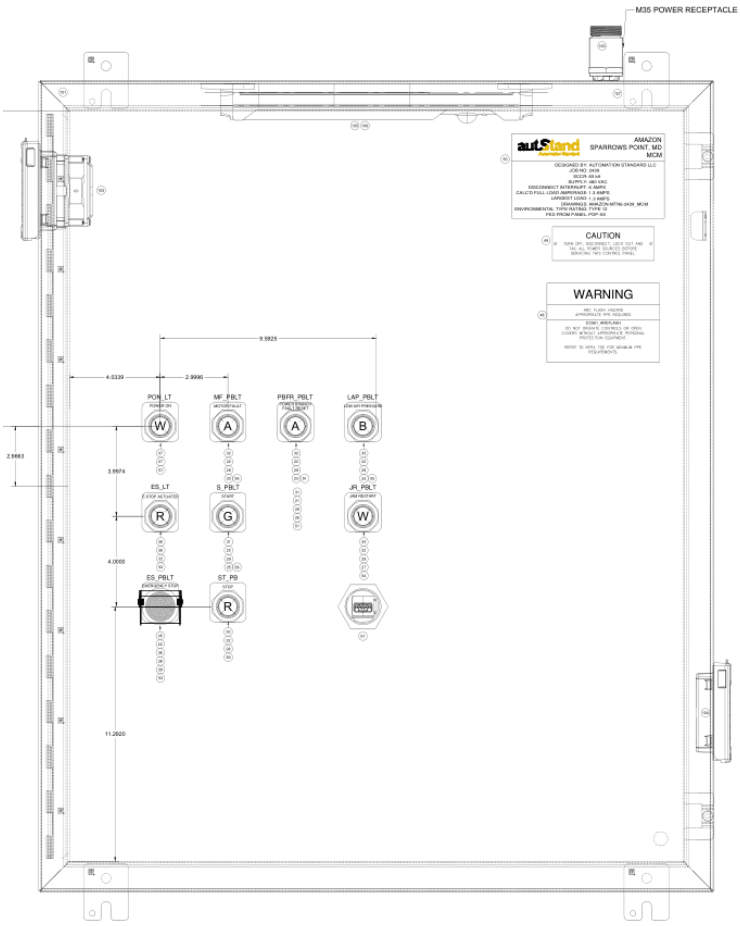


Figure 6. Main Control Module (MCM)

Table 7. MCM Buttons and Indicators

Name	Type	Color	Function
Power On	Flush pilot light	White	Illuminates when panel control circuit power is active.
Start	Flush illuminated pushbutton	Green	Used in starting all associated equipment controlled by the control panel. Illuminates solid to indicate in the started (running) state. Flashes at 1 second intervals when in Energy Saving Mode.
Stop	Extended pushbutton	Red	Used in control stopping all associated equipment controlled by the control panel.
E-Stop	Illuminated mushroom push/pull	Red with Yellow background	Used in immediately shutting down all equipment controlled by the control panel. Illuminates when button is pushed (active) and extinguishes when the button is pulled (deactivated.)
E-Stop Actuated	Extended pilot light	Red	Solid when any E-Stop device associated with the control panel has been actuated. Flashes at every 0.5 second intervals when a fault in the e-stop circuit has been detected. Flashes at 1 second intervals while VFDs are powering up after resetting of an E-Stop condition.
			Flashes at 2 second intervals when an interlocking panel E-Stop is active/activated.
Jam Restart	Flush illuminated pushbutton	White	Illuminates when a local jam condition been detected within the control panels area of control. Flashes at 2 second intervals to indicate a Motion (Encoder/PPI) fault been detected. Press to reset and restart local Jam or Motion Fault, after clearing Jam/Motion fault condition.
Motor Fault	Flush illuminated pushbutton	Amber	Illuminates when any Motor, Motor Controller (VFD), or Disconnect been detected within the control panels area of control. Press to reset Motor, Motor Controller (VFD), or Disconnect fault after clearing fault condition.
Power Branch Fault	Flush illuminated pushbutton	Amber	Illuminates when a Power Branch Circuit Fault been detected within the control panels area of control. Press to reset Power Branch Circuit Fault after clearing fault condition.
Low Air Pressure (if pneumatics is present)	Flush illuminated pushbutton	Blue	Illuminates when any air pressure fault has been detected within the panels area of control. Press to rest after restoring air pressure, then pressing Start to restart the effective areas.

6.2.2. Chutes

6.2.2.1 Pallet Build Chutes

Pallet build chutes accumulate volume in the upper part of the chute. Associates press a pushbutton at the bottom of the chute to release a brake which allows a controlled amount of volume to fall to the bottom of the chute. Associates scan parcels at the bottom of the chute and move them to the designated pallet.

6.2.3. Start/Stop Stations

Start/Stop stations shall be provided to allow associates to conveniently start, stop, or restart a machine, equipment or an area process (WWDE-CNTRL-STND-GLOBAL-SPEC-R215-121620). A list of illuminated pushbuttons and their functions can be found on Table 8. Start/Stop Station below.

Table 8. Start/Stop Station Controls

Name	Type	Color	Function
Start	Flush illuminated pushbutton	Green	Used in starting local conveyors/area and in resetting local faults/estops. Illuminated to indicate running state, or flashing when equipment is in energy management mode.
Stop	Extended pushbutton	Red	Used to stop local conveyors/area.
E-Stop (optional)	Illuminated mushroom push/pull	Red with Yellow background	Illuminates when active.
Jam Restart (optional)	Flush illuminated pushbutton	White	Illuminates when a local jam condition has been detected within the control stations area of control. Press to reset and restart after clearing a local Jam fault.

6.2.4. Jam Reset Stations

Jam reset stations are placed near all jam points in the system. A jam reset station consists of a single white pushbutton. A jam reset station allows for convenient restarting of a subsystem if a jam occurs. If a jam occurs, follow these steps to allow the conveyor to resume normal operation:

1. Navigate to the jam area, designated by its flashing amber beacon.
2. Clear the sensor which is jammed.
    a. The sensor is clear when the beacon becomes solid.
3. Reset the system and restart the conveyor by pressing the nearby illuminated white jam reset pushbutton.

If the jam reset pushbutton remains lit, then the jam condition has not been cleared. A successful reset should result in the jam reset station light turning off. If the jam reset light remains lit, recheck that the amber beacon is solid. If the beacon is still flashing, recheck the sensors in its area for any that are still blocked.

6.2.5 System Status Beacons

Regardless of their position within the system, status beacons follow the same indication scheme. See below for an explanation of system status beacon colors and animations:

Table 9. Status Beacon Colors

Color	Meaning	Explanation	Typical Application
RED	E-Stop Active	Emergency Condition	• Essential equipment actively stopped by action of a protective device (Flashing) • Essential equipment was stopped by action of a protective device, but device is ready for reset (Solid)
BLUE	Full Status	Indication of the full condition of accumulation, chutes, or shuttle containers	• Post Divert Lane 100% Full (Solid) • Post Divert Lane 50% Full (Flashing) • Shuttle Container 100% Full (Solid) • Shuttle Container 50% Full (Flashing)
PURPLE	Gridlock	Indication of sorter in Gridlock	• Sorter system in Gridlock Mode, unable to receive more product.
AMBER	Fault Condition	Indication of equipment fault condition	• Equipment Jammed (Flashing) • Equipment was Jammed but Ready for Reset (Solid)
GREEN	Lane or Equipment Enabled	Indication of normal operating conditions or operation enabled	• Divert location enabled and enabled for operation (Solid) • Divert location ready to be enabled (Flashing) • Divert Lane enabled and downstream system ready to receive (Solid) • Machine or system ready and running (Solid)

6.3. Faults and Statuses

This section describes typical faults, alarms, and statuses that are relevant to the system and how they are annunciated and resolved.

6.3.1 Jam

To protect associates, and to minimize damage to equipment and products, jam detection of product flow shall be provided at (but not limited to):

- Merging points
- Divert Spurs
- Charge and Discharge of high-speed sorters (slat)
- Curves (feeding into)
- Gravity and Powered Spirals
- Gravity Chutes

- Empty Carton transition points (elevation/change in direction)
- Product alignment (narrowing of product flow)

Jam detection shall be comprised of an appropriate sensing device that can detect the presence of all product height/width being handled by the machine/equipment/system. A jam sensing device can serve dual purposes (I.E. product present, pull-up eye, etc.)

A ***Jam Fault*** shall be generated when a Jam sensing device (i.e. photoeye) continuously senses product (blocked) for a specific amount of time. The "Block" time shall take into consideration the conveyor speed, time it would take for product to "Pile Up" and fall out of machine/equipment (possibly injuring associates), and equipment damage due to blockage of product flow. See Section 9.3. Jam Timers for the Block times of this system.

Under a ***Jam Fault***, the associated unit along with the immediate upstream and (if applicable) the immediate downstream units shall be logically stopped to inhibit movement. The fault condition is to be annunciated by:

- Illuminating the *Jam Restart* illuminated pushbutton at the associated Jam Reset Station and main control panel.
- Illuminating (strobe) a local Jam beacon(s.)
- Displaying the Jam fault condition on the HMI/SCADA by changing unit to the appropriate fault color, and/or showing an alarm message.
- Updating the SCADA logs (where applicable) with open access to Amazon for reporting/data collection.

Recovering from a Jam Fault requires clearing the affected jam photoeye sensing path of product. Upon detecting that the affected jam photoeye(s) sensing path has cleared, the local jam beacon(s) illuminates solid to indicate that the affected conveyor units can be restarted by:

- Pressing the Jam Restart illuminated pushbutton at the associated local jam restart station.
- Alternatively, by pressing the jam restart illuminated pushbutton at the main panel, or at the SCADA system.

Restarting of a jam fault condition is acknowledged by:

- Extinguishing the Jam Restart illuminated pushbutton at the main panel and associated jam restart control station.
- Extinguishing local Jam beacon(s.)
- Clearing the jam fault condition on the SCADA system.
- Sounding Start-Up Warning Horn prior to initiating motion

6.3.2 Bulk-Jam

For package collector belt applications (i.e. Bulk Flow), a Jam sensing device shall be located at the discharged end of each conveyor/chute feeding the Bulk Flow Main Trunk Take-away conveyor section.

When a Jam is detected at the discharge of the feeding conveyor/chute, the feeding conveyor shall stop while the Main Collector (Bulk) Take-away conveyor is permitted to continue to index for a

specified “Clearing” time. If the Jam condition is cleared before reaching the “Clearing” time, the feeding conveyor/chute is permitted to resume normal operation and the “Clearing” time is reset.

When the “Clearing” time is reached, the Main Collector (Bulk) Take-away conveyor section associated with the feeding conveyor/chute shall stop (along with all upstream Collector (Bulk) Take-away conveyor sections.) Under this condition, the Jam Fault signaling and resetting routines occur as described in 6.3.1 Jam.

6.3.3 Motor Disconnect

For all VFD or standalone equipment, the disconnect state shall be monitored.

A ***Disconnect Fault*** is to be generated when either:

- A disconnect switch is detected in the OFF position while an area/equipment is running (started)
- Or when a disconnect switch is detected in the OFF position when starting an area/equipment (re-starting)

Under a ***Disconnect Fault***, the associated unit along with the immediate upstream (and if applicable the downstream units) shall be logically stopped to inhibit movement (or processes). The fault condition is to be annunciated by:

- Illuminating the Motor Fault illuminated pushbutton at the main panel.
- Displaying the fault condition on the HMI/SCADA by changing unit/equipment to the appropriate fault color or showing an alarm message.
- Updating the SCADA logs (where applicable) with open access to Amazon for reporting/data collection.

Recovering from a ***Disconnect Fault*** requires placing the disconnect switch to the ON position and pressing the *Motor Fault* illuminated pushbutton at the main panel.

6.3.4 VFD

For all motors controlled through a drive controller (I.E. VFD, Soft-Starter, etc.) the operating state of the controller shall be monitored for any faulty condition. A ***Motor Fault*** is to be generated upon detecting a fault condition.

Under a ***Motor Fault***, the associated unit along with the immediate upstream (and if applicable the downstream units) shall be logically stopped to inhibit movement (or processes). The fault condition is to be annunciated by:

- Illuminating the Motor Fault illuminated pushbutton at the main panel.
- Displaying the fault condition on the HMI/SCADA by changing unit to the appropriate fault color, and/or showing an alarm message.
- Updating the SCADA logs (where applicable) with open access to Amazon for reporting/data collection.

Recovering from a ***Motor Fault*** requires fixing the controller fault and pressing the *Motor Fault* illuminated pushbutton at the main panel.

6.3.5 Emergency Circuit/Controller Fault

Emergency Stop circuits shall be constantly monitored for potential wiring/circuit failures and/or for faulted emergency stop devices. Failures/faults to be monitored should include but not limited to:

- The local E-Stop relay (controller) is energized, but one or more E-Stop devices in the E-Stop circuit are activated.
- The local E-Stop relay (controller) is not energized and no E-Stop devices in the E-Stop circuit are activated.
- E-Stop Relay / Safe PLC faulted.

Upon detecting an E-Stop fault, An ***Emergency Circuit/Controller Fault*** shall be generated.

Under an ***Emergency Circuit/Controller Fault***, the equipment associated with the emergency stop zone is to be brought to a stop and restarting functionality of the affective zone is to be disabled. The fault condition is to be annunciated by:

- Flashing the E-Stop Actuated pilot light at the main panel at 0.5 second on/off interval.
- Displaying the fault condition on the HMI/SCADA by changing unit(s) to the appropriate fault color, and/or showing an alarm message.
- Updating the SCADA logs (where applicable) with open access to Amazon for reporting/data collection.

Recovering from an ***Emergency Stop Fault*** requires repairing the faulty E-stop circuit/device and pressing the *Start* illuminated pushbutton at the main panel.

6.3.6 Motion/Encoder Fault

All equipment/machines controlled by a motion sensing device (i.e. encoder, pulse positioning, or similar devices) shall monitor the operating state of the motion sensing devices. Should a failure in detecting expected motion and/or any fault condition occur, a ***Motion/Encoder Fault*** is to be generated upon detecting the fault or loss of position.

Under a ***Motion/Encoder Fault***, the associated unit along with the immediate upstream and downstream units shall be logically stopped to inhibit movement (or processes). The fault condition is to be annunciated by:

- Flashing the Jam Reset illuminated pushbutton at the main panel at 2 second on/off interval.
- Displaying the fault condition on the HMI/SCADA by changing unit to the appropriate fault color, and/or showing an alarm message.
- Updating the SCADA logs (where applicable) with open access to Amazon for reporting/data collection.

Recovering from a ***Motion/Encoder Fault*** requires clearing the motion sensor fault or correcting the motion error, then pressing the *Jam Reset* illuminated pushbutton at the main panel.

6.3.7 Communication Fault

All equipment/machines requiring critical communication with subsystems and/or Amazon services shall be monitored for proper communications.

A ***Communication Fault*** is to be generated upon detecting loss of communications or communication buffers exceeding 95% utilization.

Under a ***Communication Fault***, the associated control panel shall be brought to a logical controlled stop (to inhibit movement) and all associated start functionality disabled. The fault condition is to be annunciated by:

- Illuminating the Communication Fault illuminated pushbutton at the main panel.
- Displaying the fault condition on the HMI/SCADA by changing unit to the appropriate fault color, and/or showing an alarm message.
- Updating the SCADA logs (where applicable) with open access to Amazon for reporting/data collection.

Recovering from a ***Communication Fault*** requires fixing the communication issue and pressing the *Communication Fault* illuminated pushbutton at the main panel.

6.3.8 Low Air Pressure Fault

For pneumatic control equipment/systems, an air pressure sensing device shall be used in monitoring equipment/machines supply air pressure. A ***Low Air Pressure Fault*** shall be generated when the pneumatic supply air pressure falls below an acceptable operating level.

Under a ***Low Air Pressure Fault***, the associated pneumatic equipment is to be brought to a controlled stop and all restarting functionally of the affective equipment is to be disabled. The fault condition is to be annunciated by:

- Illuminating the Low Air Pressure illuminated pushbutton at the main panel.
- Displaying the fault condition on the HMI/SCADA by changing unit/equipment to the appropriate fault color or showing an alarm message.
- Updating the SCADA logs (where applicable) with open access to Amazon for reporting/data collection.

Recovering from a ***Low Air Pressure Fault*** requires 1) restoring the air pressure to an acceptable sustainable level; 2) pressing the *Low Air Pressure* illuminated pushbutton to reset the Low Air Pressure Fault, and 3) pressing the START pushbutton at the main panel to restart the affected equipment.

6.3.9 Sensor Fault

Equipment/machines with critical sensing devices (i.e. Over Travel Limit Switches, Tension Sensor, or similar devices) shall monitor the state of the sensing devices (i.e. fail to make, failed to break, loss of fail-safe signal, etc.)

A ***Sensor Fault*** is to be generated upon detecting sensor fault.

Under a ***Sensor Fault***, the associated faulted unit shall be logically stopped to inhibit upstream units (or processes) from feeding product to the stopped/faulted unit, and the fault condition shall be annunciated by:

- Illuminating a Sensor Fault illuminated pushbutton at the main panel (optional).
- Displaying the fault condition on the HMI/SCADA by changing unit to the appropriate fault color, and/or showing an alarm message.

- Updating the SCADA logs (where applicable) with open access to Amazon for reporting/data collection.

Recovering from a ***Sensor Fault*** requires fixing the sensing device issue and pressing the *System Start* illuminated pushbutton at the main panel.

7. Control Concepts

This section goes into detail about the various automated processes and concepts used within this system.

7.1 Energy Management

Energy management is a state of the system when there are no parcels detected in the system. When a subsystem enters energy management mode, its conveyors will stop running. A subsystem will enter energy management mode when no parcel has been detected for a designated length of time. This value is set to 15 minutes by default but can be configured via SCADA.

A system can be taken out of energy management mode manually by pressing the global start button on SCADA, or at each subsystem's individual start button on its control panel. A subsystem will automatically exit energy management if volume is detected upstream of the subsystem.

For example, the inbound lanes will enter energy management if no product is being unloaded from trailers or thrown onto the pallet down-stack lane. However, the first conveyor in each of those lanes will continue to run, to allow for an associate to unload a parcel. When this parcel reaches the first sensor in the lane, it will take the downstream portion of the subsystem out of energy management.

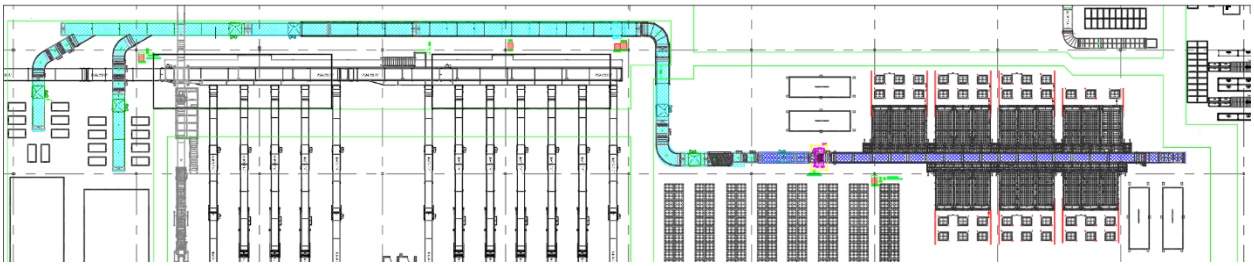


Figure 7. Energy Management Zone

Energy Management Zone	Zone Color	Conveyor	Restart Trigger Device
MCM01		UL15_1	UL15_1_SS1
		UL15_2	UL15_1_TPE1
		UL15_3	UL15_2_TPE1
		UL15_4	UL15_3_TPE1
		UL15_5	UL15_4_TPE1
		UL14_1	UL14_1_SS1
		UL14_2	UL14_1_TPE1
		UL14_3	UL14_2_TPE1
		UL14_4	UL14_3_TPE1
		UL14_5	UL14_4_TPE1
		PS3_1	PS3_1_SS1
			PS3_1_TPE1
			PS3_1_TPE2
		PS3_2	PS3_1_TPE3
		PS3_3	PS3_2_TPE1
		PS3_4	PS3_3_TPE1
		PS3_5	PS3_4_TPE1
		PS3_6	PS3_5_TPE1
		PS3_7	PS3_6_TPE1
		PS3_8	PS3_7_TPE1
		PS3_9	PS3_8_TPE1
		PS3_10	PS3_9AL_TPE1
		PS3_11	PS3_10_TPE1
			PS3_11_SS1
			PS3_11_SS2
MCM02		PS3_12	PS3_11_TPE1
		PS3_13	PS3_12_TPE1
		PS3_14	PS3_12_TPE1
		NCS1_1	NCS1_1_SS1
			NCS1_1_SS2

Table 10. Energy Management Zone

8. System Architecture and Hardware

Each Main Control Module (MCM) is connected to the Amazon network. Each MCM also its own ring of Data Power Modules (DPM). DPMs and MCMs are configured in ring networks for redundancy using the Device Level Ring (DLR) protocol. End devices (VFDs, IO modules, OEM equipment, etc.) are then networked from each DPM in a star configuration, as shown below. This example shows the connections between the Amazon network, MCM, DPMs, and field devices such as VFDs and IO blocks.

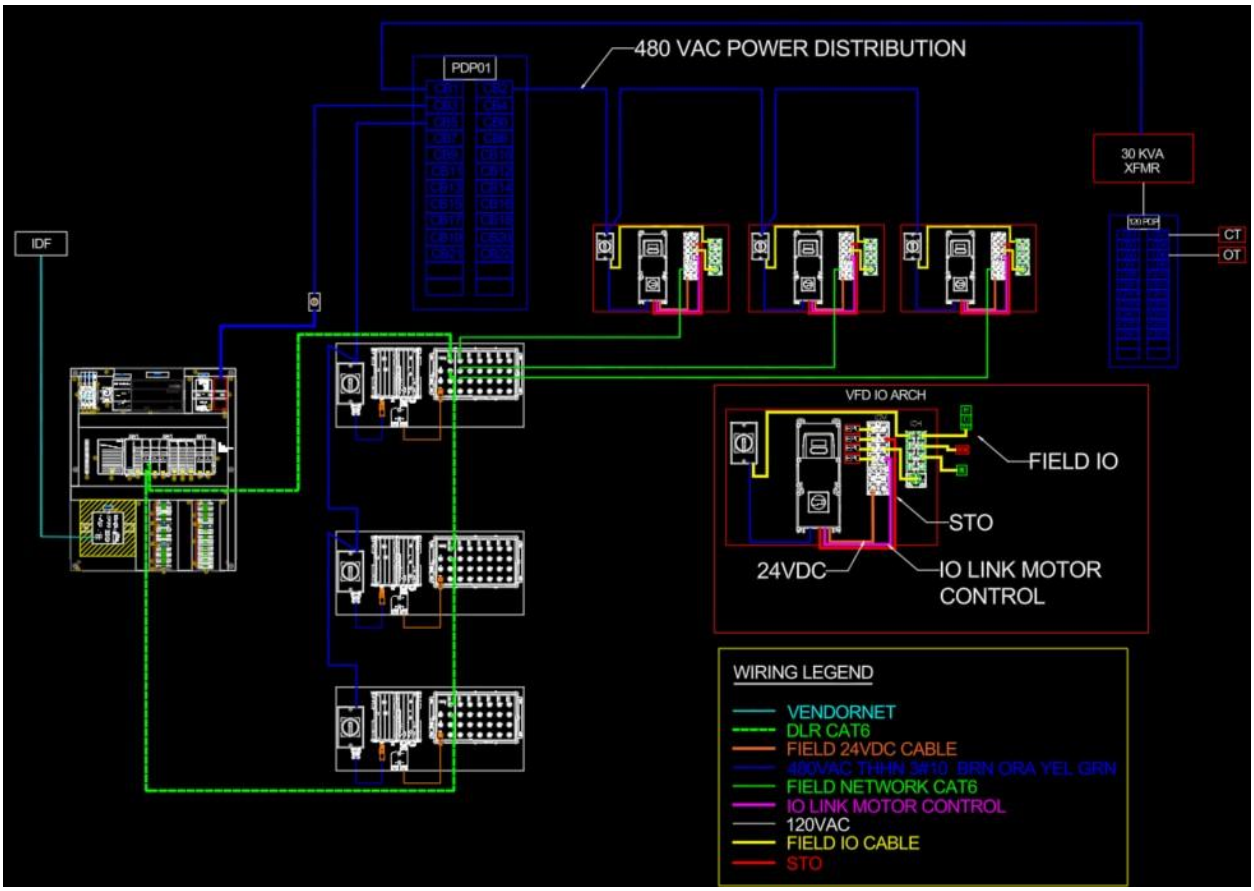


Figure 8. System Network Architecture

8.1.1. Control Panels

Table 11. Control Panels

Panel	Function	Segments
MCM01	PS3 Merge	Fluid Inbound
MCM02	Non Con Sorter	Non Con

Table 12. Control Panel Power

Control Panel	PDP Power Source	MDP Power Source
MCM01	PDP01	IDP01
MCM02	PDP01	IDP01

8.1.2. Field Devices

8.1.2.1. Control Stations

8.1.2.2. Beacons

Beacons shall be stackable type (unless otherwise noted). Beacons shall be provided for (but not limited to) Jams, E-Stops, and Lane Full status.

Beacons shall be mounted at an elevation that makes them clearly visible at associates'/operators' eyelevel (minimum elevation of 1.8m (6ft)) above floor/mezzanine surface. Additional beacons, or alternate mounting heights or locations, shall be considered if visibility is impaired by physical obstructions. Mounting of beacons shall not impede associates' operations and/or product flow. Any proposed heights or suspended mounting locations shall be reviewed for approval prior to installation.

All jam and E-Stop beacons as well as all system resets and start/stop station locations shall be easily identified by the use of placards describing and locating system areas that each control station controls.

Unless otherwise noted/approved by Operation Engineering and Controls Engineering, beacons shall be stacked in the following color order (top to bottom):

Table 13. NA Beacon Colors Hierarchy

Color	Function
RED	Emergency Conditions
BLUE	Process/Flow State
PURPLE	Gridlock State
AMBER	Fault Conditions
WHITE	Informational
GREEN	Operating State

Table 14. NA Beacon Colors

Color	Meaning	Explanation	Typical Application
YELLOW (AFE ONLY)	Assistance	Associate Call / Problem Solve	• Work/Induct stations to indicate an associate requires assistance
RED	Emergency Stop Active	Emergency Condition	• Essential equipment stopped by action of a protective device
PURPLE	Gridlock	Indication sorter in Gridlock	• Sorter system in Gridlock Mode, unable to receive more product.
BLUE	Full Status	Indication of the full condition of accumulation, chutes, or Shuttle Containers	• AFE Lines 100% full • Post Divert Lane 100% full • Gayloard Full
AMBER	Fault Condition	Indication of equipment fault condition	• Equipment Jam
WHITE	Informational	Indication of general process condition	• Bar Code No Read at AFE Induct Station
GREEN	Lane or Equipment Enabled	Indication of normal operating conditions or operation enabled	• Divert location enabled and enabled for operation • Divert Lane enabled and downstream system ready to receive • Machine or system ready and running

9. System Parameters

9.1. MTBH

The Materials to be Handled (MTBH) specifications for the system are identified below. They define the sizes and weights of packages the system is expected and required to handle. See subsections of 5.2. Subsystem Overview for subsystem-specific details.

Table 15. MTBH

MTBH			Cartons				Bags				Envelopes			
			L	*W*	*H*	*Wt*	*L*	*W*	*H*	*Wt*	*L*	*W*	*H*	*Wt*
X-LARGE (XL or NC)	MIN	cm/kg	94.1	76.1	61.1	22.7	NA							
		inch/lbs	37.1	30.1	24.1	50.1								
	MAX	cm/kg	254.0	106.6	106.6	45.3								
		inch/lbs	100	42.0	42.0	100								

- These are actual sizes, and accommodations need to be made for slightly deformed, dented or not perfectly square containers and packages.
- X-Large is considered as 'Non-conveyable' (NC) and shall be sortable via the non-con system. Anything larger than X-Large shall be declared non-compliant.
- Maintain minimum height parcel clearance of 48 inches between conveyable surface and any obstruction for all Non-Con (XL) MHE.
- Max 100" packages will be conveyed/transported from inbound, however only 85" packages can be diverted to chutes.

9.2. Speeds

All MHE conveyor speeds can be found in Table 18 in the appendix.

9.3. Jam Timers

When a photoeye is blocked for an extended time period, the system determines that a jam is occurring. Jam timers are calibrated for each photoeye during commissioning and vary based on the layout of the site. For more information about how the system processes jams, see section 6.3.1 Jam and section 6.3.2 Bulk-Jam.

For the calibrated values of each photoeye's jam timer, see Table 19 in the appendix.

10. Visualization

11. Appendices

11.1. Estop Zones

The system is separated into three emergency stop zones. Two of these zones are controlled by MCM01 and one is controlled by MCM02. These zones function such that if any E-Stop device in the zone is activated, all lines in the zone are stopped. The MCM01 and MCM02 zone devices and lines are shown in Table 16 and Table 17, respectively. Estop zones will only affect the lines within the zone, but stopping downstream belts may lead to belts upstream of the zone stopping.

11.1.1 MCM01

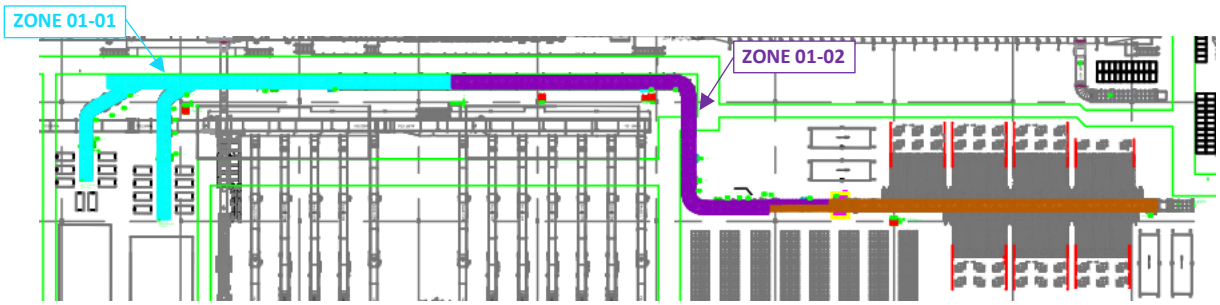


Figure 9. MCM01 Estop Zones

Table 16. MCM01 Estop Zones

E-Stop Zone	E-Stop Devices	Actuation Type	Lines Stopped
MCM01	MCM01.EPB	MCM Main E-Stop Pushbutton	ALL MCM01 Zones
01-01	UL15_1_EPC1 UL15_1_EPC2 UL14_1_EPC1 UL14_1_EPC2 PS3_1_EPC1 PS3_1_EPC2	Emergency Stop Pull Cord	UL15-1 to UL15-5 UL14-1 to UL14-5 PS3-1 to PS3-2
01-02	PS3_11_EPC1 PS3_11_EPC2	Emergency Stop Pull Cord	PS3-3 to PS3-14

11.1.2 MCM02

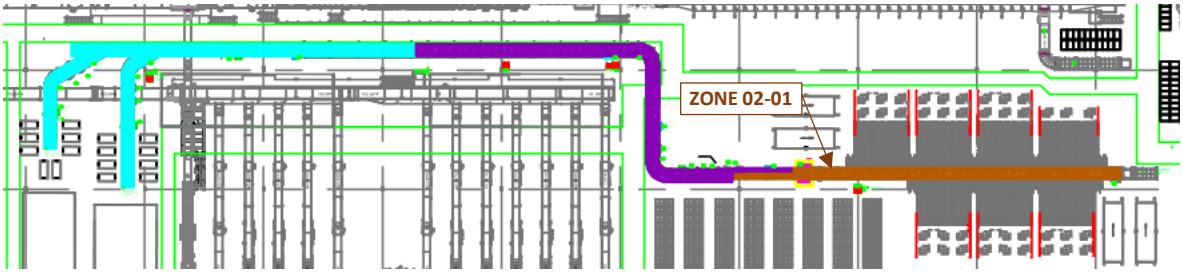


Figure 10. MCM02 Estop Zones

Table 17. MCM02 Estop Zones

E-Stop Zone	E-Stop Devices	Actuation Type	Lines Stopped
MCM02	MCM02.EPB	MCM Main E-Stop Pushbutton	ALL MCM02 Zones
02-01	PS3_12_EPC1 PS3_12_EPC2 NCS1_1_EPC1 NCS1_1_EPC2	Emergency Stop Pull Cord	PS3-12 to PS3-14 NC1-1

11.2. Conveyor Speeds

Table 18. Conveyor Speeds

Conveyor	Speed (FPM)
UL15-1	120
UL15-2	220
UL15-3	220
UL15-4	220
UL15-5	220
UL14-1	120
UL14-2	220

Conveyor	Speed (FPM)
UL14-3	220
UL14-4	220
UL14-5	220
PS3-1	200
PS3-2	200
PS3-3	200
PS3-4	220

Conveyor	Speed (FPM)
PS3-5	200
PS3-6	200
PS3-7	200
PS3-8	200
PS3-9A	200
PS3-9B	200
PS3-10	200

Conveyor	Speed (FPM)
PS3-11	200
PS3-12	200
PS3-13	200
PS3-14	200
NCS1-1	200

11.3. PE Jam Timers

Table 19. Photoeye Jam Timers

Package Speed (including on chutes from sorter)	Jam Detection Block-Time Threshold (seconds)
Package Speed (FPM)	**Jam Timer (s)**
20	30 s
40	15 s
60	10 s
100	6 s
150	4 s
200	3 s
300	2 s
400	2 s
500	2 s
600	2 s