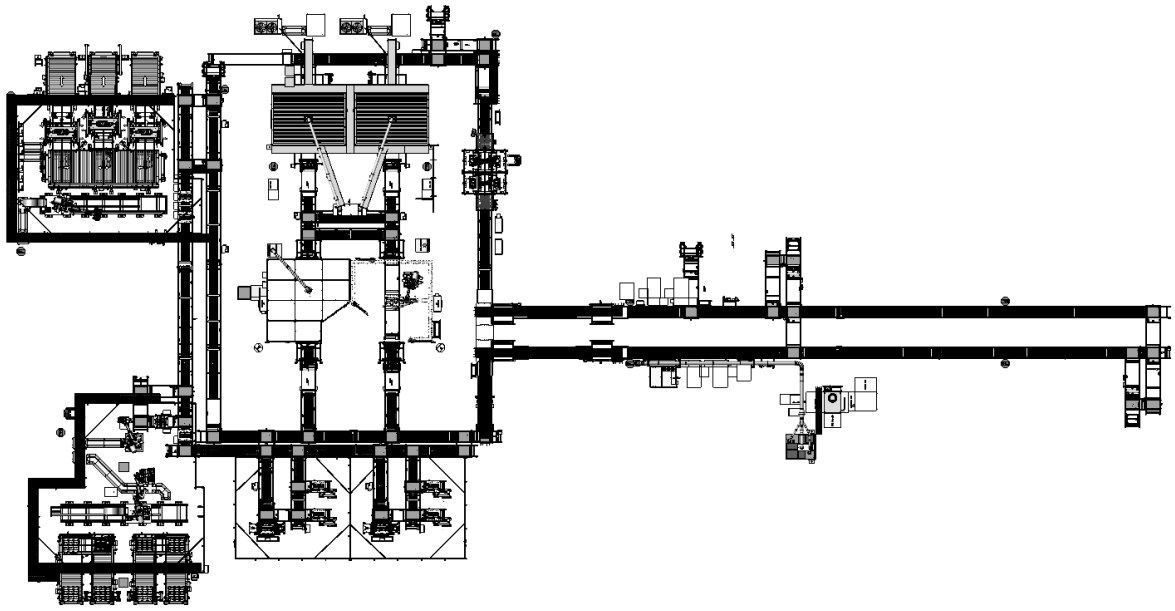

BET/BEV3 Module Final Assembly Line Operation and Maintenance Manual

Designed and Built By

ATS™
INDUSTRIAL AUTOMATION

ATS Ohio Job 2353
January 2023

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This document was created by the Technical Documentation Department of ATS Ohio.

CONTENTS

PREFACE

MANUAL REVISION HISTORY

Revisions made to this manual are listed below. Revision history information includes:

- Revision Level – When a manual is first published, it is considered a release and is identified as revision 0. All subsequent revisions to the manual are identified with a letter designation (A, B, C, etc.).
- Date – When the revision (or release) is effective.
- Description – Provides a brief explanation of why the revision was made. For example, if a machine was modified to test a new model and changes made to the machine affected pages in the manual.
- Affected Pages – Lists pages (including section number) affected by the revision.

Rev.	Date	Description	Affected Pages
0	06/2022	Document release	All

ABOUT YOUR DOCUMENTATION

Your documentation package includes this Operation and Maintenance Manual and an OEM Literature package. The following sections describe the contents of each of the documentation media.

Content

The following chapters compose the Operation and Maintenance Manual:

- ***Chapter 1 – Master Task List***. This chapter details the operation, electrical and mechanical maintenance, and repair tasks that must be performed.
- ***Chapter 2 – Safety***. This chapter details battery safety and describes the system safety-related equipment.
- ***Chapter 3 – System Description***. This chapter details the system equipment and utilities.
- ***Chapter 4 – System Operations***. This chapter details the operator interface equipment, describes the HMI screens, and describes the common operating procedures.
- ***Chapter 5 –Maintenance***. This chapter describes the maintenance tasks.
- ***Chapter 6 – Troubleshooting***. This chapter describes the system troubleshooting procedures.
- ***Chapter 7 – Assembly and Disassembly***. This chapter describes the methods for taking apart and putting together end of arm tooling and other mechanisms.
- ***Chapter 8 – Installation***. This chapter describes the methods for installing the equipment in a facility.
- ***Chapter 9 – Process Parameters***. This chapter describes the setpoints and critical parameter settings for the equipment.

Significance

This Operation and Maintenance Manual was written for the personnel responsible for the Module Final Assembly System. It is important to read, understand, and pay attention to every aspect of it.

The complete Operation and Maintenance Manual should be kept near the system for future reference.

The Operation and Maintenance Manual describes special details of the system necessary for trouble-free operation. Knowledge of these operating instructions will help avoid system faults.

Should you experience problems still, please contact our customer service department, someone will be happy to help you. Please refer to the contact information on the cover of this manual.

Graphics

All drawings, illustrations and photographs are provided to expand and enhance the text explanations. These graphics are representations only. They may not be drawn to scale. For accurate drawings, refer to the ATS mechanical and electrical drawings supplied to your company.

Style Conventions

This Operation and Maintenance Manual uses the following styles to indicate different kinds of information:

- **Bold Blue Times New Roman Text** indicates a chapter or section heading (in all chapters except for the Preface, the chapters and sections are numbered sequentially).
- SMALL CAPITAL TEXT indicates a physical button on the cell.
- **BOLD SMALL CAPITAL TEXT** indicates a button on an HMI screen.
- `Courier New Text` indicates on-screen software messages.
- A **Bold Blue Arial Letter** (such as **C**) refers to a pointer in the previous or identified figure.
- Bullets indicate listed items where order is of no significance.
- Numbered items indicate a step-by-step procedure or ordered list.

Special Notations

Throughout the Operation and Maintenance Manual, special symbols and notations alert the reader to safety concerns, which, if procedures are not properly performed, could cause death, serious injury or equipment damage. They may also indicate important or supplemental information, and where to find it. Boxed notations always appear immediately before or after the information or step to which they pertain.

WARNING!

Warning messages identify actions or conditions that could result in personal injury, health hazard, or loss of life.

CAUTION!

Caution messages identify conditions or practices that could result in machine operating faults or damage to equipment.

NOTE

Notes are generally used to highlight a suggestion or stress important information; they may also bring attention to a unique operating condition or provide a clarifying statement.

REFERENCE

References are used to call attention to a piece of literature provided by a third-party OEM equipment supplier.

Due to variations found in the operating conditions of certain applications and their working environments, the special notations in this manual cannot identify all potential problems or hazards. Caution and discretion must always be used while operating machinery, especially when using electrical power. Equipment should be operated and maintained only by qualified and trained personnel.

OEM Literature Package

The OEM Literature Package includes copies of the third-party equipment manuals, cut sheets, and associated product information. The hard copies are sorted alphabetically in an accordion-style folder. This package contains information as received by the product vendor. In the event any product information is missing or is out-of-date, please contact the product manufacturer directly.

1. MASTER TASK LIST

Number	Task Description	Manual Reference Location
CHAPTER 2 - SAFETY		
1.	Battery Safety	2.1 Battery Safety Overview
2.	Health and Safety	2.2 Health and Safety Statement
3.	General Safety	2.3 General Safety Guidelines
4.	Personal Safety	2.4 Personal Safety
5.	Work Area Safety	2.5 Work Area Safety
6.	Energy Control and Power Lockout	2.6 ECPL Placards and Tags
7.	Tool Safety	2.7 Tool Usage
8.	Machine Safety	2.8 Machine Safety
9.	Safety Device Locations	2.9 Safety Device Summary
10.	Energy Control Devices	2.10 Energy Control Device Descriptions
11.	SDS References	2.11 SDS References
12.	Visual Aids	2.12 Visual Aids
CHAPTER 3 – SYSTEM DESCRIPTION		
13.	Module Final Assembly Line Summary	3.1 Module Final Assembly Line Summary
14.	Module Final Assembly Line Utilities	3.2 Module Final Assembly Line Utilities
15.	Battery Pack Assembly System Layout	3.3 Battery Pack Assembly System Layout
16.	Module Final Assembly Line Layout	3.4 Module Final Assembly Line Layout
17.	Module Input VTU Equipment	3.5 Module Input VTU (EX010) Equipment
18.	Post Tab Bend Equipment	3.6 Post Tab Bend (EX020) Equipment
19.	Tab Weld Equipment	3.7 Tab Weld (EX070) Equipment
20.	Pulse Phase Thermography Equipment	3.8 Pulse Phase Thermography (EX110) Equipment
21.	Module Electrical Test Equipment	3.9 Module Electrical Test (EX140) Equipment
22.	Module Cover Install Equipment	3.10 Module Cover Install (EX190) Equipment
23.	Module Transfer Equipment	3.11 Module Transfer (EX280) Equipment
24.	Module Return VTU Equipment	3.12 Module Return VTU (EX500) Equipment
CHAPTER 4 – SYSTEM OPERATION		
25.	Operator Interface Devices	4.1 Operator Interface Devices
26.	HMI Screens	4.2 HMI Screens
27.	Inspecting the Line	4.3.1 Inspecting the Line
28.	Starting an Automatic Cycle	4.3.2 Starting an Automatic Cycle

Number	Task Description	Manual Reference Location
29.	Stopping a Cycle	4.3.3 Stopping a Cycle
30.	Shutting Down	4.3.4 Shutting Down
31.	Recovering from an Emergency Stop	4.3.5 Recovering from an Emergency Stop
32.	Recovering from a Fault	4.3.6 Recovering from a Fault
33.	Opening and Closing an Entrance Gate	4.3.7 Opening and Closing an Entrance Gate
34.	Loading Components	4.3.8 Loading Components
35.	Modes of Operation	4.4 Modes of Operation
36.	System Backup and Recovery	4.5 System Backup
CHAPTER 5 – MAINTENANCE		
37.	General Service Guidelines	5.1 General Service Guidelines
38.	Hazardous Energy Guidelines	5.2 Hazardous Energy Guidelines
39.	Lockout/Tagout Instructions	5.3 Lockout/Tagout Instructions
40.	Preventive Maintenance Tasks	5.4 Preventive Maintenance Tasks
41.	Lubrication Points	5.5 Lubrication Points
42.	Maintenance Task Instruction Sheets	5.6 Maintenance Task Instruction Sheets
43.	Third-party Equipment Manuals	5.7 Third-Party Equipment Manuals
CHAPTER 6 – TROUBLESHOOTING		
44.	Part Faults	6.1.1 Part Faults
45.	Moving Device Faults	6.1.2 Moving Device Faults
46.	Sensor Faults	6.1.3 Sensor Faults
47.	Pneumatic Faults	6.1.4 Pneumatic Faults
48.	Air Cylinder Faults	6.1.5 Air Cylinder Faults
49.	Solenoid Faults	6.1.6 Solenoid Faults
50.	Gripper Faults	6.1.7 Gripper Faults
51.	Air Pressure Faults	6.1.8 Air Pressure Faults
52.	Conveyor Faults	6.1.9 Conveyor Faults
53.	Servo Motor Faults	6.1.10 Servo Motor Faults
54.	Vision Faults	6.1.11 Vision Faults
55.	Processor Faults	6.1.12 Processor Faults
56.	Common Fault Troubleshooting	6.2 Common Fault Troubleshooting
CHAPTER 7 – ASSEMBLY AND DISASSEMBLY		
57.	Pallet Locating Posts	7.1 Pallet Locating Posts
58.	EX020 Tab Bend Tooling	7.2 EX020 Tab Bend Tooling
59.	EX070 Weld Contact Tooling Tool Block	7.3 EX070 Weld Contact Tooling Tool Block
60.	EX190 Cover Install Robot End of Arm Tooling	7.4 EX190 Cover Install Robot End of Arm Tooling

Number	Task Description	Manual Reference Location
61.	EX190 Cover Delivery Robot End of Arm Tooling	7.5 EX190 Cover Delivery Robot End of Arm Tooling
62.	EX280 Module Transfer Robot End of Arm Tooling	7.6 EX280 Module Transfer Robot End of Arm Tooling
CHAPTER 8 – INSTALLATION		
63.	Long Term Storage	8.1 Long Term Storage
64.	Commissioning	8.2 Commissioning
65.	Lifting Points	8.3 Lifting Points
66.	Connection Points	8.4 Connection Points
67.	Module Final Assembly Line Utilities	8.5 Utilities
68.	Decommissioning	8.6 Decommissioning
69.	Packing and Moving	8.7 Packing and Moving
70.	Disposal	8.8 Disposal
CHAPTER 9 – PROCESS PARAMETERS		
71.	Module Input VTU Parameters	9.1 EX010 Module Input VTU Parameters
72.	Post Tab Bend Parameters	9.2 EX020 Post Tab Bend Parameters
73.	Tab Weld Parameters	9.3 EX070 Tab Weld Parameters
74.	Pulse Phase Thermography Parameters	9.4 EX110 Pulse Phase Thermography Parameters
75.	Module Electrical Test Parameters	9.5 EX140 Module Electrical Test Parameters
76.	Module Cover Install Parameters	9.6 EX190 Module Cover Install Parameters
77.	Module Transfer Parameters	9.7 EX280 Module Transfer Parameters
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2. SAFETY

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2.1. BATTERY SAFETY OVERVIEW

WARNING!

Refer to the SDS for the Lithium-Ion Polymer Battery. Be aware of all hazards, air measures, fire hazards, leakage, handling and storage, toxicological data, environmental effects, and transportation requirements. Severe injury or potential harmful exposure is possible if these warnings are not followed.

WARNING!

Do not touch any battery from this line with two hands. Battery voltage may be lethal. Always assume a battery is charged. Follow all warnings and related safety procedures as described by your company. Severe injury or death may occur if this warning is not followed.

System personnel must comply with the following safety rules:

- Only have one hand touching the battery at any time.
- Never reach across the battery for any reason.
- Always wear appropriate personal protective equipment.
- Remove or properly cover all personal metal objects (watches, rings, earrings, necklaces, badges, and belt buckles).
- Never touch anyone working on a battery.
- Never distract anyone working on a battery.
- Keep all battery terminals covered except when needed for operations.

2.2. HEALTH AND SAFETY STATEMENT

Operate all assemblies, electrical components, and parts of this cell with care. Routinely inspect and maintain the cell as described in section 5.4 “Preventive Maintenance”.

Automation Tooling Systems (ATS) makes every effort to design and integrate automation systems that operate in a safe and predictable manner.

Each system employs safety devices that reduce the risk of personal injury. These devices include, but are not limited to, guarding around moving devices, emergency stop controls, and status indicators. It is the customer’s responsibility to ensure that personnel using the system are properly trained in the system’s operating, safety, and emergency procedures, industry safety standards (OSHA/OHSA) and to ensure that these procedures and practices are adhered to.

Any system modifications (including software and hardware) not authorized by Automation Tooling Systems may affect the safe operation of the system and result in personal injury.

Failure to meet these responsibilities or any unauthorized attempt to modify the system will void ATS-provided warranties.

2.3. GENERAL SAFETY GUIDELINES

The general safety guidelines, outlined below, are an overview of the safety topics covered in this section. While these guidelines provide information that will help prevent personnel injury and damage to equipment, read the entire section for a thorough understanding of safety practices and specific devices related to this equipment.

- Read this entire manual and become thoroughly familiar with the cell operation before working on any part of the cell
- Adopt good work habits regarding safety when working on or around the cell
- Avoid working on the cell when poor physical or mental health may affect job-related judgment
- Always dress properly for the job and use appropriate sight and hearing protection
- Always maintain a clean and safe work area
- Read and obey all signs posted on and around the cell
- Know the location of all Energy Control and Power Lockout (ECPL) placards and properly follow all posted procedures
- Use tools properly and safely whenever working on the cell
- Follow all Electrical and Mechanical System safety precautions outlined in this manual and dictated by plant safety specifications.
- Follow all System Operating Safety precautions outlined in this manual.
- Become thoroughly familiar with the location and function of all safety devices on the system including EMERGENCY STOP pushbuttons and lockout valves.

2.4. PERSONAL SAFETY

2.4.1. Overview

Accidents do not occur as the result of a single cause, but may occur because of an interaction between working conditions, human error, and other events. Given the complexity of machine technology, some accidents will inevitably occur. However, an error in judgment will always be the weakest link in the chain of events leading to an accident. Even under the best circumstances, judgment is affected by:

- Knowledge (and lack of knowledge) of the cell and peripheral equipment
- Personal work habits on the job
- Physical and mental fitness on the job

2.4.2. Knowledge First

It is vitally important for anyone working on the cell to become thoroughly familiar with its operation before working with it. Knowledge of the cell will help to avoid accidents. Read and understand all safety instructions before setting up, operating, maintaining, or servicing the cell. Know the location and function of all safety devices provided with the cell and check regularly to ensure their proper operation.

2.4.3. Work Habits

Personal safety combines knowledge, positive attitudes, and good work habits into a proactive awareness of potential hazards. Safe actions occur when an awareness of the importance of safety is combined with an understanding of tasks and becomes part of daily work habits on the job.

You have a responsibility to conduct your daily work actions safely. Adopt a professional attitude toward safety and develop personal safety skills you can depend on – for life!

2.4.4. Fitness for Duty

"Fitness for duty" is the state of being physically and mentally fit to perform job-related duties. It is important to reduce or eliminate anything that impairs job-related judgment.

Alertness is essential for sound judgment, and nothing affects alertness more adversely than fatigue. Several causes are:

- Lack of sleep – The most common cause of fatigue; continued loss of sleep causes increased nervousness and decreased reaction time. The ability to react quickly to a situation is affected
- Poor eyesight – Tired eyes lead to drowsiness, decrease your depth perception, and reduce field of vision
- Emotional stress – A buildup of emotional stress causes tension, irritability, and mental distraction
- Anger – If not managed appropriately, it causes drowsiness, impairs concentration and job performance
- Physical problems – Even minor ailments (headache, indigestion, sore throat) and other conditions-such as consuming a heavy meal can impair judgment, cause sluggishness, or make you drowsy
- Drug and alcohol use – The resulting drowsiness, nausea, or dizziness dulls reflexes and turns you into an "accident waiting to happen"

2.4.5. Dressing for Safety

Unless plant safety specifications indicate otherwise, always observe the following guidelines:

- Do not wear loose or baggy clothes. They should fit close to the body, *but not so tight as to hinder free movement*.
- Do not wear ties or scarves around the system at any time.
- Do not wear jewelry such as rings, bracelets, and necklaces around the system at any time. Medical alert jewelry should be worn with caution.
- Do not wear gloves unless handling hot, rough, or sharp surfaces.
- Wear shoes approved by plant safety specifications.
- Wear the correct protective clothing, especially when a job calls for it.
- Tie back long hair or restrain it with a cap or net.
- Wear a hard hat or other appropriate protection when a job requires it or where a risk of falling objects may exist.

2.4.6. Eye Protection

To reduce the risk of eye injury, wear the proper eye protection. Choose eye protection equipment that will best protect your eyes against an injury that may result from the type of work being performed. Unless plant safety specifications indicate otherwise, safety glasses with side shields will be sufficient for normal system operation. Always keep eyewear clean.

2.4.7. Hearing Protection

To reduce the risk of long-term hearing damage, use hearing protection appropriate for the job. Choose hearing protection equipment (foam ear plugs, padded headset) that protects against noise levels produced by the cell and surrounding equipment. However, do not select hearing protection that will totally muffle all noise. During cell operation, it is important to hear any unusual noises that may indicate a problem. Check with your plant safety specifications to determine the best hearing protection for the job and the area where the job is performed.

2.4.8. Head Protection

To reduce the risk of damage to your head, wear a bump cap when working under equipment, within an automated cell, and when appropriate for the job. Check with your plant safety specifications to determine the best bump cap for the job and the area where the job is performed.

2.4.9. Foot Protection

To reduce the risk of damage to your feet, wear safety-rated steel toed shoes appropriate for the job. Check with your plant safety specifications to determine the best shoes for the job and the area where the job is performed.

2.5. WORK AREA SAFETY

2.5.1. Cleanliness

Keep work areas clean and free of hazardous obstructions. Be aware of protruding machine components. Keep floors clean and dry. Clean up chemical (cleaning solvent, beverage) and process fluid (hydraulic oil) spills immediately. Follow plant-approved procedures to clean up all spills.

2.5.2. Warning Signs

Warning signs are posted to alert workers of hazardous conditions. Observe all warning signs when working on/around the cell. Warning signs should always be clearly visible. Do not cover, paint over, alter or deface signs, or remove them from the cell. Replace signs that become unreadable.

2.5.3. Traffic Areas

Aisles, pathways, and catwalks must be kept clear of obstructions to allow free movement in all directions. Do not block their access with items such as boxes, tool chests or ladders. This is especially true in case of an emergency, where rescue personnel must have quick access to an injured worker.

2.5.4. Unsafe Conditions

Immediately report any unsafe working conditions to your supervisor or safety department. Faulty safety devices, damaged hoses, and loose or broken parts all pose a safety hazard. Report all fluid leaks (oil) and unusual odors (excessive vapors, overheated metal).

2.5.5. Cell Guarding

The guarding used in the BET/BEV3 Module Final Assembly Line forms a protective housing around automated equipment that allows for safe operation. The guarding is comprised of a metal framework fitted with fixed guarding panels, light curtains, and safety-interlocked guarding doors. The guarding should never be removed or modified except by qualified technicians familiar with the cell.

2.5.6. Conveyor Safety

Operators and maintenance personnel must be aware of all safety hazards before operating or maintaining any of the line conveyor equipment.

REFERENCE

For more information about the conveyance equipment, refer to the equipment supplier documentation (Bosch Belt Section BS 2 pg. 2, Bosch BS 2C-…, BS 2R… Belt Sections Assembly Instructions pg. 8-11, Bosch HQ 2U Lift Transverse Unit Assembly Instructions pg. 7-10, Bosch PE 2X Positioning Unit Assembly Instructions pg. 7-10).

2.5.7. Working at Heights Safety

Working at heights means that Personnel are working in a place that requires necessary precautions to prevent them from falling at a distance and injuring themselves. Working at heights precautions are outlined below:

- Ensure all Personnel are trained for working at heights.
- Perform as much work as possible at ground level before working at heights.
- Inspect work area for hazards, possible falling objects, and that the work area is suitable for working at heights.
- Ensure Personnel can move safely to and from the work area while they are working at height.
- Ensure equipment used for working at heights (harasses, elevated platforms, ladders, etc.) are suitable for the task.
- All equipment used for working at heights should be inspected before each use.
- Ensure emergency procedures are in place before beginning work.
- Ensure to use appropriate anchor points for fall arresting equipment.
- Do not overload equipment with personnel, tools, and materials.
- Do not reach too far, twist, or extend from equipment.

NOTE

Consult your GM Working at Heights training and manuals for a proper understanding of Working at Heights.

2.6. ECPL PLACARDS AND TAGS

Energy Control and Power Lockout (ECPL) placards identify the primary, associated, and stored energy or power sources of the cell. The ECPL placard(s) are usually located on the main electrical enclosure. Color-coded lockout tags corresponding to the source icons (such as E-1, A-1) on the placard help locate the same sources on the cell. These tags are mounted near, or hanging directly on, the energy and power source locations.

2.7. TOOL USAGE

Tool usage safety guidelines, as they apply to the cell, are as follows:

- Do not leave any tools (hand or electric) on or around the cell. Any machine vibration may cause tools to fall into moving automation and cause extensive damage.
- When repairing or adjusting any part of the cell, use the proper tool for the job. The incorrect size or type of tool may damage the cell components.

2.8. MACHINE SAFETY

2.8.1. Electrical Safety

Electrical safety precautions are outlined below:

- Cell troubleshooting or maintenance should be performed only by qualified technicians familiar with the cell, using an up-to-date set of cell schematics.
- Before performing maintenance or service on any part of the Electrical System, perform all applicable ECPL procedures. Before proceeding, verify that power is removed from all circuits.

WARNING! ***Before working on electrical or mechanical problems with the cell (whenever possible), place the MAIN DISCONNECT SWITCH in the OFF position and lockout the switch. Severe injury or death may occur if this warning is not followed.***

- If it is necessary to perform troubleshooting with the power on, know where power is present and proceed with extreme caution. Whenever possible, use electrically insulated tools.
- When servicing electrical enclosures, follow all PPE (personal protective equipment) requirements per posted arc flash warnings in accordance with plant safety specifications.
- Always use an appropriate fuse puller. Never attempt to replace a specified fuse with a higher-rated fuse (such as replacing a 5-amp fuse with a 10-amp fuse).

2.8.2. Pneumatic Safety

Pneumatic safety precautions are outlined below:

- Cell troubleshooting or maintenance should be performed only by qualified technicians familiar with the cell, using an up-to-date set of cell schematics.
- Before performing maintenance or service on the Pneumatic System, shut off the air supply at the main shutoff valve and bleed air from pneumatic lines. Perform all applicable ECPL procedures.
- Purge from pneumatic lines any trapped air that was not relieved by performing the ECPL procedure(s); for example, air trapped by a pilot-operated check valve.
- Use extreme caution around automation (such as clamps, slides, or lifts) that may move when air is relieved from the cell. Before relieving air from lines, secure all such automation.
- Avoid manually actuating solenoid valves, especially if others are working in the area.

WARNING! ***The inherent danger of electrical energy is well known. Similarly, compressed air energy is powerful and may also be very dangerous. Before attempting to remove a component from an air line, always disconnect the supply air and thoroughly exhaust the line or system. Failure to heed the following precautions could result in serious, even fatal, personal injury.***

2.8.3. Mechanical Safety

Mechanical safety precautions are outlined below:

- Mechanical maintenance, adjustments or repairs should be performed only by qualified technicians familiar with the cell.

- Before performing any maintenance or repairs on an upper platen, ensure safety pins are properly placed. Refer to the ECPL placard if such conditions exist.
- If mechanical service does not require cell power, perform the appropriate ECPL procedures to disconnect or dissipate energy sources.
- Keep all moving parts of machinery and surrounding areas free of rags, dirt, and excessive oil or metal debris.
- Before operating any moving machinery, all protective guards must be in place and secured.

2.8.4. Laser Safety

2.8.4.1. Laser Safety Compliance

ATS Ohio certifies that the Class 4 lasers utilized in this machine (when operated as instructed in this User Manual) complies with all applicable laser safety regulations as administered by the Center for Devices and Radiological Health (CDRH). A Laser Product Report was submitted for the purposes of reporting and recordkeeping as required by the CDRH (see 21 CFR 1000-1040.11 and related sections in 21 CFR 1000-1010).

2.8.4.2. General Laser Safety Warnings

In addition to the warnings found in this manual, read through the warnings and safety precautions sections in the Trumpf manuals provided for the laser. Operators and maintenance personnel must be aware of all safety hazards before operating or maintaining the laser or any equipment in or near the laser. Use the following warnings as a general guide for laser safety:

- Misuse of the controls or adjustments, or performance of procedures other than those specified in this manual and the Trumpf manuals may result in hazardous radiation exposure and electrical risks.
- The laser emits invisible infrared laser radiation. Since direct or diffuse laser radiation can inflict severe corneal injuries, always wear eye protection when in the same area as an exposed laser beam. Eyewear protects against scattered energy and is not intended to protect against direct viewing of the beam or reflections from metallic surfaces.
- Direct viewing of a laser beam can cause irreversible damage to eyesight. Laser radiation is invisible but if a person stands close enough to the visibility threshold, the eye receives it almost completely. Direct viewing of the laser beam should absolutely be avoided. A collimator focuses the laser energy right at the exit of the nozzle.
- If the skin is exposed to direct focused radiation, it could burn.
- DO NOT place materials inside the machine other than those specifically designed for the machine. Any material placed inside the laser radius other than that specifically designed may result in damage, radiation, or fire.
- DO NOT open the laser power supply unit for any reason. Dangerous voltage is present even when the power supply is disconnected from the main supply.
- The laser system is sealed in certain points. These seals MUST NOT be broken or removed for any reason.
- Refer to and follow the laser safety precautions in ANSI Z136.1-199, American National Standard for Safe User of Lasers. Procedures listed under the Standard include appointment of a Laser Safety Officer, operation of the product in an area of limited access by trained personnel, servicing of equipment only by trained and authorized personnel, and posting of signs warning of the potential hazards.

2.8.4.3. Laser Warning Signs

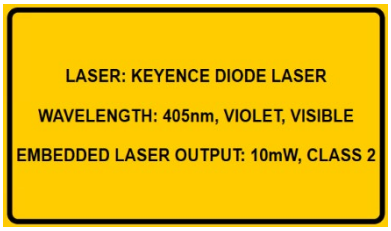
Laser warning signs alert operators to the hazards present in the system. This section provides illustrations and information about the laser labels around the system.

REFERENCE

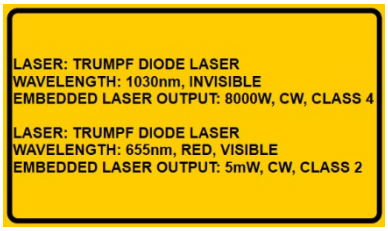
For information about the labels on the actual laser, refer to the literature supplied by Trumpf (Trumpf – Operator's Manual TruDisk 1000-8002 Chapter 1 pg. 19-28).

This symbol is located on the laser to warn of laser radiation hazards.

This sign is located on each guard door and opening to warn of laser radiation hazards.

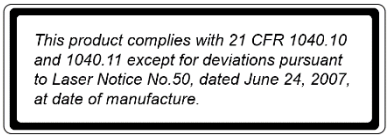


This sign is located on each guard door and opening to warn of laser radiation hazards.



This sign is located on each guard door and opening to warn of laser radiation hazards.

This sign is located on the main PDP enclosure to identify the product and CDRH accession number.

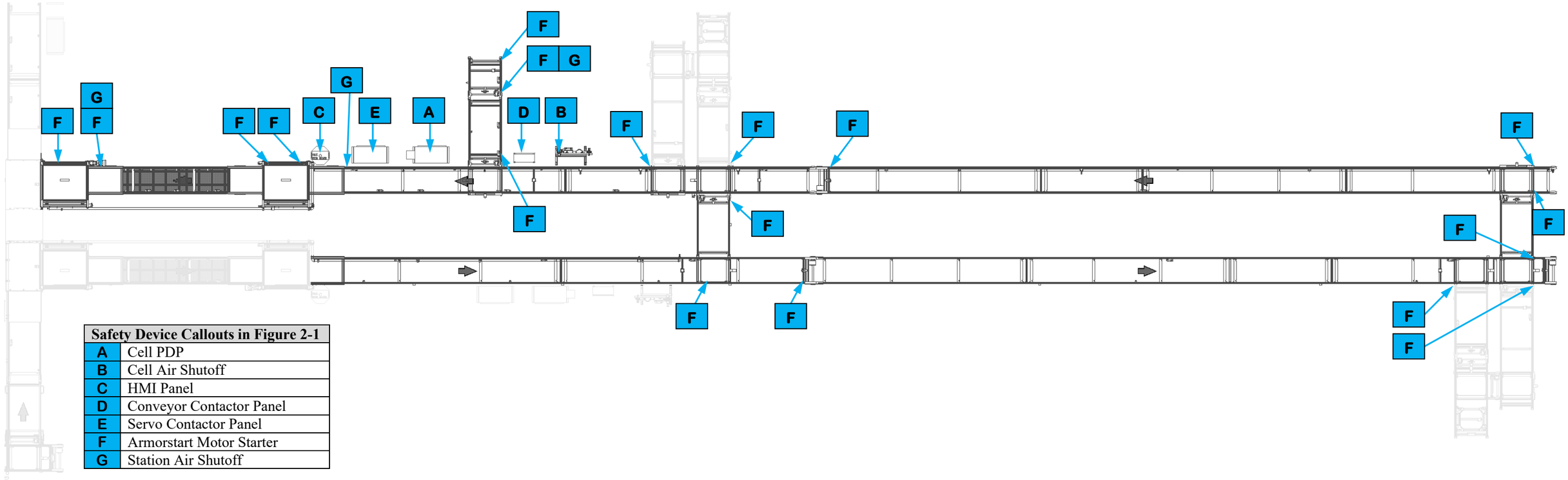


This sign is located on the main PDP enclosure to indicate compliance with CDRH regulations.

2.9. SAFETY DEVICE SUMMARY

The figures that follow identify the locations of the various safety devices used in each of the work cells. Section 2.10 describes each of these safety devices. Refer to the cell Energy Control Lockout Placards for specific information about the energy control devices.

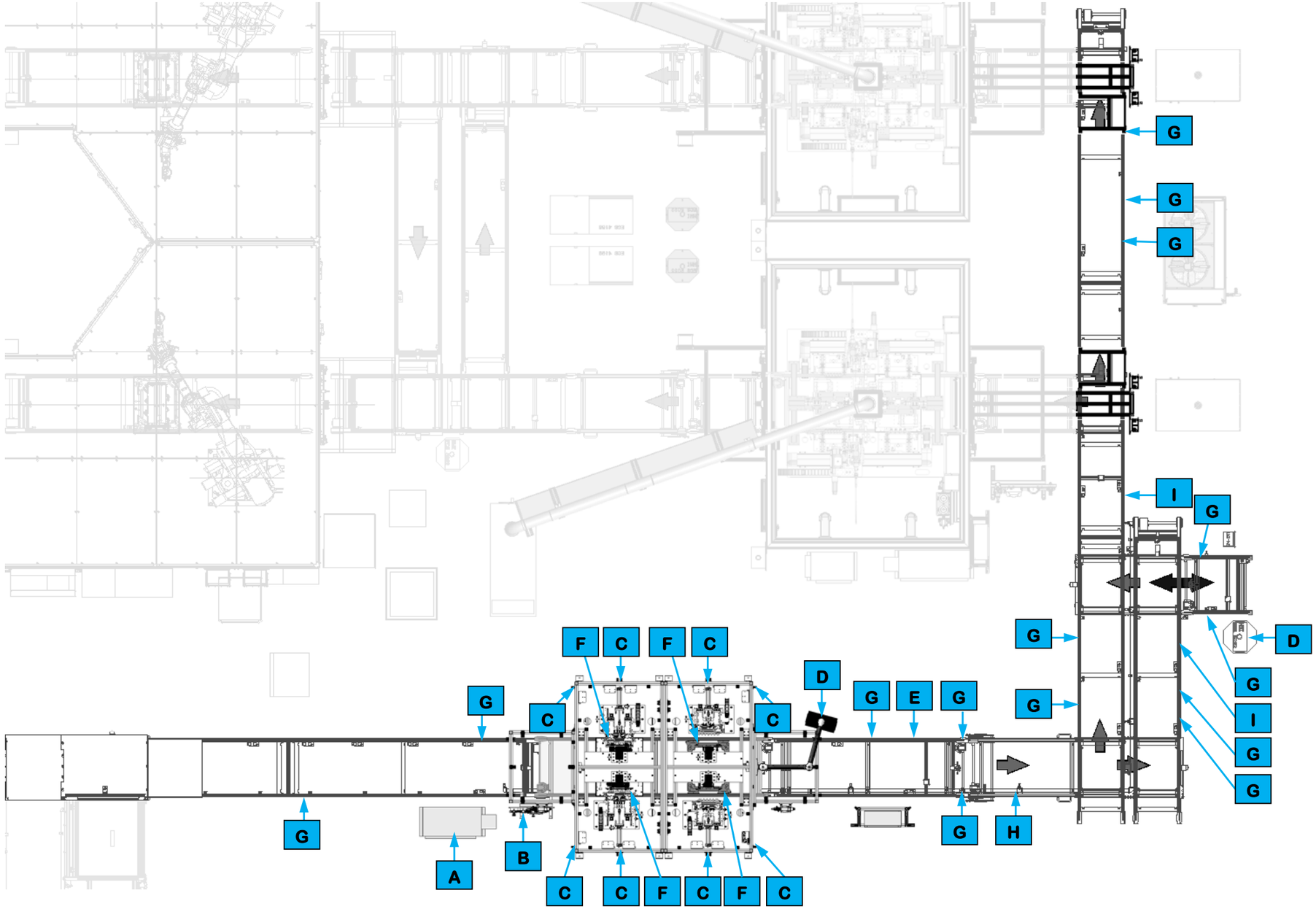
2.9.1. Module Input VTU Safety Devices



Safety Device Callouts in Figure 2-1	
A	Cell PDP
B	Cell Air Shutoff
C	HMI Panel
D	Conveyor Contactor Panel
E	Servo Contactor Panel
F	Armorstart Motor Starter
G	Station Air Shutoff

Figure 2-1. Module Input VTU safety device locations.

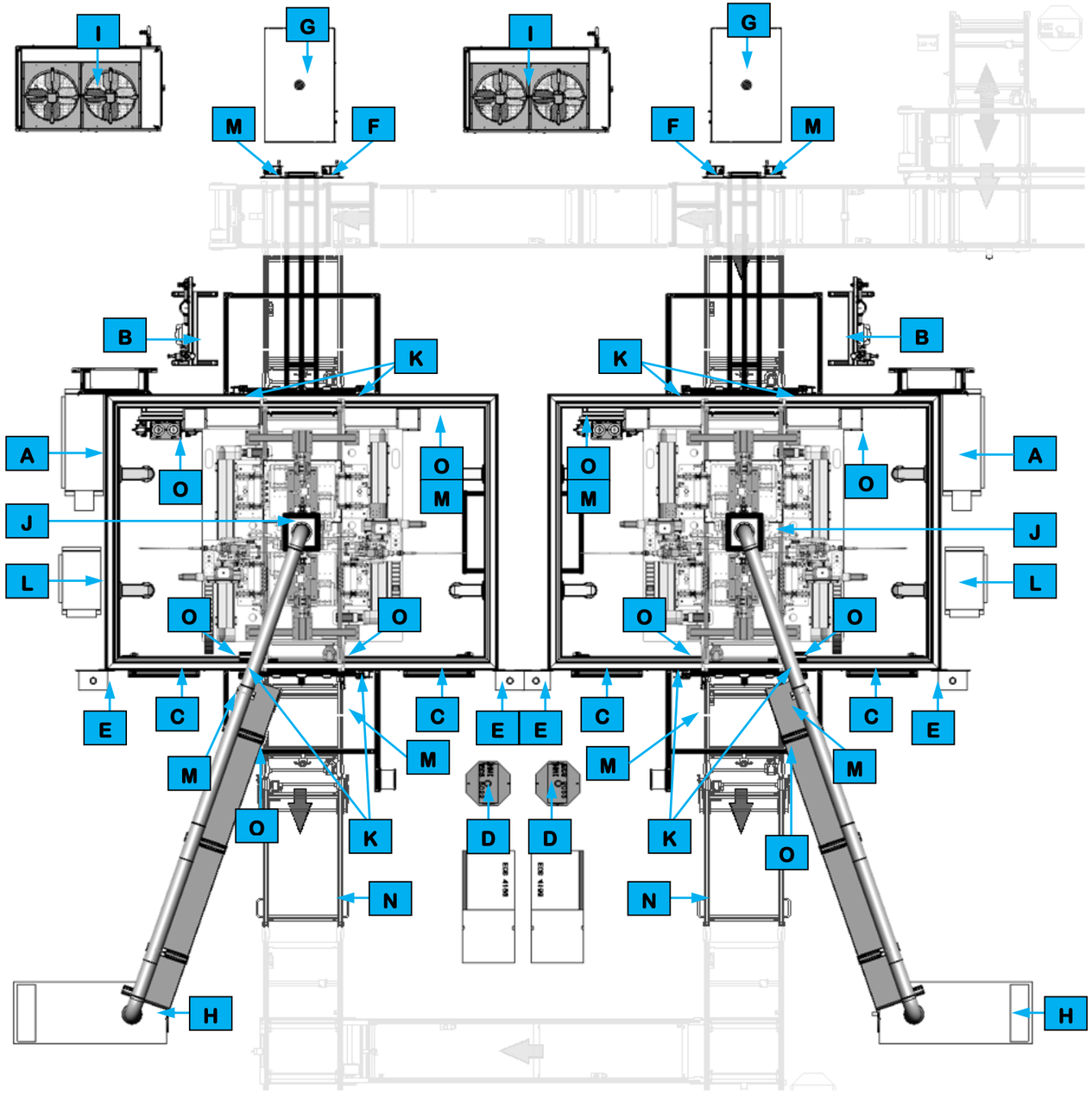
2.9.2. Post Tab Bend Safety Devices



Safety Device Callouts in Figure 2-2	
A	Cell PDP
B	Cell Air Shutoff
C	Guard Door
D	HMI
E	Conveyor Contactor Panel
F	Gravity Pin
G	Armorstart Motor Starter
H	Conveyor Lift Gate
I	Station Air Shutoff

Figure 2-2. Post Tab Bend safety device locations.

2.9.3. Tab Weld Safety Devices



Safety Device Callouts in Figure 2-3	
A	Cell PDP
B	Cell Air Shutoff
C	Entrance Gate
D	PHMI Panel
E	Entrance Gate Box
F	Conveyor Contactor Panel
G	Laser Controller
H	Torit Air Handler
I	Riedel Chiller
J	Flame Detector
K	Gravity Pin
L	Servo Contactor Panel
M	Armorstart Motor Starter
N	Conveyor Lift Gate
O	Station Air Shutoff

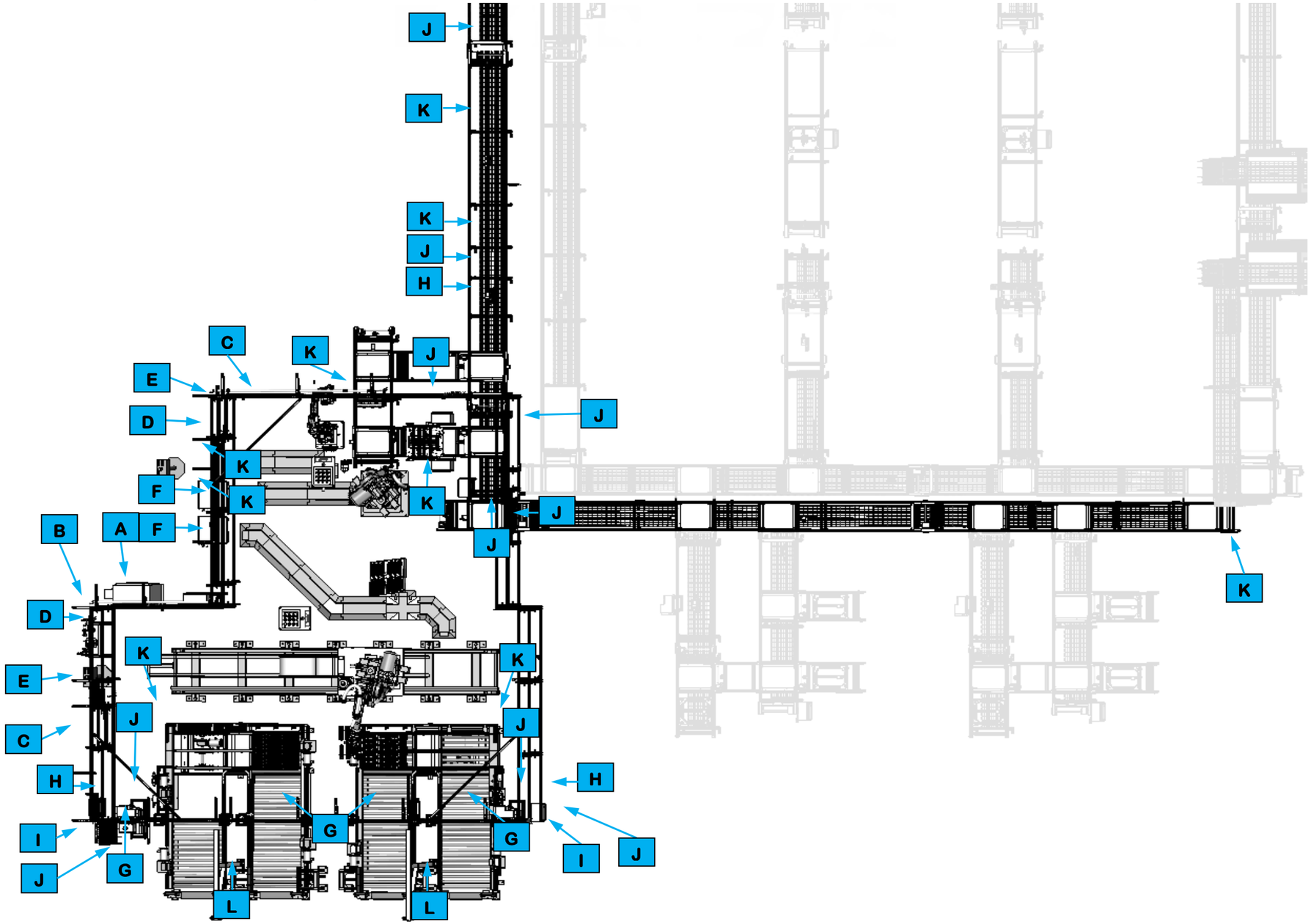
Figure 2-3. Tab Weld safety device locations.

2.9.4. Pulse Phase Thermography / Module Electrical Test Safety Devices

NOTE

The PPT and Module Electrical Test equipment was not supplied by ATS Ohio. Refer to the Pulse Phase Thermography and Module Electrical Test EX110 and EX140 Operation and Maintenance Manual for information about the safety devices used in that equipment.

2.9.5. Module Cover Install Safety Devices



Safety Device Callouts in Figure 2-4	
A	Cell PDP
B	Cell Air Shutoff
C	Entrance Gate
D	HMI Panel
E	Entrance Gate Box
F	Robot Controller
G	Light Curtain
H	Conveyor Contactor Panel
I	Safety Device Junction Box
J	Armorstart Motor Starter
K	Station Air Shutoff
L	Conveyor Pull Cord

Figure 2-4. Module Cover Install safety device locations.

2.9.6. Module Transfer Safety Devices

Safety Device Callouts in Figure 2-5	
A	Cell PDP
B	Cell Air Shutoff
C	Entrance Gate
D	HMI Panel
E	Entrance Gate Box
F	Robot Controller
G	Light Curtain
H	Conveyor Contactor Panel
I	Safety Device Junction Box
J	Armorstart Motor Starter
K	Station Air Shutoff
L	Conveyor Pull Cord

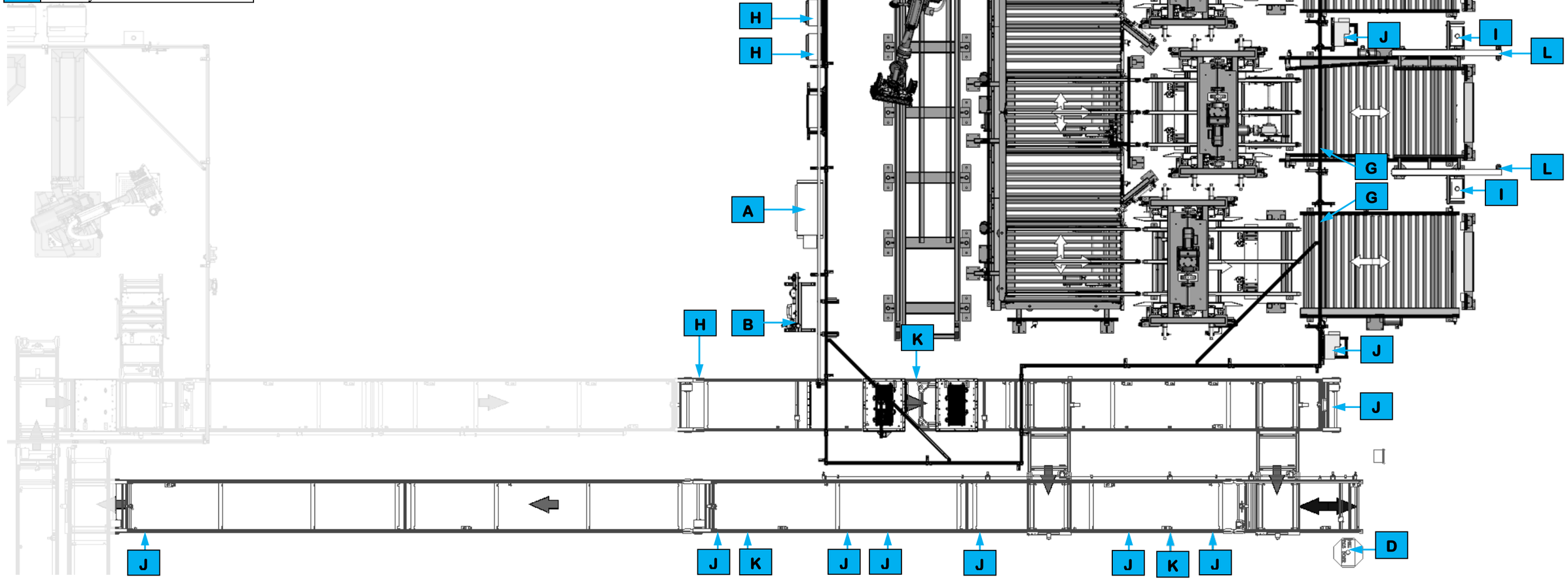


Figure 2-5. Module Transfer safety device locations.

2.9.7. Module Return VTU Safety Devices

Safety Device Callouts in Figure 2-6	
A	Cell PDP
B	Cell Air Shutoff
C	HMI Panel
D	Conveyor Contactor Panel
E	Servo Contactor Panel
F	Armorstart Motor Starter
G	Station Air Shutoff

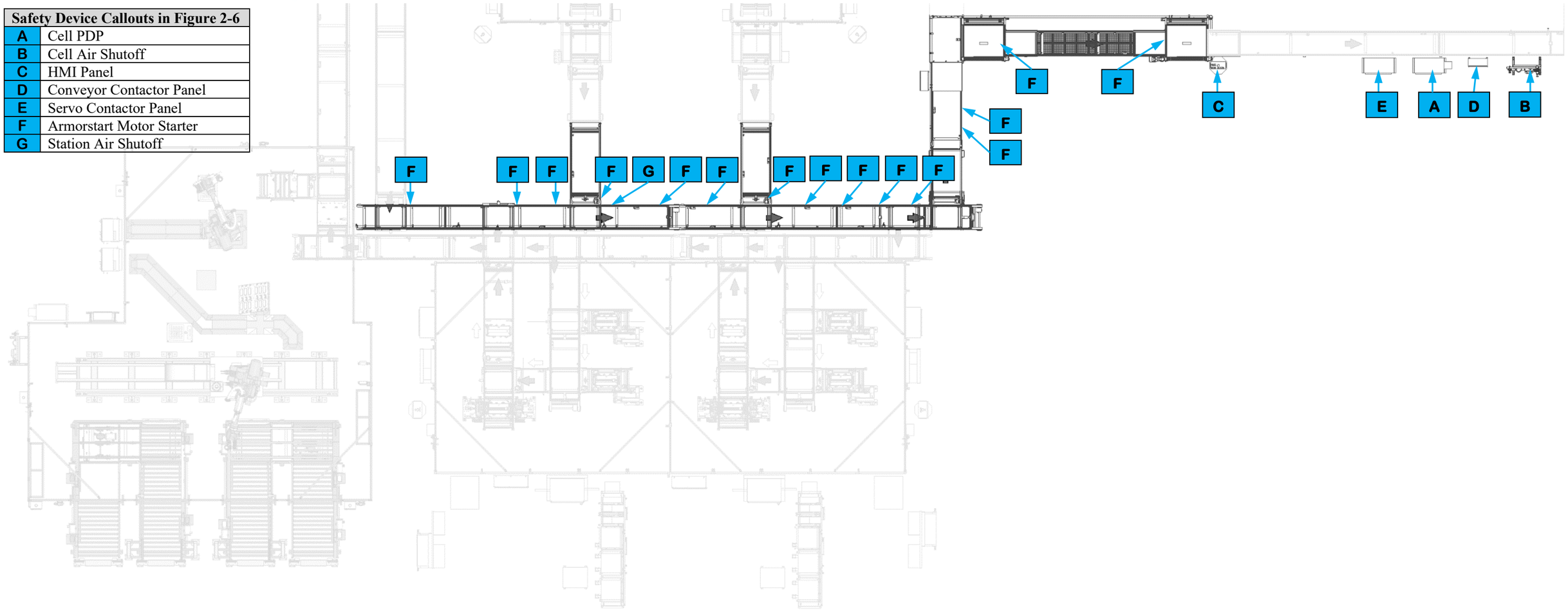


Figure 2-6. Module Input VTU safety device locations.

2.10. ENERGY CONTROL DEVICE DESCRIPTIONS

There are many different types of energy control devices used throughout the system. Some of the devices include lockable disconnects and are part of the Energy Control and Power Lockout (ECPL) program. Lockable devices are shown on the ECPL placards affixed to each of the main PDP enclosures. The section that follows describes the various energy control devices, their locations (also reference ***Figure 2-1*** through ***Figure 2-1*** on the previous pages), and their uses.

2.10.1. Cell Power Distribution Panel

Each cell has a single Power Distribution Panel (PDP) that is used to distribute control power to the related equipment and to communicate with the cell processor. The PDP features indicators that illuminate to identify when control power is on. A fused disconnect (Lockout Point E-1) is located on the outside of the PDP and is used to enable or disable control power for the cell. Inside the PDP is an additional disconnect (Lockout Point E-2) that provides auxiliary power control. Refer to the GM standards and to the ATS electrical drawings for more information about the PDP equipment and functionality. Refer to the ECPL placards on each PDP for information about locking out the cell energy sources.

2.10.2. Cell Main Pneumatic Disconnect

Each cell requires compressed air and has its own air processing equipment that processes air supplied from the plant and distributes the processed air to the cell equipment. The air processing equipment has a shutoff valve (Lockout Point A-1) that removes the flow of processed air from the plant through the cell equipment. Turning the valve to the off position disconnects air pressure to the cell valve packs and vents the pressure through a muffler. A lockout hole in the handle of the valve allows a lock to be installed for energy control purposes. Refer to the ECPL placards on each PDP for information about locking out the cell energy sources.

2.10.3. Entrance Gate Door

Most of the cell devices are surrounded by guarding that prevents unauthorized (and unsafe) access to the equipment while it is in operation. Guard doors are incorporated in various locations around the guarding to provide access to the equipment when necessary.

Each guard door is equipped with an interlock switch and slide bar. The slide bar helps hold the door closed. The interlock switch detects when the slide bar is removed and signals the system processor. The processor then removes control power and air from the appropriate equipment. The guard doors are part of the cell safety circuit, along with EMERGENCY STOP buttons and other safety devices.

WARNING!

The interlock circuit is used as a safety precaution to prevent personnel from injury due to sudden mechanism movement. Never attempt to defeat or bypass an interlock switch, an interlock device, or any part of the interlock circuit. Failure to observe this warning may result in serious injury or death.

REFERENCE

For more information about the interlock switch, refer to the equipment supplier documentation (Fortress – amGardpro Guard Switch Operating Instructions pg. 1-3, Fortress – Stainless amGardpro Slidebar Operating Instructions pg. 1-3).

2.10.4. HMI/PHMI Panels

Each cell has one or more HMI panels (or Portable HMI panels) that personnel use to interface with the cell. Each HMI panel features an EMERGENCY STOP button that can be used to immediately stop all cell equipment. The EMERGENCY STOP button immediately removes control power from the cell. The EMERGENCY STOP button requires the button to be pulled back out after it has been pressed in. After pressing an EMERGENCY STOP button, follow the recovery procedure outlined in Chapter 4.

WARNING!

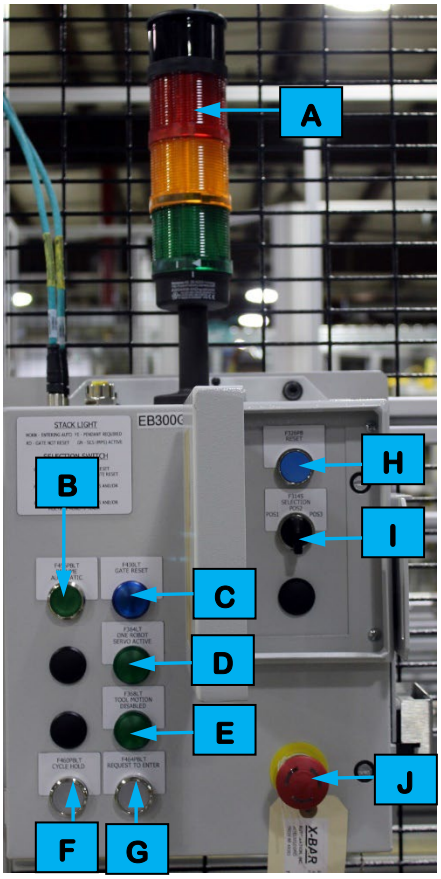
Press an EMERGENCY STOP ***button to immediately stop movement of all mechanisms. Ensure that all movement has stopped before entering the cell. Follow procedures taught in your GM-UAW Lockout class. Severe injury or death may occur if this warning is not followed.***

2.10.5. Entrance Gate Box

Each cell has an entrance gate box (see ***Figure 2-7***) at each guard door. Each gate box provides numerous controls, used as follows.

NOTE

Consult your GM-UAW Lockout training for a proper understanding of the MPS system. Chapter 4 details the procedure for using the Gate Box.



Device Callouts in Figure 2-7	
A	Stack Light indicators
B	RESUME AUTOMATIC button
C	Gate Reset indicator
D	One Robot Servo Active indicator
E	Tool Motion Disabled indicator
F	CYCLE HOLD button
G	REQUEST TO ENTER button
H	RESET button
I	SELECTION toggle switch
J	E-STOP button

Figure 2-7. An illustration of an entrance gate box.

Stack Light Indicators

On top of the entrance gate box is a stack light (see **A** in ***Figure 2-7***) with three colored indicator lights and a horn. The lights and horn are used to indicate the status of the gate reset relay and the MPS system. When activated, each indicator identifies the following condition:

- Red Indicator (Flashing) – gate is not reset
- Yellow Indicator (Solid) – hazardous motion has been enabled and pendant is required
- Green Indicator (Solid) – MPS system is active, all hazardous motion has been disabled
- Horn – entering automatic mode

RESUME AUTOMATIC button

The RESUME AUTOMATIC button (see **B** in ***Figure 2-7***) is used to restart the cell after the safety system is reset and all other control devices have been placed in the proper state for automatic operation. An indicator light inside the button can illuminate solid, flash off and on, or go dark to indicate the following:

- Steady On – all stations are in auto
- Normal Flash – all stations are ready for auto
- Rapid Flash – at least one station is not in auto or is not ready for auto

- Off – no stations are in auto or are not ready for auto

Gate Reset Indicator

The Gate Reset indicator (see **C** in ***Figure 2-7***) illuminates to indicate the gate is closed and reset.

One Robot Servo Active Indicator

The One Robot Servo Active indicator (see **D** in ***Figure 2-7***) illuminates to indicate the gate is not reset, one of the robot servo contactors has been successfully enabled, an any other robots are disabled by the Entrance Gate Box.

Tool Motion Disabled Indicator

The Tool Motion Disabled indicator (see **E** in ***Figure 2-7***) illuminates to indicate when the gate is not reset and the tool outputs are disabled by the entrance gate box.

CYCLE HOLD Button

The CYCLE HOLD button (see **F** in ***Figure 2-7***) stops the cell after the cycle has been completed. Inside the button is a white indicator that flashes when the button is pressed and turns solid when the cell has come to rest at the end of the cycle. The indicator will also flash if the Position Selector is not in "Pos1" after closing and resetting the Entrance Gate Box.

REQUEST TO ENTER Button

The REQUEST TO ENTER button (see **G** in ***Figure 2-7***) stops the cell after the cycle has been completed. Inside the button is a white indicator that flashes when the button is pressed and turns solid when the cell has come to rest at the end of the cycle. Once the cycle is complete and all devices have come to a stop and the button is solid, the gate can be opened. The indicator will also flash if the Position Selector is not in "Pos1" after closing and resetting the Entrance Gate Box.

RESET Button

The RESET button (see **H** in ***Figure 2-7***) re-energizes the gate reset function once the gate has been closed and the Fortress Interlocks slide switch has been re-inserted into the gate box.

SELECTION Toggle Switch

The three-position selector switch (see **I** in ***Figure 2-7***) allows maintenance personnel to selectively enable or disable hazardous and non-hazardous tooling motions within the cell for routine maintenance tasks. The selector switch provides the following levels of control:

- Pos1 – allows automatic operation if the gate is reset; disables all tooling motion with the gate open. The switch must be in this position for automatic mode.
- Pos2 – allows only non-hazardous (minor) tooling motion within the cell and/or single robot teach.
- Pos3 – allows all tooling motion within the cell, with hazardous (major) motion requiring the use of an enabling pendant. This position also allows all robot teach.

The selector switch does not affect non-motion output power, such as indicators, vacuum, and horns.

E-STOP Button

The EMERGENCY STOP button (see ❙ in ***Figure 2-7***) immediately removes control power from the cell. The EMERGENCY STOP button requires the button to be pulled back out after it has been pressed in. After pressing an EMERGENCY STOP button, follow the recovery procedure outlined in Chapter 4.

2.10.6. Robot Electrical / Pneumatic Disconnect

Each robot in each cell has its own proprietary controller. Each controller features an electrical disconnect and a pneumatic disconnect (for robot end of arm tooling that utilizes vacuum equipment). Power is distributed from the cell Power Distribution Panel (Lockout Point E-1) to the robot controller. The robot controller distributes power to the robot. During normal cycling, the robot controller is automatically directed by the cell processor. By removing automatic control from the cell processor, interface buttons and other controls provide manual control of the robot. To remove power from the entire robot (480V), turn the electrical disconnect switch and pneumatic shutoff valve to off and install locks. Refer to the ECPL placard at the cell for more information.

REFERENCE

For more information about the robot equipment, refer to the equipment supplier documentation (Fanuc – Robot R-2000iC Mechanical Unit Operator's Manual pg. i - s-12).

2.10.7. Light Curtain / Sensing Field

Three sensing devices are located on both the input and output sides of the line dunnage conveyors at the point of passage between the guarded and unguarded areas of the work cell. The sensing devices are in series to aid in the detection and distinction of the object traversing the sensing fields. Each series includes a retro-reflective sensing field, a light curtain sensing field, and another retro-reflective sensing field. The processor monitors the status of the sensing fields and the time delay between the activation of each sensing field to determine if a person or a container is traversing the field. When a container traverses, the fields are broken in a very specific time sequence. When the processor detects the inputs within the specified time frame, the safety circuit is overridden momentarily to allow the equipment to pause processing while the container traverses in or out. Any variation in the timing triggers the processor to disable the safety circuit and disconnect control power.

REFERENCE

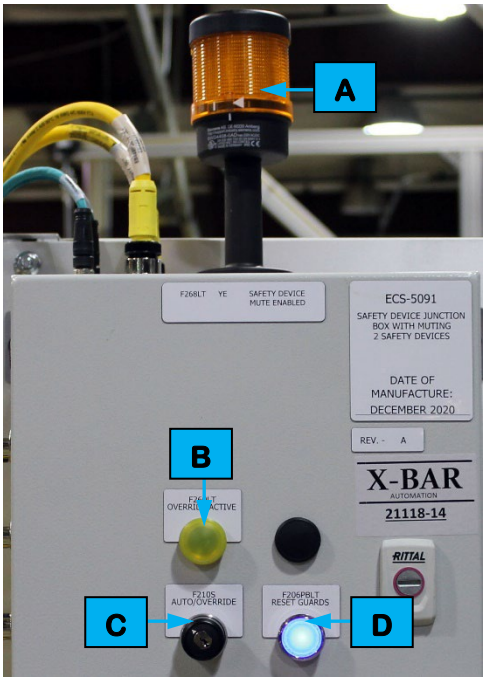
For more information about the light curtain, refer to the equipment supplier documentation (Sick deTec4 Prime Safety Light Curtain Operating Instructions pg. 13-20).

2.10.8. Conveyor Contactor Panel

The line conveyors are configured in distinct groupings. Each grouping has a dedicated contactor panel that provides complete energy control and monitoring of all the conveyor devices within the defined group. The outside of the panel enclosure features indicators that illuminate to identify when control power is on. A fused disconnect is located on the outside of the enclosure and is used to enable or disable control power for the associated conveyor equipment. Refer to the GM standards and to the ATS electrical drawings for more information about the contactor panel equipment and functionality. Refer to the ECPL placards on each PDP for information about locking out the cell energy sources.

2.10.9. Safety Device Junction Box (ECS-5091)

The safety device junction box (see ***Figure 2-8***) provides connectivity and interface from the MCP to a cell by picking up wiring for light curtains, auxiliary power for valve manifolds, and receptacles for DeviceNet. The junction box features the following controls and indicators.



Device Callouts in Figure 2-8	
A	Status Light
B	OVERRIDE ACTIVE indicator
C	AUTO/OVERRIDE key
D	RESET GUARDS button

Figure 2-8. An illustration of an example safety device junction box.

Status Light

An amber colored status light (see **A** in ***Figure 2-8***) sits on the top of the junction box and is used to identify when the cell safety circuit is muted.

Override Active Indicator

An override active indicator light (see **B** in ***Figure 2-8***) illuminates whenever the AUTO/OVERRIDE key is set to OVERRIDE.

AUTO/OVERRIDE Key

The AUTO/OVERRIDE key (see **C** in ***Figure 2-8***) is used to toggle the operating mode of the light curtains and other safety devices. The override function can only be used for 120-seconds at a time. The switch must be held in the OVERRIDE position.

RESET GUARDS Button

The RESET GUARDS button (see **D** in ***Figure 2-8***) is used to reset the guard safety circuit.

2.10.10. Laser Controller

Cell EX070 utilizes a pair of laser controllers to generate the energy required to weld the metal battery module tabs to the ICB bus bars. Each laser generator has its own proprietary enclosure (with controls and indicators) that supplies laser energy, through a laser fiber, to a laser head. The energy is focused by the laser head into a beam that is projected at a weld location at a specific focal distance.

REFERENCE 	***For more information about the laser controller, refer to the equipment supplier documentation (Trumpf Operator's Manual TruDisk 1000-8002 Chapter 3).***

2.10.11. Torit Air Handler

Cell EX070 utilizes a pair of air handlers to remove fumes and debris from the laser weld processes. Each air handler has its own proprietary enclosure with controls and indicators.

REFERENCE 	***For more information about the air handler, refer to the equipment supplier documentation (Donaldson Torit Downflo Oval DFO 1-1 to 3-3 Installation and Operation Manual pg. 2-3).***

2.10.12. Riedel Chiller

Cell EX070 utilizes a pair of chillers to pump coolant through the laser heads to keep the tooling cool. Each chiller has its own proprietary enclosure with controls and indicators.

REFERENCE 	***For more information about the chiller, refer to the equipment supplier documentation (Riedel Chiller Operating Instructions pg. 12).***

2.10.13. Flame Detector

Cell EX070 utilizes two flame detectors, each located on the roof of the associated weld chamber, that are attached to sprinkler systems. The flame detector automatically activates the sprinkler system in the event a fire is detected.

REFERENCE 	***For more information about the flame detector, refer to the equipment supplier documentation (Flamex Minimax Operating Instructions Flame Detector UniVario FMX5000 IR pg. 7-33).***

2.10.14. Gravity Pins

Some of the vertically actuated tooling in the line features a gravity pin that can be inserted to prevent the tooling from falling during maintenance activities. A holder with sensing houses the gravity pin. The gravity pin can be engaged to secure the tooling in the raised position. Refer to the ECPL placards on each PDP for information about the use and locations of the gravity pins.

2.10.15. ArmorStart Motor Starter

Each conveyor in each cell has a separate motor starter that is used to enable or disable power to the individual conveyor motor. The motor starter is a proprietary device with a rotary disconnect. A lockout hole in the handle allows a lock to be installed for energy control purposes. Refer to the ECPL placards on each PDP for information about locking out a conveyor motor.

REFERENCE 	***For more information about the motor starter, refer to the equipment supplier documentation (Allen-Bradley ArmorStart Distributed Motor Controller User Manual pg. 15-28).***

2.10.16. Servo Contactor Panel

Designated cells have a dedicated contactor panel that provides complete energy control and monitoring of all the servo motors within the cell. The outside of the panel enclosure features indicators that illuminate to identify when control power is on. A fused disconnect is located on the outside of the enclosure and is used to enable or disable control power for the associated servo drives. Refer to the GM standards and to the ATS electrical drawings for more information about the contactor panel equipment and functionality. Refer to the ECPL placards on each PDP for information about locking out the cell energy sources.

2.10.17. Conveyor Lift Gate

Designated cells have a conveyor lift gate that can be raised to allow personnel to move between conveyor sections. Lift gates are located upstream and downstream of EX020, downstream of EX070, and downstream of EX110.

2.10.18. Station / Device Air Shutoff

Specific devices, and groups of devices, have independent air shutoff valves that can be used to disconnect the air supply from only the associated equipment. Turning the valve to the off position disconnects air pressure to the devices and vents the pressure through a muffler. A lockout hole in the handle of the valve allows a lock to be installed for energy control purposes. Refer to the ECPL placards on each PDP for information about locking out the cell energy sources.

2.10.19. Conveyor Pull Cord

Each of the dunnage conveyors at EX190 and EX280 have a conveyor pull cord that is used to indicate the loading or unloading of dunnage at a conveyor. Pull cords are utilized when loading and unloading is done manually. Stack lights are used in conjunction with the pull cords to indicate status.

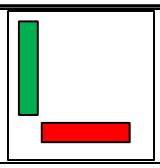
2.11. SDS REFERENCES

There are several different chemical products used in the operation and maintenance of the Module Final Assembly Line equipment. Refer to the following Safety Data Sheets for safe handling of these chemicals.

Product	Manufacturer	SDS File Name
Lubricant	Bosch	Bosch - Dynalub 510 SDS
Lubricant	Chevron	Chevron - Delo Silver SAE SDS
Lubricant	Drislide	Drislide - LG-01-02 Grease SDS
Lubricant	ExxonMobil	ExxonMobil - Mobilgear 600 XP 220 SDS
Lubricant	ITW Pro Brands	ITW Pro Brands - LPS Force 842 SDS
Lubricant	Kluber	Kluber - Klubersynth UH1 6-460 SDS
Lubricant	Kyodo Yushi	Kyodo Yushi - Vigogrease REO SDS
Lubricant	Lucas	Lucas - White Lithium Grease NLG1 #2 SDS
Lubricant	Shell	Shell - Alvania Grease S 2 SDS
Lubricant	THK	THK - AFB-LF Grease SDS

2.12. VISUAL AIDS

There are visual aids that have been added to select pieces of equipment that are in addition to safety and maintenance labels already attached by third party manufacturers. Refer to the following table for information about these additional visual aids.

Visual Aid	Visual Aid Description	Visual Aid Location(s)
	Displays a warning about possible pinch points for mechanical equipment along with arrows that indicate the moving part's direction of travel	Can be found on each conveyor lift gate
	Displays various pressures that equipment is normally set for	Can be found at all pressure regulators
	Displays a valve's normal position (Open or Closed)	Can be found at all manually controlled air valves
	Displays an air valve handle in open and closed positions with green being open and red being closed	Can be found at all manually controlled air valves
	Displays the contents and direction of air flow in air lines	Can be found on all air lines

3. SYSTEM DESCRIPTION

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3.1. MODULE FINAL ASSEMBLY LINE SUMMARY

The Module Final Assembly Line is part of a larger BET/BEV3 Battery Pack Assembly System. There are four Module Final Assembly Lines in the system. Each Module Assembly Line is identical and is used to build two module types, a 2P design and a 3P design. The Module Final Assembly Line equipment bends the metal battery module tabs over the ICB bus bars, welds the metal battery module tabs to the ICB bus bars, detects module defects using pulse phase thermography, conducts electrical tests on the module, installs covers to the module, and then offloads the module into stacked trays that are retrieved by an AGV for further processing downstream in other equipment.

3.2. MODULE FINAL ASSEMBLY LINE UTILITIES

The Module Final Assembly System has the following utility requirements:

		Module Input VTU (EX010)	Post Tab Bend (EX020)	Tab Weld 1 (EX070P1)	Tab Weld 2 (EX070P2)	PPT1 (EX110P1)	PPT2 (EX110P2)	Module Electrical Test 1 (EX140P1)		Module Electrical Test 2 (EX140P2)		Module Cover Install (EX190)	Module Transfer (EX280)	Module Return VTU (EX500)
Compressed Air Supply	Air Pressure (PSI)	65	65	65	65	65	65	65		65		65	65	65
	Max. CFM	10	20	30	30	10	10	20		20		30	30	10
	Supply Pipe Size	1.5″	1.5″	1.5″	1.5″	1.5″	1.5″	1.5″		1.5″		1.5″	1.5″	1.5″
Electrical Supply	Equipment Volts	480	480	480	480	480	480	480	480	480	480	480	480	480
	Equipment Phase	3	3	3	3	3	3	3	3	3	3	3	3	3
	Main Disconnect Amps	100	100	200	200	100	100	100	200	100	200	100	100	100
Water Supply	Water Pressure (PSI)	N/A	N/A	43	43	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Water Flow (GPM)	N/A	N/A	132	132	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

3.3. BET/BEV3 BATTERY PACK ASSEMBLY SYSTEM LAYOUT - DETROIT

The BET/BEV3 Battery Pack Assembly System for Detroit includes a Pack Main Line, four Module Final Assembly Lines, and eight Stacker Lines. ***Figure 3-1*** illustrates this system layout. For information about the Pack Main Line, refer to the ATS *Pack Main Line Operation and Maintenance Manual*. For information about the Stacker Line, refer to the ATS *Stacker Line Operation and Maintenance Manual*.

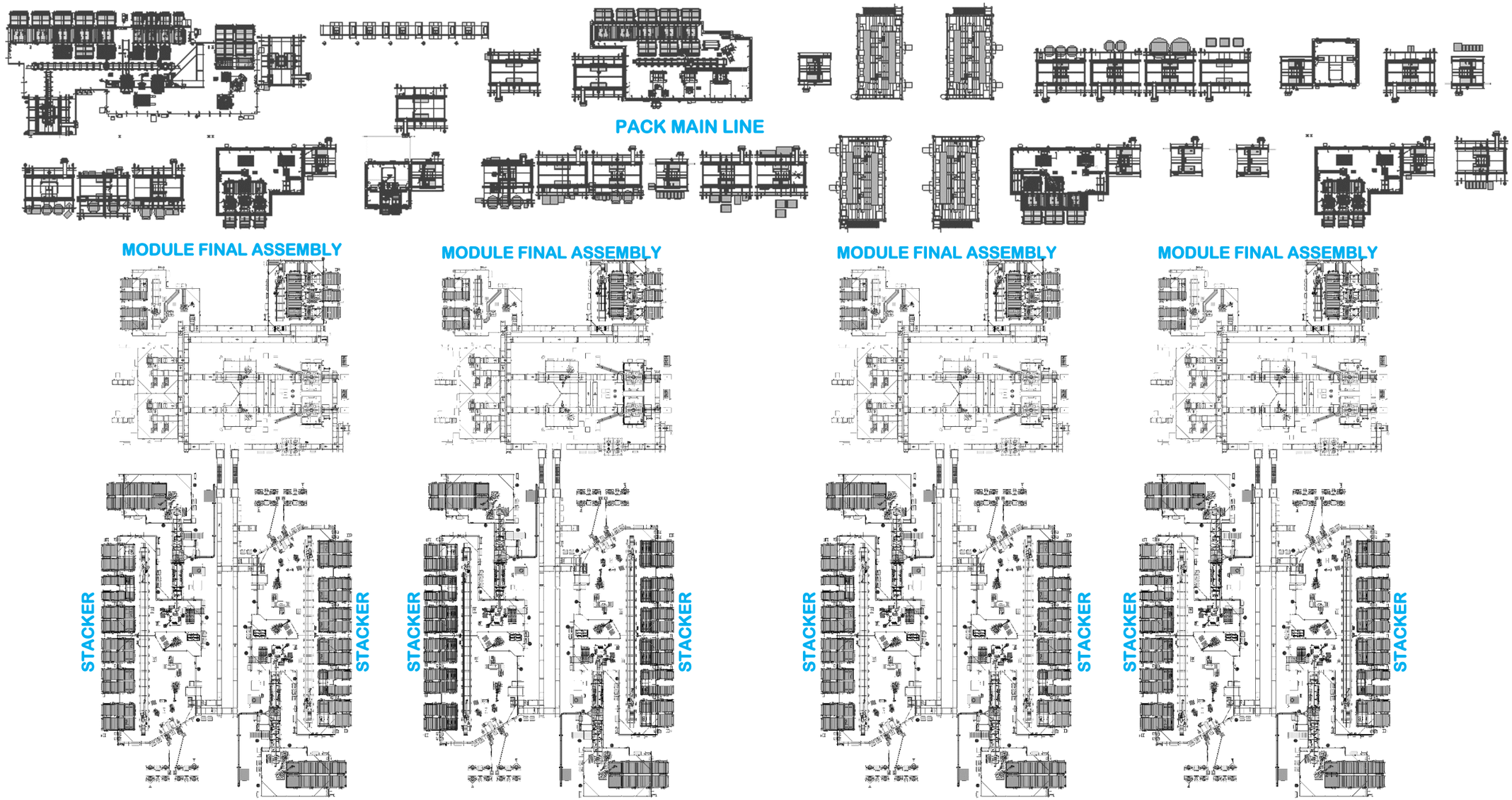


Figure 3-1. BET/BEV3 System Detroit layout

The BEV3 Battery Pack Assembly System for Ramos Arizpe includes a Pack Main Line, two Module Final Assembly Lines, and four Stacker Lines. ***Figure 3-3*** illustrates this system layout. For information about the Pack Main Line, refer to the ATS *Pack Main Line Operation and Maintenance Manual*. For information about the Stacker Line, refer to the ATS *Stacker Line Operation and Maintenance Manual*.

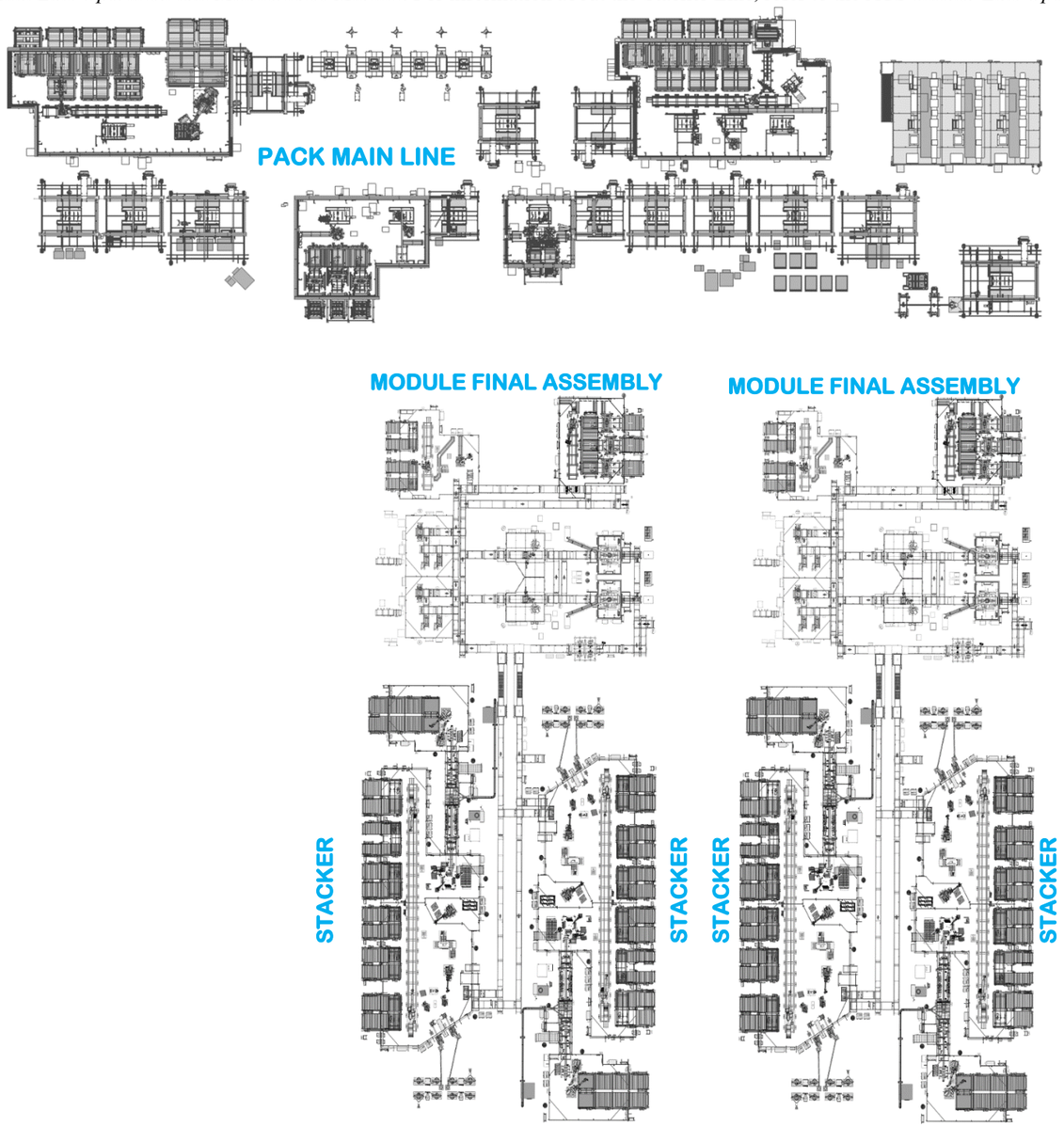
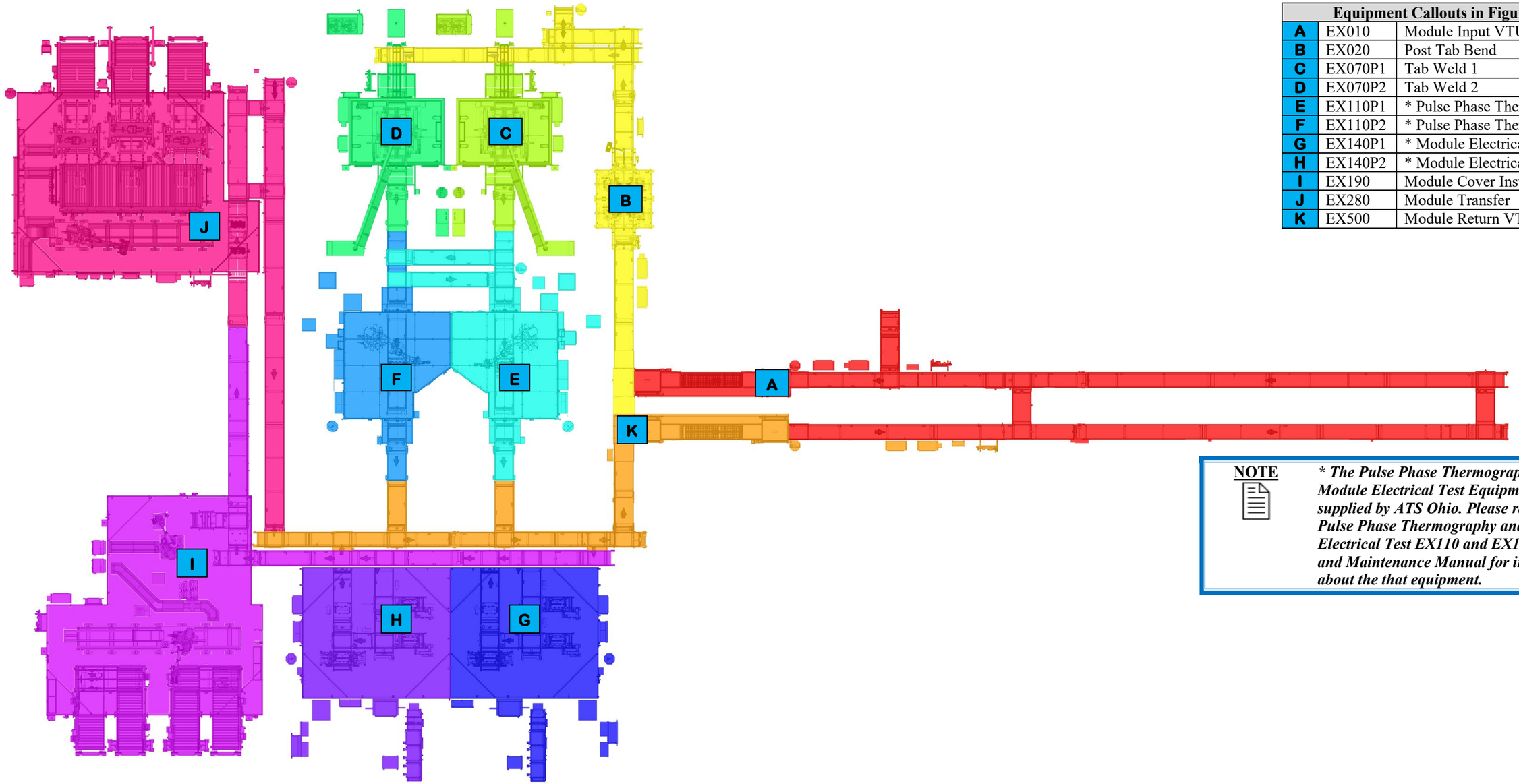


Figure 3-2. BEV3 System Ramos Arizpe layout

3.4. MODULE FINAL ASSEMBLY LAYOUT

Each Module Final Assembly line consists of eleven cells: Module Input VTU, Post Tab Bend, Tab Weld 1 and 2, Pulse Phase Thermography 1 and 2, Module Electrical Test 1 and 2, Module Cover Install, Module Transfer, and Module Return VTU. ***Figure 3-3*** illustrates the layout of this equipment.



Equipment Callouts in Figure 3-3		
A	EX010	Module Input VTU
B	EX020	Post Tab Bend
C	EX070P1	Tab Weld 1
D	EX070P2	Tab Weld 2
E	EX110P1	* Pulse Phase Thermography 1
F	EX110P2	* Pulse Phase Thermography 2
G	EX140P1	* Module Electrical Test 1
H	EX140P2	* Module Electrical Test 2
I	EX190	Module Cover Install
J	EX280	Module Transfer
K	EX500	Module Return VTU

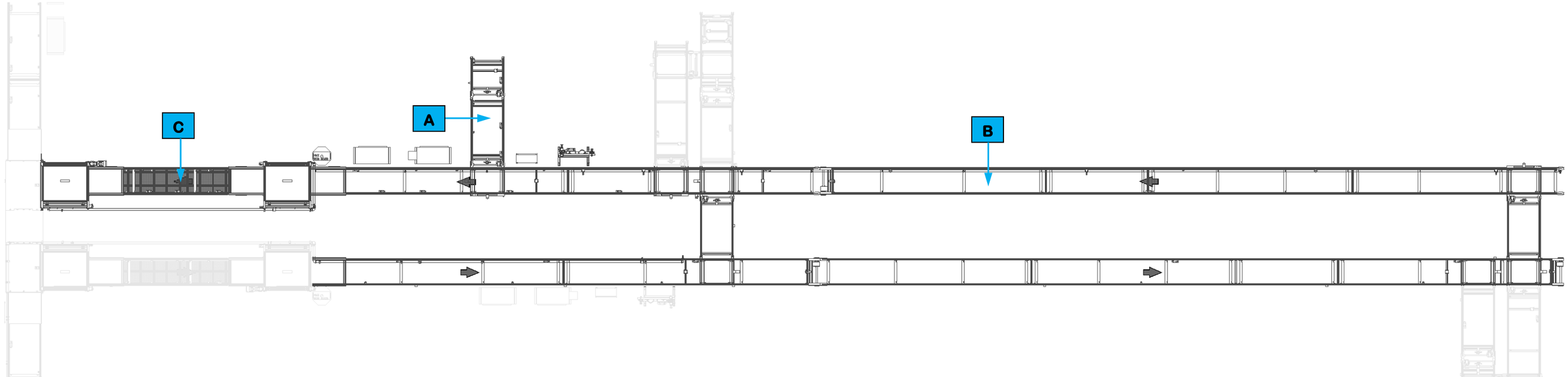
NOTE

**** The Pulse Phase Thermography and Module Electrical Test Equipment was not supplied by ATS Ohio. Please refer to the Pulse Phase Thermography and Module Electrical Test EX110 and EX140 Operation and Maintenance Manual for information about the that equipment.***

Figure 3-3. Module Final Assembly layout

3.5. MODULE INPUT VTU (EX010) EQUIPMENT

The Module Input VTU equipment (see ***Figure 3-4***) transports pallets to the Stacker Zones so that modules can be loaded to the pallet.



Equipment Callouts in Figure 3-4		
A	EX005T01	Set In/Out
B	EX010T01	Conveyance
C	EX010T02	VTU

Figure 3-4. Module Input VTU equipment layout

3.5.1. Sequence of Operation

The Module Input VTU equipment completes the following operations during a normal cycle.

1. EX500 Module Output VTU transfers empty pallets to EX010T01 Conveyance.
2. EX010T01 transports the empty pallets to the Stacker Zone EB480T01 Conveyance.
3. The Stacker Zone loads a module assembly to each pallet. EB480T01 then transfers the pallet back to EX010T01 Conveyance.
4. If the module is a reject, EX010T01 transports the associated pallet to EX005T01 Set Out where an operator divorces the reject from the pallet and removes the rejected module. An operator can also marry another module assembly to a pallet and introduce the pallet into the line at this position.
5. EX010T01 transfers the pallet to EX010T02 VTU.
6. EX010T02 VTU transfers the pallet to EX020 Post Tab Bend.

For more detailed sequences, refer to the ATS timing charts provided to your company.

3.5.2. EX005T01 Set In/Out

The Set In/Out position (see callout **A** in ***Figure 3-4***) is provided to allow operators to manually load or unload modules to/from pallets. The position includes a bank of controls that an operator uses for interface, a short section of roller chain conveyor, and pneumatic-actuated pallet lift-and-transfer units used to transfer the pallets from one perpendicular conveyor section to another. An RFID reader at the position reads the module bar code and the pallet RFID and joins the two (marries) or divorces the two. Refer to your company operating procedures for detailed information regarding the use of this position.

More information on Set in/out can be found in Chapter 4 sections ***4.3.8 Loading (or Unloading) Components***, ***4.3.9 Removing Rejects***, and ***4.3.10 Reintroducing Parts***.

3.5.3. EX010T01 Conveyance Equipment

The Conveyance Equipment (see callout **A** in ***Figure 3-4***) uses roller chain conveyor sections to transport empty pallets to the Stacker Zone EB480T01 Conveyance where a module assembly is loaded to each pallet. Cushioned stops are located throughout the conveyance with RFID tag readers at decision points and work positions. Pneumatic-actuated pallet lift-and-transfer units are used to transfer the pallets from one perpendicular conveyor section to another.

REFERENCE	***For more information about the conveyance equipment, refer to the equipment supplier documentation (Bosch Belt Section BS 2 pg. 4-7, Bosch BS 2C-…, BS 2R… Belt Sections Assembly Instructions pg. 13-15, Bosch HQ 2U Lift Transverse Unit Assembly Instructions pg. 12-14, Bosch PE 2X Positioning Unit Assembly Instructions pg. 11-14).***

3.5.4. EX010T02 VTU

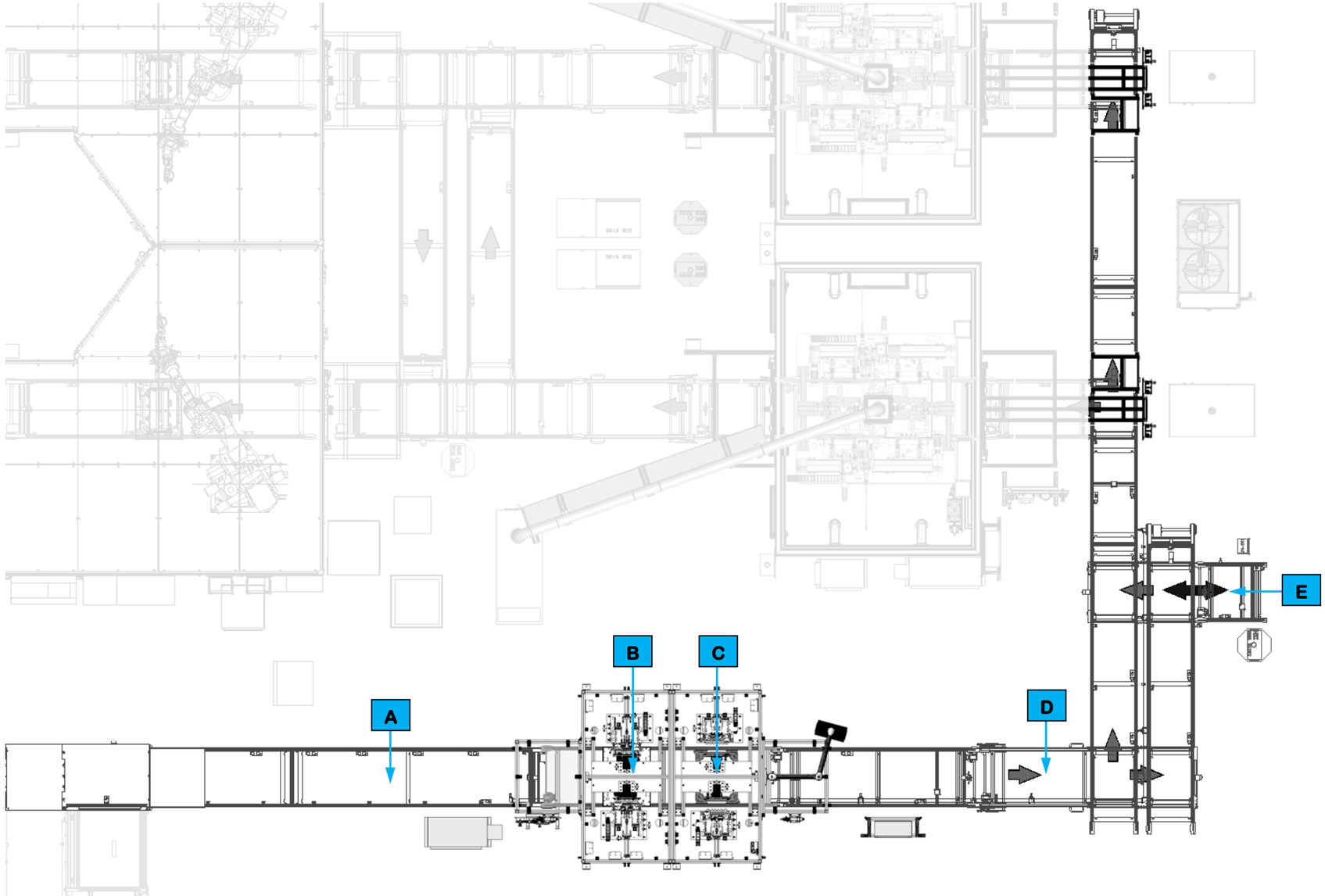
The VTU (see callout **B** in ***Figure 3-4***) consists of two proprietary Bosch Vertical Transfer Modules (elevators) connected by a section of overhead roller chain conveyor. The first elevator raises each pallet (one at a time) to the overhead conveyor section. The overhead conveyor section transports the pallet to the second elevator. The second elevator lowers each pallet back to the main conveyor height. The pallet is then transferred to EX020 Post Tab Bend.

The VTU provides an area where AGVs, forklifts, and personnel can move under and between the various work zones.

REFERENCE 	***For more information about the VTU equipment, refer to the equipment supplier documentation (Bosch TSplus Vertical Transfer Module Model VT2 Installation and Maintenance pg.7-8, 10).***

3.6. POST TAB BEND (EX020) EQUIPMENT

The Post Tab Bend equipment (see ***Figure 3-5***) conveys a pallet with a module assembly into a work cell where equipment bends the metal battery module tabs over the ICB bus bars and then the pallet is released downstream on conveyor equipment. Downstream of the work cell is a Set In/Out position where an operator can introduce a module assembly to the conveyor system, or an operator can remove a rejected module assembly from the conveyor system.



Equipment Callouts in Figure 3-5		
A	EX015T01	Entry Conveyance
B	EX020	2P Station
C	EX030	3P Station
D	EX040T01	Exit Conveyance
E	EX050	Set In/Out

Figure 3-5. Post Tab Bend equipment layout.

3.6.1. Sequence of Operation

Post Tab Bend completes the following operations during a cycle.

1. EX015T01 transports a pallet with a battery module into the station.
2. EX015T01 stops the pallet at either EX020 or EX030, depending on the battery type.
3. EX015T01 Lift Position Unit raises the pallet off the conveyor.
4. EX020 or EX030 Bend Tooling advances on two sides of the pallet. The tooling engages the battery module tabs and bends them over the ICB bus bars. Vision Inspection Tooling checks that the tabs were bent and then all of the tooling retracts clear.
5. EX015T01 Lift Position Unit lowers the pallet to the conveyor.
6. EX015T01 releases the pallet downstream to EX040T01.
7. EX040T01 transports the pallet downstream to the next process. If the battery is good, it is released to an operator at EX050.

For more detailed sequences, refer to the ATS timing charts provided to your company.

3.6.2. EX015T01 Entry Conveyance

The Entry Conveyance (see callout **A** in ***Figure 3-5***) transports pallets with modules into the cell via roller chain conveyors. Pneumatic-actuated pallet lift-and-locate units engage precision bushings on the pallet base and are used to raise pallets off the conveyor into tooling and back the pallets up. Cushioned stops are located throughout the conveyance with RFID tag readers at decision points and work positions. The RFID equipment at the cell works positions have a read/write head that looks up the pallet data prior to the start of the cycle and update the pallet data after the cycle.

REFERENCE 	***For more information about the conveyance equipment, refer to the equipment supplier documentation (Bosch Belt Section BS 2 pg. 4-7, Bosch BS 2C-…, BS 2R… Belt Sections Assembly Instructions pg. 13-15, Bosch HQ 2U Lift Transverse Unit Assembly Instructions pg. 12-14, Bosch PE 2X Positioning Unit Assembly Instructions pg. 11-14).***

3.6.3. EX020 2P Station

The 2P Station equipment (see callout **B** in ***Figure 3-5***) has duplicate mechanisms on both sides of a pallet that are used to bend the metal battery module tabs over the ICB bus bars on 2P modules. Each of the duplicate mechanisms operate similarly and identically.

3.6.3.1. Bend Tooling

There are two Bend Tools at the station (see ***Figure 3-6***), one on each side of the pallet. Each mechanism utilizes five SMC pneumatic cylinders to engage and bend the metal battery module tabs. Both mechanisms operate simultaneously and identically.

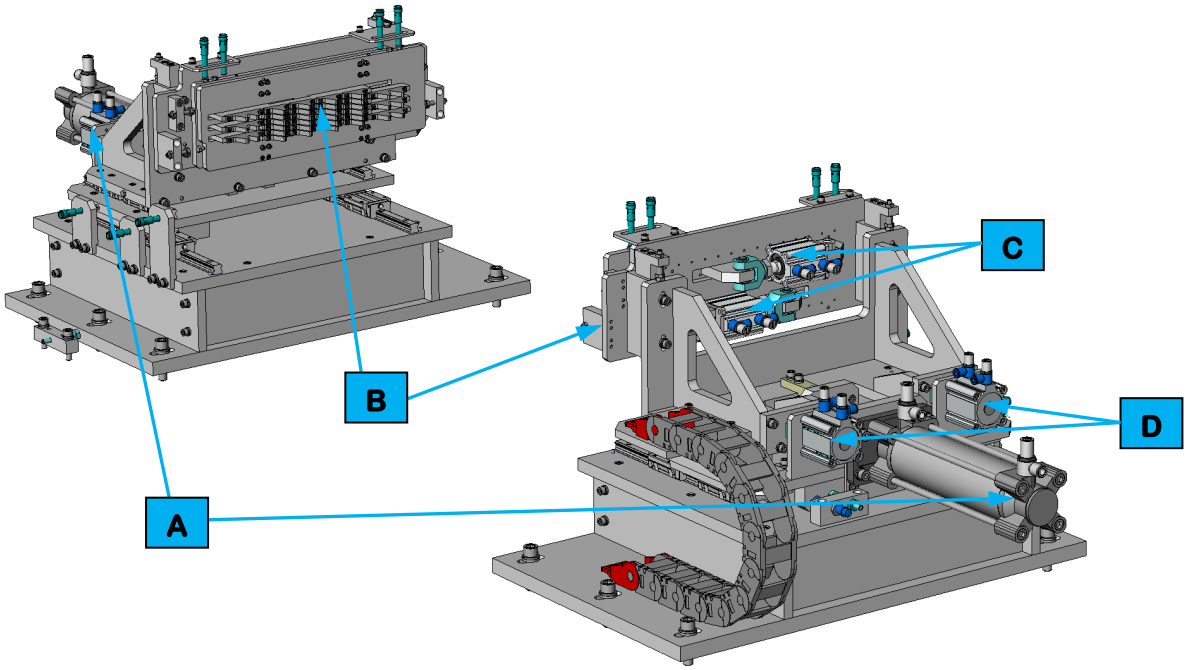


Figure 3-6. 2P Tab Bend Tooling equipment.

At each side, the first cylinder (see callout **A** in ***Figure 3-6***) advances bending fingers (see callout **B** in ***Figure 3-6***) toward the battery module. Cylinders 2 and 3 (see callout **C** in ***Figure 3-6***) actuate the bending fingers to move in opposing directions to bend the tabs a particular direction. Cylinders 4 and 5 (see callout **D** in ***Figure 3-6***) advance to push the bending fingers further against the tabs to tamp them. (Unlike the 3P Tooling, the 2P Tooling does not have a mid-stop.)

After the tabs have been tamped each of the cylinders retract to the home position. Once the tooling is at home then the Vision Inspection equipment cycles.

3.6.3.2. Vision Inspection Tooling

The Vision Inspection Tooling has duplicate mechanisms on both sides of the pallet. Each mechanism utilizes a SMC pneumatic cylinder to lower a through-beam sensor over the battery module tabs after they have been bent. If any tab has not been bent correctly, the through-beam sensor beam will be broken, and the module will be flagged as a reject. If the through-beam sensor is not broken, then the module passes. The pneumatic cylinder then raises the through-beam sensor clear, the Lift Position Unit lowers the pallet, and the pallet is released downstream.

3.6.4. EX030 3P Station

The 3P Station equipment (see callout **C** in ***Figure 3-5***) has duplicate mechanisms on both sides of a pallet that are used to bend the metal battery module tabs over the ICB bus bars on 3P modules. Each of the duplicate mechanisms operate similarly and identically.

3.6.4.1. Bend Tooling

There are two Bend Tools at the station (see ***Figure 3-7***), one on each side of the pallet. Each mechanism utilizes six SMC pneumatic cylinders to engage and bend the metal battery module tabs. Both mechanisms operate simultaneously and identically.

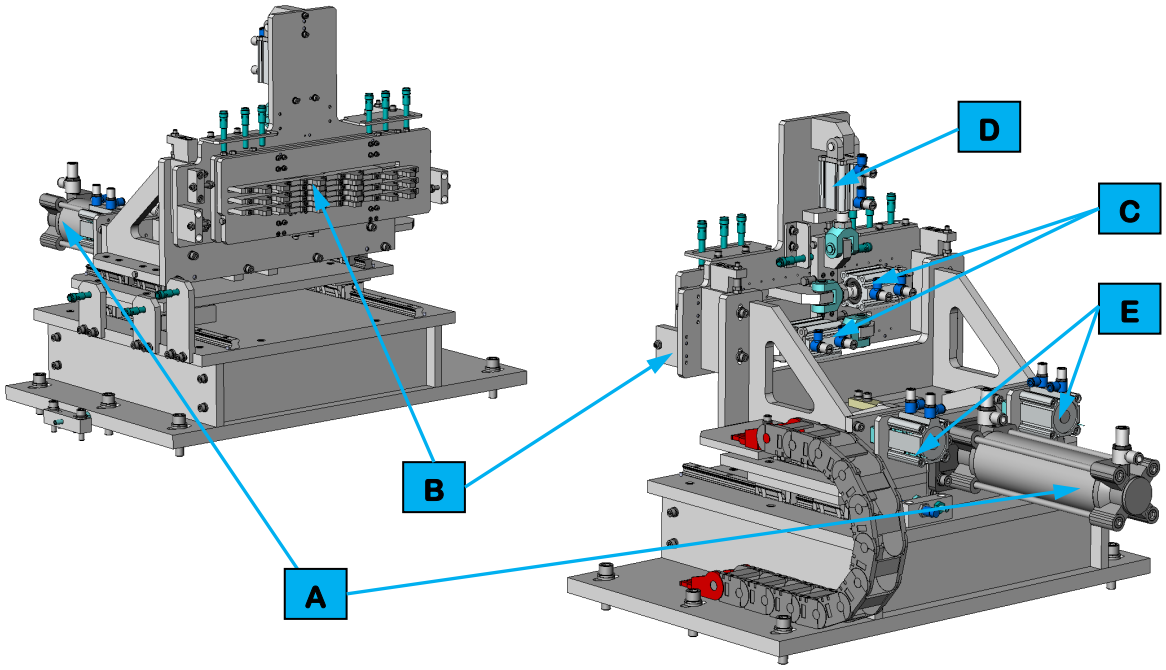


Figure 3-7. 3P Tab Bend Tooling equipment.

At each side, the first cylinder (see callout **A** in ***Figure 3-7***) advances bending fingers (see callout **B** in ***Figure 3-7***) toward the battery module. Cylinders 2 and 3 (see callout **C** in ***Figure 3-7***) actuate the bending fingers to move in opposing directions to bend the tabs a particular direction. Cylinder 4 (see callout **D** in ***Figure 3-7***) actuates a mid-stop. Cylinders 2 and 3 then retract to the mid-stop. Cylinders 5 and 6 (see callout **E** in ***Figure 3-7***) advance to push the bending fingers further against the tabs to tamp them.

After the tabs have been tamped each of the cylinders retract to the home position. Once the tooling is at home then the Vision Inspection equipment cycles.

3.6.4.2. Vision Inspection Tooling

The Vision Inspection Tooling has duplicate mechanisms on both sides of the pallet. Each mechanism utilizes a SMC pneumatic cylinder to lower a through-beam sensor over the battery module tabs after they have been bent. If any tab has not been bent correctly, the through-beam sensor beam will be broken, and the module will be flagged as a reject. If the through-beam sensor is not broken, then the module passes. The pneumatic cylinder then raises the through-beam sensor clear, the Lift Position Unit lowers the pallet, and the pallet is released downstream.

3.6.5. EX040T01 Exit Conveyance

The Exit Conveyance (see callout **D** in *Figure 3-5*) transports pallets with modules downstream of the work cell. Pallets with good modules are routed to a section of roller chain conveyor that transports the pallets to the next process. Pallets with rejected modules are routed to a section of roller chain conveyor that transports the pallets to EX050 for Set Out. Pneumatic-actuated pallet lift-and-transfer units engage precision bushings on the pallet base and are used to raise pallets off one conveyor section and onto another section. Cushioned stops are located throughout the conveyance with RFID tag readers at decision points and work positions. A conveyor lift gate is used to provide access inside of the conveyor loop.

REFERENCE

For more information about the conveyance equipment, refer to the equipment supplier documentation (Bosch Belt Section BS 2 pg. 4-7, Bosch BS 2C-…, BS 2R… Belt Sections Assembly Instructions pg. 13-15, Bosch HQ 2U Lift Transverse Unit Assembly Instructions pg. 12-14, Bosch PE 2X Positioning Unit Assembly Instructions pg. 11-14).

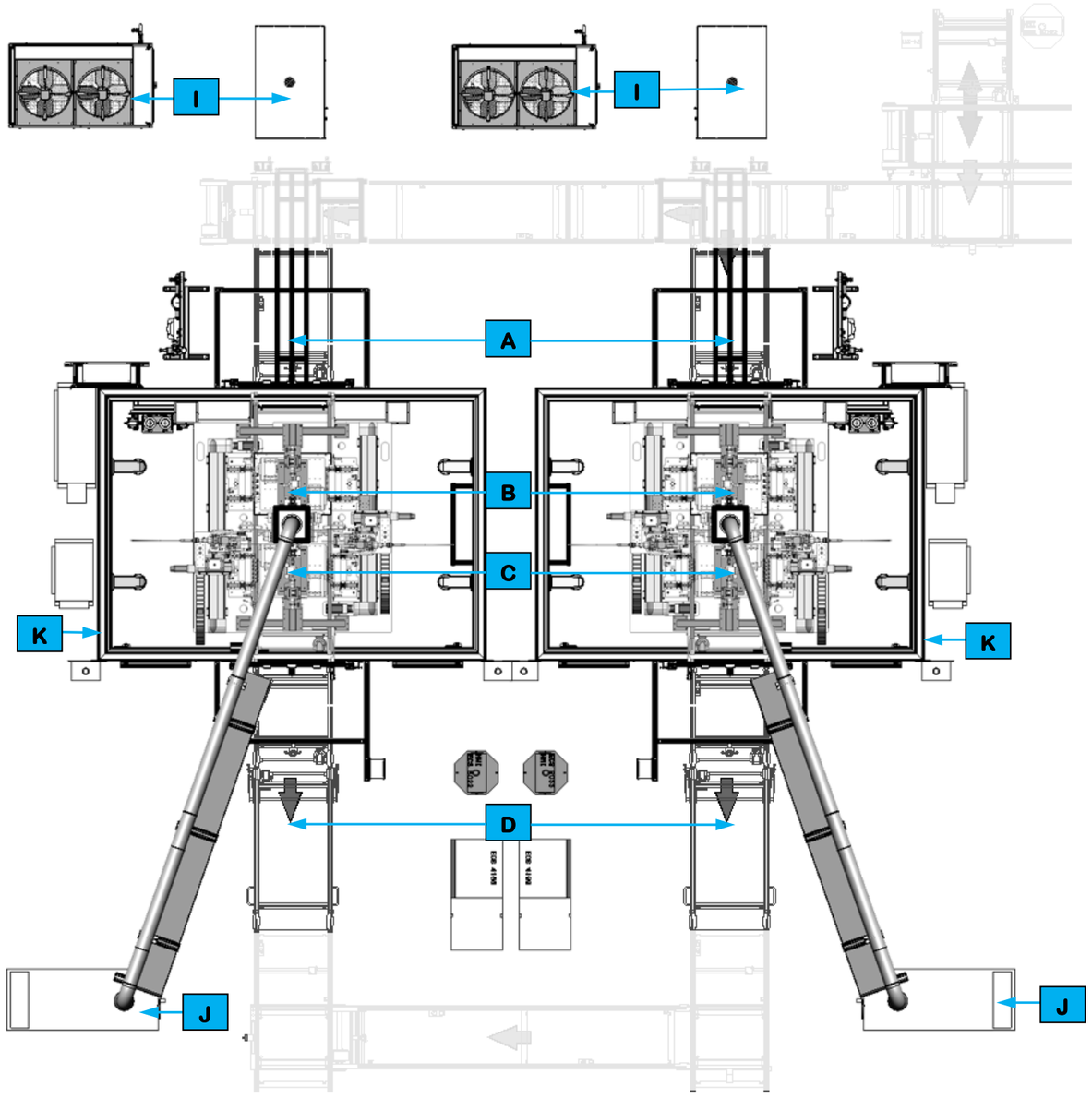
3.6.6. EX050 Set In/Out

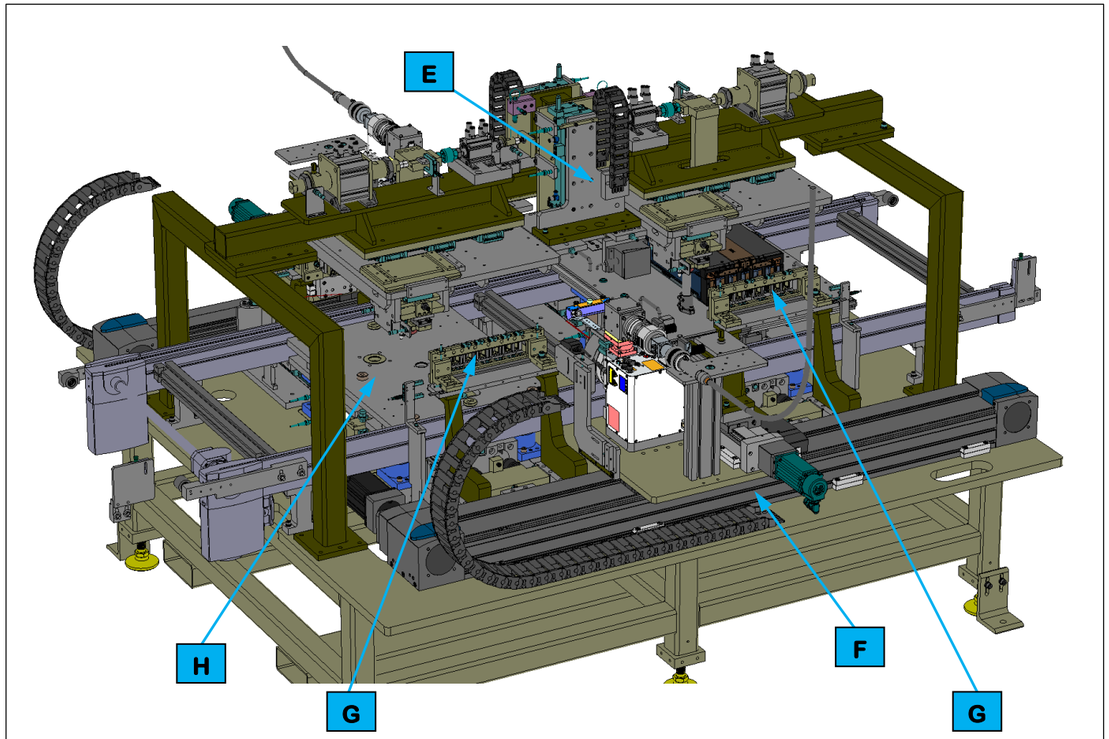
The Set In/Out position (see callout **E** in *Figure 3-5*) is provided to allow operators to manually load or unload modules to/from pallets. The position includes a bank of controls that an operator uses for interface, a short section of roller chain conveyor, and pneumatic-actuated pallet lift-and-transfer units used to transfer the pallets from one perpendicular conveyor section to another. An RFID reader at the position reads the module bar code and the pallet RFID and joins the two (marries) or divorces the two. Refer to your company operating procedures for detailed information regarding the use of this position.

More information on Set in/out can be found in Chapter 4 sections ***4.3.8 Loading (or Unloading) Components***, ***4.3.9 Removing Rejects***, and ***4.3.10 Reintroducing Parts***.

3.7. TAB WELD (EX070) EQUIPMENT

There are two Tab Weld stations (see ***Figure 3-8***) that weld the metal battery module tabs to the ICB bus bars.





An illustration of the laser weld equipment inside of one of the Weld Chambers.

Equipment Callouts in Figure 3-8		
A	EX060T01	Entry Conveyance
B	EX070	Weld Nest 1
C	EX080	Weld Nest 2
D	EX090T01	Exit Conveyance
E	N/A	Laser Calibration / Backup Tooling
F	N/A	Laser Slide Tooling
G	N/A	Weld Contact Tooling
H	N/A	Wobble Table
I	N/A	Laser Weld Equipment
J	N/A	Fume Extraction Equipment
K	N/A	Weld Chamber Equipment

Figure 3-8. Tab Weld equipment layout.

3.7.1. Sequence of Operation

Tab Weld completes the following operations during a cycle.

1. EX060T01 Entry Conveyance transports a pallet with a battery module into the Weld Chamber. The pallet is stopped at either a 2P position (EX070 Weld Nest 1) or a 3P position (EX080 Weld Nest 2), depending on the battery module type. Once the pallet is stopped, sliding doors close at the conveyor entry and exit locations to seal the chamber.
2. A Wobble Table raises the pallet and battery module into overhead Backup Tooling.
3. The Wobble Table latches release, and the Backup Tooling grippers close on the battery module. With the tooling thus positioned, the pallet can "wobble around" slightly.
4. Weld Contact Tooling advances from opposite sides of the pallet, squeezing against the battery tabs and pushing the tabs securely against the ICB bus bars. The ability of the pallet to "wobble around" allows the pallet and battery module to shift position as needed so that they align squarely with the Weld Contact Tooling.
5. Laser Slide Tooling (on both sides of the pallet) slowly moves across the face of the Weld Contact Tooling while measuring the distance to each battery tab so that the laser weld focal distance can be precisely calculated.
6. The Laser Slide Tooling (on both sides of the pallet) positions the laser weld heads at the first weld location. The laser weld head then fires to weld the battery tab to the ICB bus bar.
7. The Laser Slide Tooling repositions, and the laser weld head then fires for the second weld.
8. Each consecutive weld is completed with the Laser Slide Tooling repositioning as needed.
9. Once all welds have been completed the Laser Slide Tooling returns home.
10. The Weld Contact Tooling retracts clear of the pallet.
11. The Backup Tooling grippers release the battery module.
12. The Wobble Table lowers the pallet to the conveyor.
13. The Weld Chamber sliding doors open.
14. EX060T01 Entry Conveyance transfers the pallet to EX090T01 Exit Conveyance. The conveyor releases the pallet downstream to the next process.
15. The Wobble Table latches engage to center the tooling for the next cycle.

NOTE

At periodic intervals, the Laser Slide Tooling positions the laser weld head at Calibration Tooling where calibrations are performed on the laser power, laser focus, and scanner distance measurements.

For more detailed sequences, refer to the ATS timing charts provided to your company.

3.7.2. EX060T01 Entry Conveyance

The Entry Conveyance equipment (see callout **A** in *Figure 3-8*) transports pallets with modules into the cell via two roller chain conveyors.

REFERENCE

For more information about the conveyance equipment, refer to the equipment supplier documentation (Bosch Belt Section BS 2 pg. 4-7, Bosch BS 2C-…, BS 2R… Belt Sections Assembly Instructions pg. 13-15, Bosch HQ 2U Lift Transverse Unit Assembly Instructions pg. 12-14, Bosch PE 2X Positioning Unit Assembly Instructions pg. 11-14).

3.7.3. EX070 Weld Nest 1

Weld Nest 1 (see callout **B** in ***Figure 3-8***) is a position on the EX060T01 Entry Conveyance where 2P modules are stopped and worked on. RFID equipment looks up the pallet data prior to the start of the cycle and updates the pallet data after the cycle.

3.7.4. EX080 Weld Nest 2

Weld Nest 2 (see callout **C** in ***Figure 3-8***) is a position on the EX060T01 Entry Conveyance where 3P modules are stopped and worked on. RFID equipment looks up the pallet data prior to the start of the cycle and updates the pallet data after the cycle.

3.7.5. EX090T01 Exit Conveyance

The Exit Conveyance equipment (see callout **D** in ***Figure 3-8***) transports pallets with modules out of the cell via a roller chain conveyor and a conveyor lift gate. The pallets traverse the lift gate and are then transported to the EX110 Pulse Phase Thermography cell.

REFERENCE

For more information about the conveyance equipment, refer to the equipment supplier documentation (Bosch Belt Section BS 2 pg. 4-7, Bosch BS 2C-…, BS 2R… Belt Sections Assembly Instructions pg. 13-15, Bosch HQ 2U Lift Transverse Unit Assembly Instructions pg. 12-14, Bosch PE 2X Positioning Unit Assembly Instructions pg. 11-14).

3.7.6. Laser Calibration Tooling / Backup Tooling

The Laser Calibration Tooling / Backup Tooling (see ***Figure 3-9***) is located above the conveyor on both sides of the cell. There are two sets of Laser Calibration Tooling and two sets of Backup Tooling.

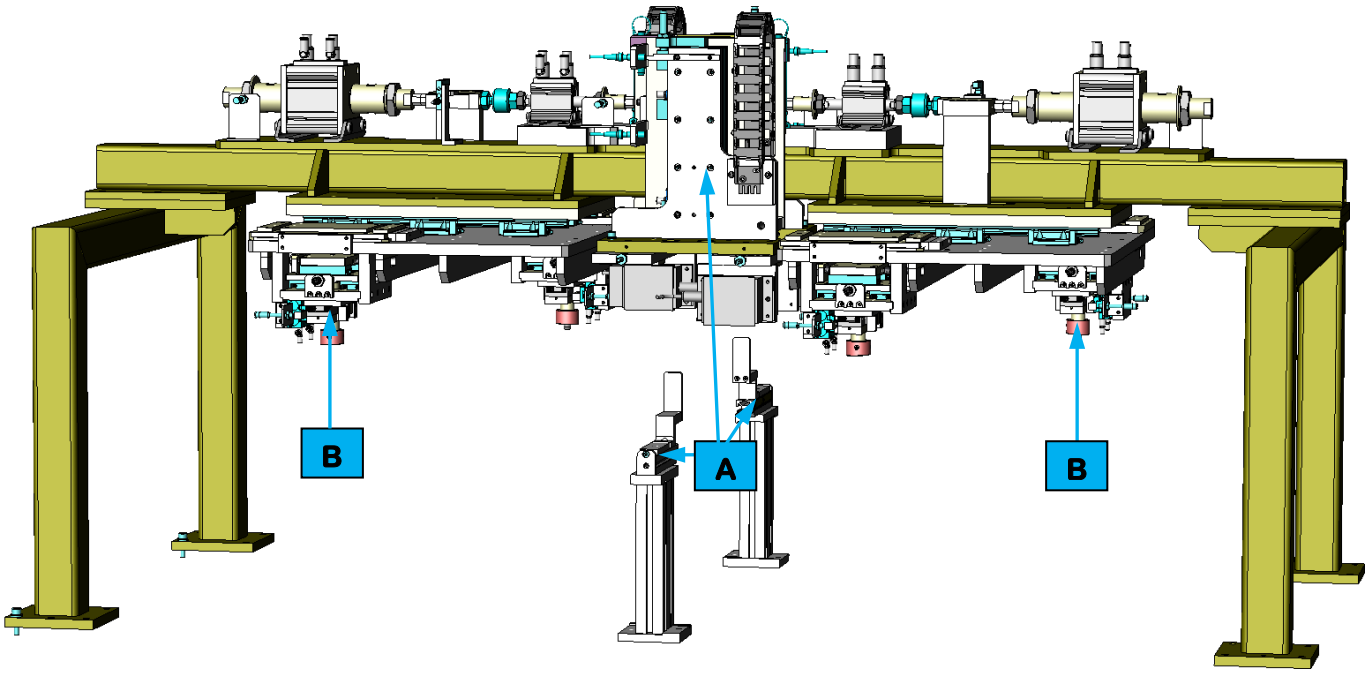


Figure 3-9. Laser Calibration / Backup Tooling equipment.

The Laser Calibration Tooling (see callout **A** in *Figure 3-9*) is only used during a calibration cycle that is initiated automatically at defined intervals. There are two Laser Calibration Tools, one on either weld side of the battery module. The tools each utilize a vertical air cylinder to lower a Trumpf power calibration unit and a Trumpf focus calibration unit in front of the Laser Slide Tooling. There is also a distance calibration tool in this location. When the defined interval has been reached, the Laser Slide Tooling positions so that the laser head can fire at the required calibration unit or so that the laser profiler can measure the distance from the calibration tool. The readings from the calibrations are used by the cell programming to adjust the equipment as needed to achieve proper welds. Once the calibration routine has been completed, the vertical air cylinder raises the calibration units clear.

REFERENCE	***For more information about the calibration units, refer to the equipment supplier documentation (Trumpf Operator's Manual CalibrationLine Focus Calibration Program & Power Calibration Program pg. 6-19).***

The Backup Tooling (see callout **B** in *Figure 3-9*) is used to secure a battery module and pallet while still allowing it to "wobble around" to allow the pallet and battery module to shift position as needed so that the module can align squarely with the Weld Contact Tooling. There are two Backup Tools, one for the 3P Station and one for the 2P Station. Only one tool is used during the cycle.

The Backup Tooling features a pair of pneumatic grippers mounted to several cross-roller tables that allow the grippers to "float" in the X- and Y-axes. A battery module is lifted (by the Wobble Table) into the overhead grippers. The pneumatic grippers close securely on locating features of the battery module to secure the module until the weld process has been completed.

A secondary function of the Backup Tooling is to shift the entire battery module along the X-axis for the purposes of re-welds. A pair of pneumatic cylinders are located above each Backup Tool. The cylinders either extend or retract as needed to slightly shift the battery module so that fresh weld points can be presented. The pneumatic cylinders are able to achieve a mid-position, a left-shifted position, or a right-shifted position as necessary to achieve the proper weld position.

3.7.7. Laser Slide Tooling

There are two Laser Slide Tools, one on either side of the pallet. Each Laser Slide Tool (see ***Figure 3-10***) moves a laser weld head and a distance sensor to various locations around the cell.

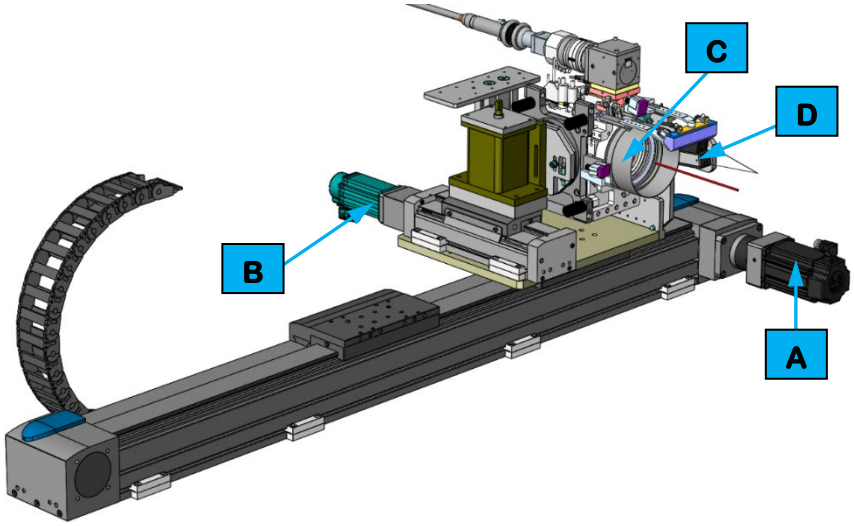


Figure 3-10. Laser Slide Tooling equipment.

Each of the Laser Slide Tools features two Festo linear actuators driven by Allen-Bradley servo motors (see callouts **A** and **B** in ***Figure 3-10***) to provide precise positioning of a Trumpf laser head (see callout **C** in ***Figure 3-10***) and a Keyence laser profiler (see callout **D** in ***Figure 3-10***).

Laser fiber delivers energy from the laser generator. The energy is focused by the laser head into a beam that is projected at a weld location at a specific focal distance. The focal distance is determined at the start of the cycle by the laser profiler which is swept across the weld face by one of the linear actuators. When the weld cycle initiates, the linear actuators precisely position the laser in the X- and Y-axes at each of the weld locations.

REFERENCE	***For more information about the laser head and profiler, refer to the equipment supplier documentation (Trumpf Operator's Manual TruDisk 1000-8002 Chapter 3, Keyence Laser Profiler LJ-X800 Series Instruction Manual pg. 7-9).***

3.7.8. Weld Contact Tooling

There are two sets Weld Contact Tooling, one configured for 3P battery modules and one configured for 2P battery modules (see ***Figure 3-11***). Each set has a pair of tooling with one half of each pair located on opposing sides of the pallet. The tools are mounted to press inward toward each other, sandwiching the module between them and pressing on the folded tabs. Each set (3P, 2P) is nearly identical with the only difference being in the configuration of the contact tooling.

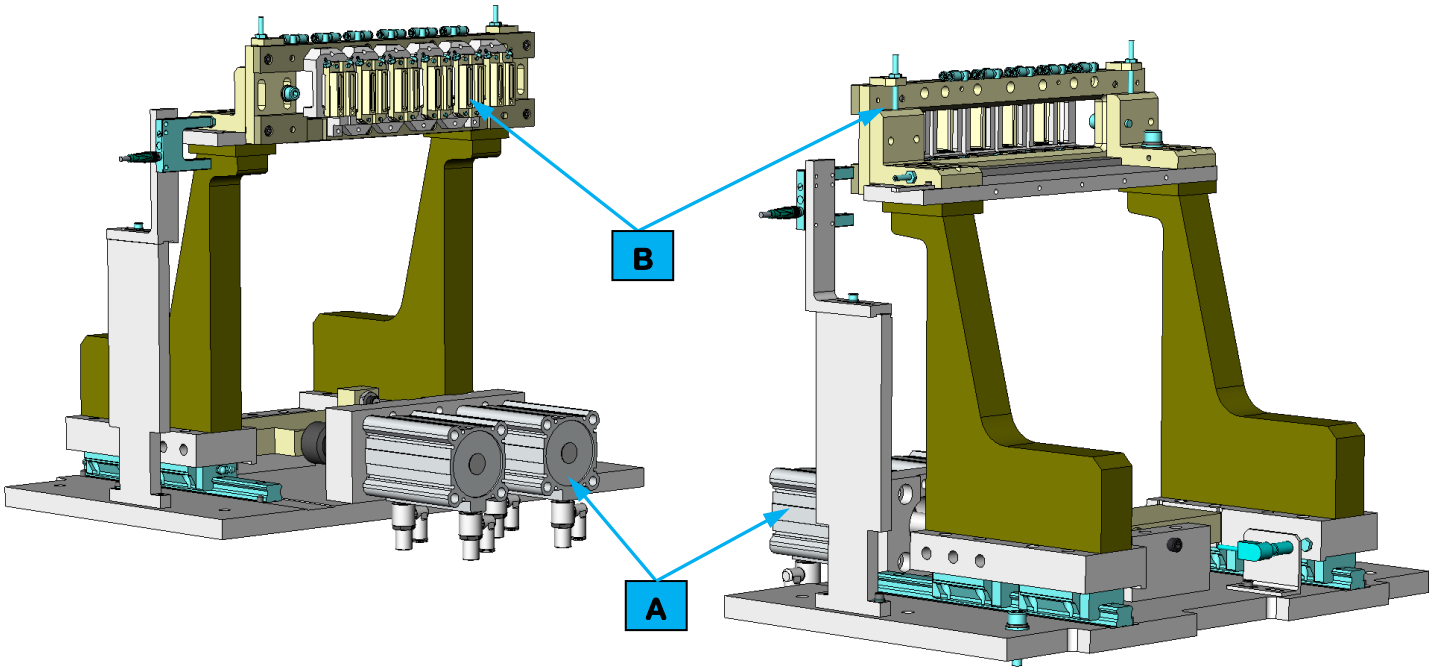


Figure 3-11. Weld Contact Tooling equipment.

Each Weld Contact Tool utilizes a pair of pneumatic cylinders (see callout **A** in ***Figure 3-11***) to advance tooling risers along linear guide rails. Mounted to the tooling risers are insulated tools bars and a series of copper shoes (see callout **B** in ***Figure 3-11***) that seat the folded tabs against the ICB bus bar terminals. The copper shoes surround each of the tab weld locations with openings to allow the focused laser beam to reach the tab and ICB bus bar.

3.7.9. Wobble Table

The Wobble Table (see ***Figure 3-12***) raises a pallet off the conveyor and then unlatches to provide the pallet the ability to "wobble around", allowing the pallet and battery module to shift position as needed so that they align squarely with the Weld Contact Tooling.

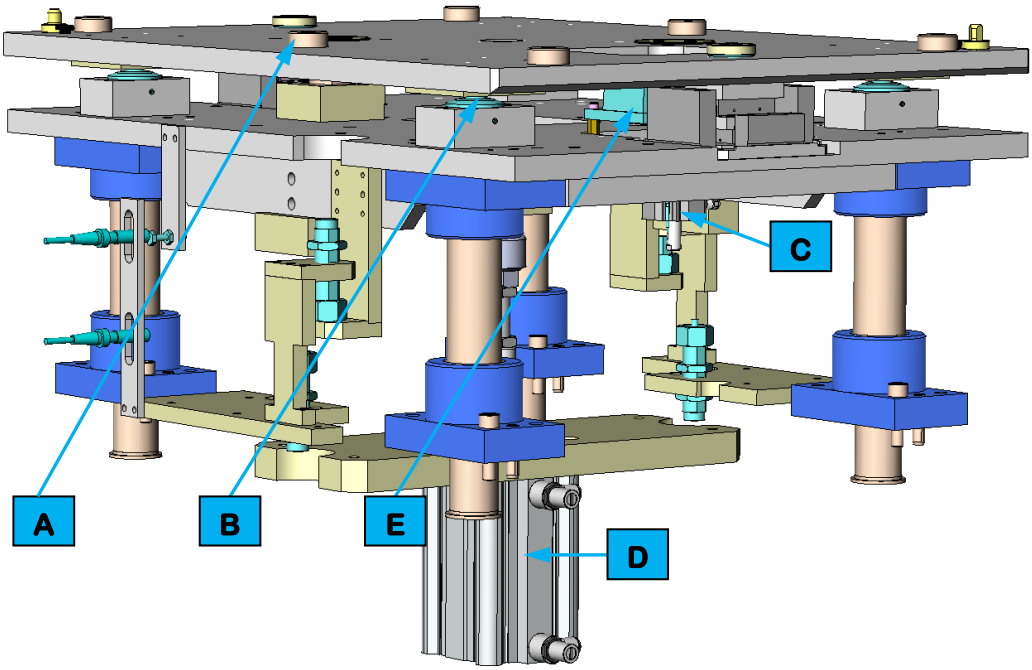


Figure 3-12. Wobble Table equipment.

A top plate (see callout **A** in *Figure 3-12*) with locator tooling is used to capture and secure the pallet. The top plate "floats" on top of four ball transfers (see callout **B** in *Figure 3-12*) and can be locked in place and re-centered with a pair of cylinder-actuated tools (see callout **C** in *Figure 3-12*). A vertical cylinder (see callout **D** in *Figure 3-12*) provides lift to raise the plate and pallet/battery module into overhead tooling. A RFID reader (see callout **E** in *Figure 3-12*) interfaces with the pallet RFID tag. Sensors verify the tooling positions.

When a pallet is first stopped at the Wobble Table, the RFID tag is read, and the vertical lift cylinder raises the pallet. The cylinder-actuated tooling then releases to allow the top plate to "float". After the vertical lift cylinder has lowered the pallet back to the conveyor at the end of the cycle, the cylinder-actuated tooling recenters the top plate and latches the top plate in place.

3.7.10. Laser Weld Equipment

Laser weld equipment generates power and focuses laser light through a lens to weld the aluminum and copper caps on battery sections. The laser head is attached to the Laser Slide Tooling inside of a weld chamber. The laser generator and associated equipment is located around the outer perimeter of the weld chamber.

WARNING!

DO NOT operate the laser with the chamber open. DO NOT stare directly at the laser beam. The safety circuit prevents the laser from firing while the chamber door is open. DO NOT attempt to circumvent or disable the interlock circuit.

WARNING!

Avoid all exposure to visible and invisible laser radiation. Failure to comply may result in hazardous laser radiation exposure and/or blindness. Review the General Laser Safety Warnings found in Chapter 2 of this manual as well as those found in the Trumpf documentation.

REFERENCE

For more information about the laser equipment, refer to the equipment supplier documentation (Trumpf Operator's Manual TruDisk 1000-8002 Chapter 3, Riedel Chiller Operating Instructions pg. 12).

A Trumpf laser generator supplies the energy for the Trumpf laser head to cycle. A Riedel chiller pumps coolant through the laser head to keep the tooling cool.

The proprietary weld and cooling equipment was integrated by ATS Ohio.

3.7.11. Fume/Dust Extraction Equipment

A proprietary Donaldson Torit Dust Collector removes dust and fumes from the laser chamber. The collection equipment includes a duct spark cooler to mitigate sparks in the dust collection system by creating turbulence in the air flow stream.

REFERENCE

For more information about the collection equipment, refer to the equipment supplier documentation (Donaldson Torit Downflo Oval DFO 1-1 to 3-3 Installation and Operation Manual pg. 2-3).

3.7.12. Weld Chamber

A metal chamber provides a sealed enclosure in which the lasers operate. The enclosure provides a light-tight environment suitable for laser operations. Four cameras are located inside the enclosure and connect to a terminal outside of the chamber. A monitor displays the images from the cameras so that operations can be monitored during a weld cycle.

There is a sliding door at the conveyor transition points into and out of the Weld Chamber. Each sliding door utilizes a pneumatic cylinder to raise the door when a pallet is transitioning and to close the door after the pallet is clear. Each of the sliding doors features a gravity pin that can be inserted to prevent the door from falling during maintenance activities. A holder with sensing houses the gravity pin. An operator removes the pin from the holder and inserts the pin into a through-hole in the door, securing the door in the raised position.

A pair of guard doors provide access inside the chamber. Each guard door is equipped with a safety switch and actuator. The switch detects when the actuator is removed and signals the cell processor. The processor then removes control power and air from the appropriate equipment. The guard doors are part of the cell safety circuit, along with EMERGENCY STOP buttons and other safety devices.

WARNING!

The interlock circuit is used as a safety precaution to prevent personnel from injury due to sudden mechanism movement. Never attempt to defeat or bypass an interlock switch, an interlock device, or any part of the interlock circuit. Failure to observe this warning may result in serious injury or death.

A flame detector is located on the roof of the chamber and is attached to a sprinkler system. The flame detector automatically activates the sprinkler system in the event a fire is detected.

REFERENCE

For more information about the flame detector, refer to the equipment supplier documentation (Flamex Minimax Operating Instructions Flame Detector UniVario FMX5000 IR pg. 7-33).

3.8. PULSE PHASE THERMOGRAPHY (EX110) EQUIPMENT

The Pulse Phase Thermography equipment (see ***Figure 3-13***) was not provided by ATS Ohio. Please refer to the Pulse Phase Thermography and Module Electrical Test EX110 and EX140 Operation and Maintenance Manual for information about that equipment.

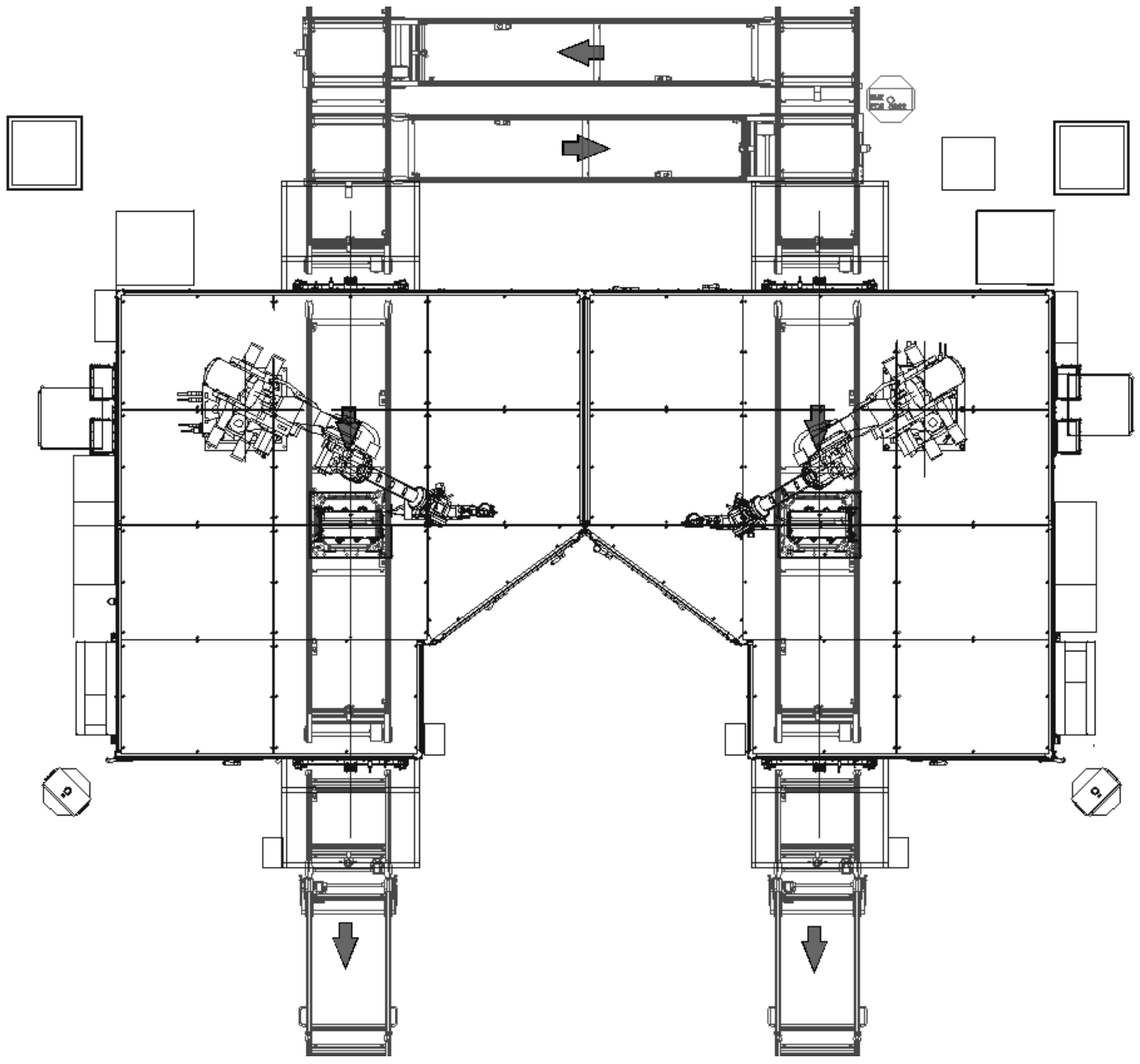


Figure 3-13. Pulse Phase Thermography equipment layout.

3.9. MODULE ELECTRICAL TEST (EX140) EQUIPMENT

The Module Electrical Test equipment (see ***Figure 3-14***) was not provided by ATS Ohio. Please refer to the Pulse Phase Thermography and Module Electrical Test EX110 and EX140 Operation and Maintenance Manual for information about that equipment.

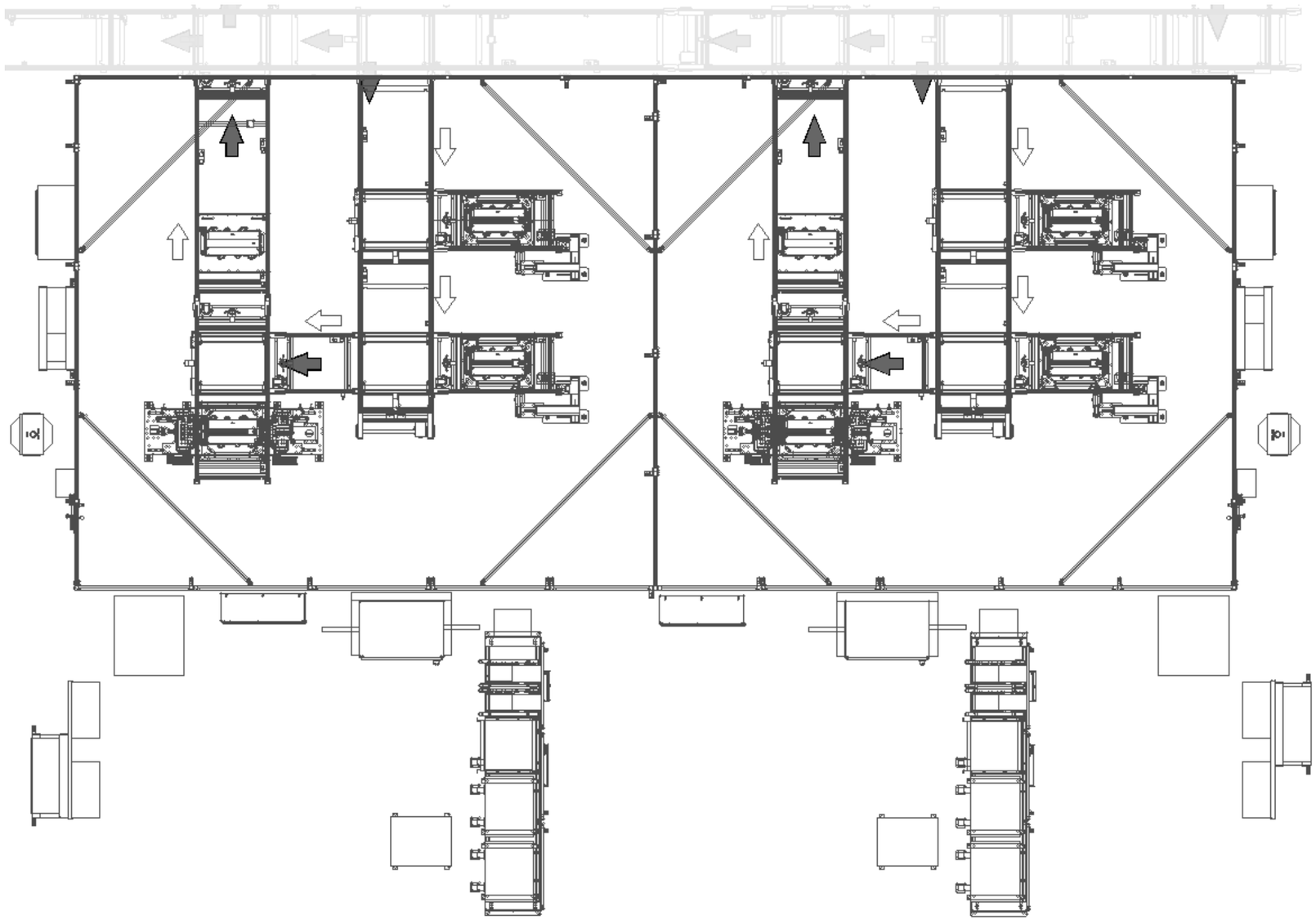
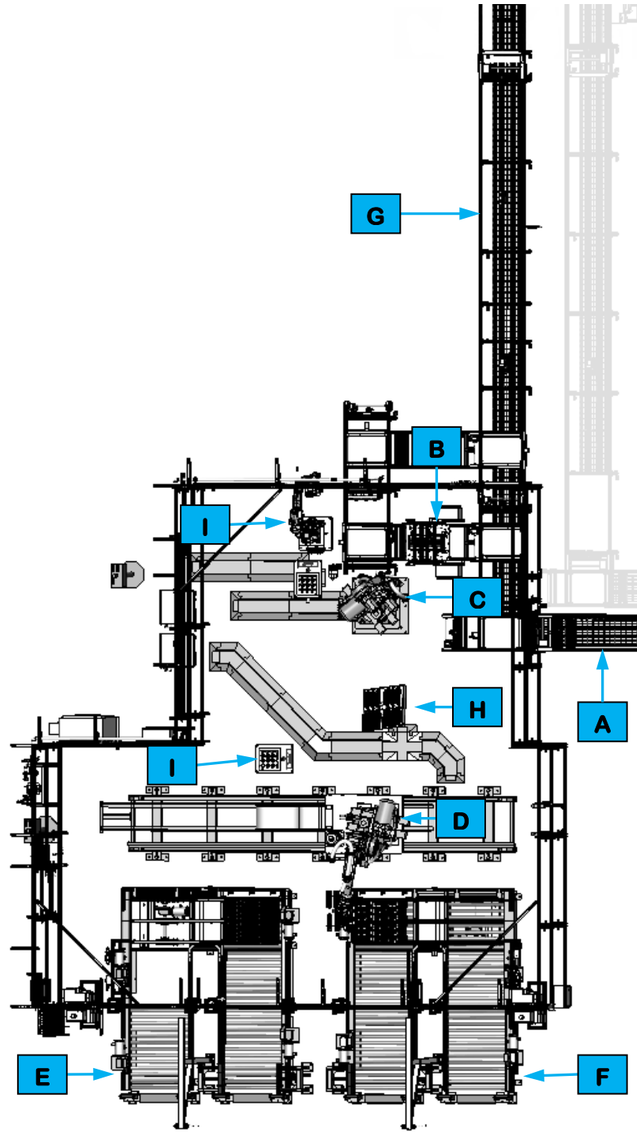


Figure 3-14. Module Electrical Test equipment layout.

3.10. MODULE COVER INSTALL (EX190) EQUIPMENT

Module Cover Install (see ***Figure 3-15***) installs a transfer cover and a non-transfer cover to a module assembly on a pallet.



Equipment Callouts in Figure 3-15		
A	EX180T01	Entry Conveyance
B	EX190	Cover Install Station
C	EX190R01	Cover Install Robot
D	EX220R01	Cover Delivery Robot
E	EX220T01	Mother Conveyor
F	EX220T02	Daughter Conveyor
G	EX250T01	Exit Conveyance
H	N/A	Cover Positioning Table
I	N/A	Robot and Vision Calibration Stand

Figure 3-15. Module Cover Install equipment layout.

3.10.1. Sequence of Operation

Module Cover Install completes the following operations during a cycle.

1. EX180T01 Entry Conveyance transports a pallet with a module assembly to EX250T01 Exit Conveyance.
2. EX250T01 Exit Conveyance transports the pallet into EX190 Cover Install Station.
3. EX190 Cover Install Station clamps the module assembly against the pallet to hold the module in place.
4. EX220R01 Cover Delivery Robot picks three transfer covers from EX220T02 Daughter Conveyor and places the covers to a Cover Positioning Table.
5. EX220R01 Cover Delivery Robot picks three non-transfer covers from EX220T01 Mother Conveyor and places the covers to the Cover Positioning Table.
6. EX190R01 Cover Install Robot picks a transfer cover from the Cover Positioning Table, repositions, and then picks a non-transfer cover from the Cover Positioning Table.
7. EX190R01 Cover Install Robot moves to EX190 Cover Install Station, installs the transfer cover to the module, repositions, and installs the non-transfer cover to the module. EX190R01 then moves clear.
8. EX190 retracts clear of the module.
9. EX250T01 Exit Conveyance transports the pallet downstream to EX280 Module Transfer.

For more detailed sequences, refer to the ATS timing charts provided to your company.

3.10.2. EX180T01 Entry Conveyance

The Entry Conveyance equipment (see callout **A** in ***Figure 3-15***) uses three roller chain conveyor sections to transport pallets with module assemblies out of EX140 Module Electrical Test and into the Module Cover Install work cell. Cushioned stops are located throughout the conveyance with RFID tag readers at decision points and work positions. Pneumatic-actuated pallet lift-and-transfer units are used to transfer the pallets from one perpendicular conveyor section to another.

REFERENCE	***For more information about the conveyance equipment, refer to the equipment supplier documentation (Bosch Belt Section BS 2 pg. 4-7, Bosch BS 2C-…, BS 2R… Belt Sections Assembly Instructions pg. 13-15, Bosch HQ 2U Lift Transverse Unit Assembly Instructions pg. 12-14, Bosch PE 2X Positioning Unit Assembly Instructions pg. 11-14).***

3.10.3. EX190 Cover Install Station

The Cover Install Station (see callout **B** in ***Figure 3-15***) clamps a module assembly to a pallet while covers are installed and then uses sensors to check that the covers were installed properly. The station is located on a spur of the EX250T01 Exit Conveyance and is mounted to an overhead extrusion frame. Four SMC pneumatic slide tables are used to extend backup posts to clamp down on the module. Two sides of the extrusion frame feature pairs of Pepperl & Fuchs through-beam sensors. The sensors emit beams across the face of the module cover and are positioned such that if the beams remain unbroken then the cover is determined to be successfully installed; if a beam is broken then the cover is determined to have not been successfully installed.

3.10.4. EX190R01 Cover Install Robot

The Cover Install Robot (see callout **C** in ***Figure 3-15***) manipulates End of Arm Tooling (EOAT) to pick two covers (a transfer and a non-transfer) from a Cover Positioning Table and to install both covers to a module on a pallet at the EX190 Cover Install Station.

The Fanuc robot is a third-party component integrated with the other cell mechanisms. The robot manipulates several axes to properly position the EOAT. Vision equipment (also third-party Fanuc equipment) assists the robot in properly installing the covers inspecting the module sides to calculate the place coordinates.

The EOAT consists of a gripper frame with two pick heads (one for transfer covers, one for non-transfer covers), two spotlights, two vacuum generators, and the Fanuc camera. The spotlights are used to illuminate the module cover install area for the Fanuc camera. The vacuum generators are used to enable vacuum to the two pick heads, one generator per pick head.

The transfer cover pick head features four vacuum pads, four spring-loaded compliance pins, and two locating pins attached to a SMC pneumatic slide table. Prior to picking a transfer cover, the slide table extends the two locating pins to assist in locating the cover by its datums. Prior to installing a transfer cover, the slide table retracts the two locating pins so that they do not interfere with the cover installation. The vacuum pads are enabled with vacuum to suction the cover against the pads. Vacuum remains enabled until the EOAT has snapped the cover into the module. The compliance pins are positioned on the EOAT such that they apply pressure to the snapping features of the cover to ensure that the cover is properly snapped into the module.

The non-transfer cover pick head features three vacuum pads and two locating pins attached to a SMC pneumatic slide table. Prior to picking a non-transfer cover, the slide table extends the two locating pins to assist in locating the cover by its datums. Prior to install a non-transfer cover, the slide table retracts the two locating pins so that they do not interfere with the cover installation. The vacuum pads are enabled with vacuum to suction the cover against the pads. Vacuum remains enabled until the EOAT has installed the cover to the module.

REFERENCE

For more information about the robot equipment, refer to the equipment supplier documentation (Fanuc Robot R-2000 iC Operator's Manual, pg. 26-65).

3.10.5. EX220R01 Cover Delivery Robot

The Cover Delivery Robot (see callout **D** in *Figure 3-15*) manipulates End of Arm Tooling (EOAT) to pick covers (three at a time) from a dunnage Conveyor and to place the covers to the Cover Positioning Table. The Robot alternates pick cycles between the EX220T01 Mother Conveyor and the EX220T02 Daughter Conveyor. The Robot also uses the EOAT to pick and place empty dunnage trays.

The Cover Delivery Robot consists of a Fanuc Robot Transport Unit (RTU) and a Fanuc R-2000IC/210L robot equipped with End of Arm Tooling (EOAT). The RTU is an electric servo-driven linear axis that shuttles the robot along a single axis between multiple pick points. The Fanuc robot manipulates several axes to properly position the EOAT to pick components and place components at various locations around the work envelope. Vision equipment (also third-party Fanuc equipment) assists the robot in properly picking and placing covers and trays by inspecting the dunnage tray to calculate the pick coordinates (the camera also uses an algorithm to determine the tray height based on the distance between the tray fiducial positions).

The EOAT consists of a gripper frame that holds four linear lights, the Fanuc camera, four vacuum generators, and 16 vacuum pads. The linear lights are used to illuminate the pick area for the Fanuc camera. The vacuum pads are configured into four groups of four. Each group has its own dedicated vacuum generator. Three of the groups are used when picking covers (one cover per group). The fourth group is used (along with the other three) when picking empty trays. When the

EOAT is lowered to a pick position, the vacuum generators turn on to enable vacuum through the vacuum pads to suction the component against the pads. The vacuum generators remain turned on until the EOAT is lowered at a release point.

REFERENCE	***For more information about the robot, refer to the equipment supplier documentation (Fanuc Generation VI – Robot Transport Unit (RTU) Mechanical Assembly, Operation and Maintenance Manual pg. 3-9, Fanuc Robot R-2000iC Mechanical Unit Operator's Manual pg. 26-65).***

3.10.6. EX220T01 Mother Conveyor, EX220T02 Daughter Conveyor

The Mother Conveyor equipment (see callout **E** in ***Figure 3-15***) transports tray containers full of non-transfer covers into the work cell and transports empty tray containers out of the work cell.

The Daughter Conveyor equipment (see callout **F** in ***Figure 3-15***) transports tray containers full of transfer covers into the work cell and transports empty tray containers out of the work cell.

REFERENCE	***For more information about the conveyor equipment, refer to the equipment supplier documentation (Omni Chain Driven Live Roller Conveyor Straight and Curve Technical Handbook pg. 3-10).***

The Conveyor Equipment utilizes third-party Omni conveyance devices. Powered roller conveyor sections are used to pull containers into the work cell and to push empty containers out of the work cell. Each powered roller conveyor section has its own motor and motor starter. At the work position, a perpendicular section of chain conveyor is used to transfer a single container from the input side to the output side.

Three sensing devices are located on both the input and output sides of the conveyor at the point of passage between the guarded and unguarded areas of the work cell. The sensing devices are in series to aid in the detection and distinction of the object traversing the sensing fields. Each series includes a retro-reflective sensing field, a light curtain sensing field, and another retro-reflective sensing field. The processor monitors the status of the sensing fields and the time delay between the activation of each sensing field to determine if a person or a container is traversing the field. When a container traverses, the fields are broken in a very specific time sequence. When the processor detects the inputs within the specified time frame, the safety circuit is overridden momentarily to allow the equipment to pause processing while the container traverses in or out. Any variation in the timing triggers the processor to disable the safety circuit and disconnect control power.

3.10.7. EX250T01 Exit Conveyance

The Exit Conveyance equipment (see callout **G** in *Figure 3-15*) uses three roller chain conveyor sections to transport pallets with module assemblies into the EX190 Cover Install Station and then downstream to EX280 Module Transfer. Cushioned stops are located throughout the conveyance with RFID tag readers at decision points and work positions. Pneumatic-actuated pallet lift-and-transfer units are used to transfer the pallets from one perpendicular conveyor section to another.

REFERENCE

For more information about the conveyance equipment, refer to the equipment supplier documentation (Bosch Belt Section BS 2 pg. 4-7, Bosch BS 2C-…, BS 2R… Belt Sections Assembly Instructions pg. 13-15, Bosch HQ 2U Lift Transverse Unit Assembly Instructions pg. 12-14, Bosch PE 2X Positioning Unit Assembly Instructions pg. 11-14).

3.10.8. Cover Positioning Table

The Cover Positioning Table (see callout **H** in *Figure 3-15*) provides a tilted nest that locates 12 covers (6 transfer covers and 6 non-transfer covers) in a repeatable position to ensure they are properly aligned before being placed to the next operation. When the Cover Delivery Robot End of Arm Tooling (EOAT) releases the covers to the table, the covers fall into the bottom edge of the nest and one of the nest sides. The Cover Install Robot EOAT then acquires the covers again in their repeatable position. Sensors in the table detect when covers are present or absent.

3.10.9. Robot and Vision Calibration Stand

The two Robot and Vision Calibration Stands (see callout **I** in *Figure 3-15*) each provide a calibration grid that is used as a reference when calibrating the robot and robot vision equipment. Terminal Cap Install Robot shares a calibration stand. Calibration of the robot and robot vision equipment is documented in the associated Fanuc documentation.

REFERENCE

For information about the robot and vision equipment calibration, refer to the equipment supplier documentation (Fanuc Robot R-2000 iC Operator's Manual pg. 26-65).

3.11. MODULE TRANSFER (EX280) EQUIPMENT

Module Transfer (see ***Figure 3-16***) performs a BOM check on the module on a pallet and offloads the module into stacked trays that are retrieved by an AGV for further processing downstream in other equipment.

Equipment Callouts in Figure 3-16		
A	EX270T01	Entry Conveyance
B	EX280R01	Module Transfer Robot
C	EX300T01	Empty Dunnage Conveyor
D	EX300T02	2P Dunnage Conveyor
E	EX300T03	3P Dunnage Conveyor
F	EX350T01	Exit Conveyance
G	EX400	Set In/Out
H	N/A	BOM Check

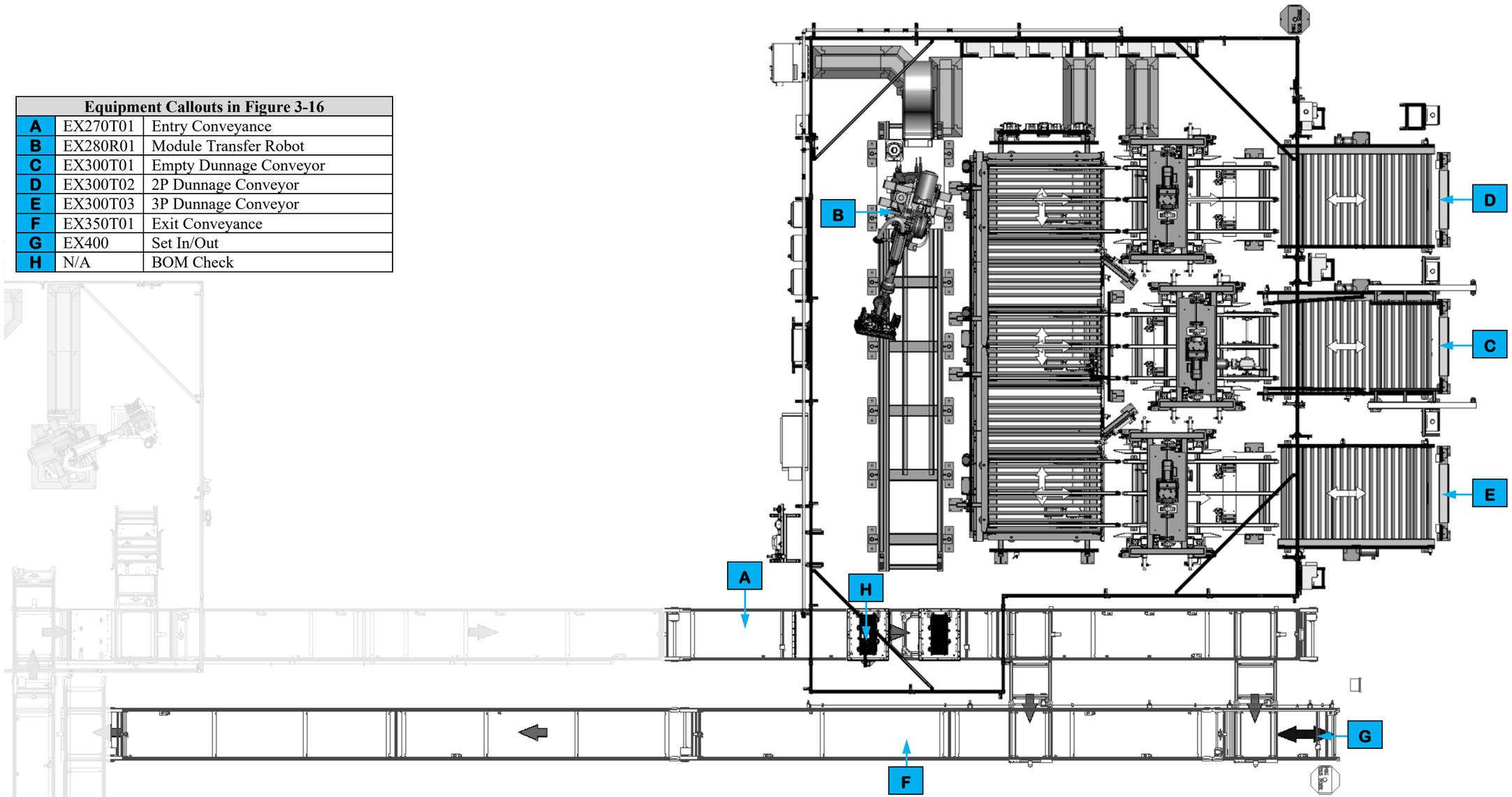


Figure 3-16. Module Transfer equipment layout.

3.11.1. Sequence of Operation

Module Transfer completes the following operations during a normal cycle.

1. EX270T01 Entry Conveyance transports a pallet with a module assembly into the Module Transfer work cell and stops the pallet at a BOM Check position.
2. The BOM Check scans the module bar code and looks up all the component data to verify that the module has been properly assembled. If the module is good, the pallet is released to an unload position. If the module is a reject, the pallet is released downstream to EX400 Set In/Out.
3. When a good module is present at the unload position, a Lift Position Unit raises the pallet off the conveyor.
4. EX280R01 Module Transfer Robot manipulates End of Arm Tooling (EOAT) to pick the module off the pallet and then moves to EX300T02 2P Dunnage Conveyor or to EX300T03 3P Dunnage Conveyor, depending on the module type.
5. EX270T01 Entry Conveyance releases the pallet downstream where it is transferred to EX250T01 Exit Conveyance. If the pallet has a rejected module, EX250T01 Exit Conveyor transports the pallet to EX400 Set In/Out where an operator unloads the reject. EX250T01 Exit Conveyor transports the empty pallet downstream to EX500.
6. EX280R01 Module Transfer Robot locates an empty slot in a tray and manipulates the EOAT to place the module into the tray.
7. EX280R01 Module Transfer Robot moves clear of the tray.

Module Transfer completes the following operations when exchanging trays.

1. When a tray at EX300T02 or EX300T03 is full, the Dunnage Conveyor releases the tray into a Carrier Stacker.
2. The Carrier Stacker adds the tray to a stack of other full trays (until a total of four trays are stacked).
3. When four trays have been stacked, the Carrier Stacker releases the stack to a location where the stack can be retrieved by an AGV (AGV and downstream processing are not covered in this manual).
4. EX300T01 Empty Dunnage Conveyor Carrier Stacker singulates an empty tray out of a stack, toggles a flag on the tray to the appropriate module type (2P or 3P) and then transfers the empty tray to EX300T02 tray load position or EX300T03 tray load position.
5. A Crowder locates the tray in a repeatable position for module loading.
6. When EX300T01 Empty Dunnage Conveyor has no more trays in a stack, the conveyor transports a fresh stack of four trays into the Carrier Stacker and begins singulating the trays and transferring them to EX300T02 and EX300T03.

For more detailed sequences, refer to the ATS timing charts provided to your company.

3.11.2. EX270T01 Entry Conveyance

The Entry Conveyance equipment (see callout **A** in *Figure 3-16*) uses a roller chain conveyor section to transport pallets with module assemblies into the Module Transfer work cell. Cushioned stops are located throughout the conveyance with RFID tag readers at decision points and work positions. Pneumatic-actuated pallet lift-and-transfer units are used to transfer the pallets from one perpendicular conveyor section to another.

REFERENCE

For more information about the conveyance equipment, refer to the equipment supplier documentation (Bosch Belt Section BS 2 pg. 4-7, Bosch BS 2C-…, BS 2R… Belt Sections Assembly Instructions pg. 13-15, Bosch HQ 2U Lift Transverse Unit Assembly Instructions pg. 12-14, Bosch PE 2X Positioning Unit Assembly Instructions pg. 11-14).

3.11.3. EX280R01 Module Transfer Robot

The Module Transfer Robot (see callout **B** in *Figure 3-16*) picks a module from a pallet and places the module into a tray on the Dunnage Conveyors. The Module Transfer Robot consists of a Fanuc Robot Transport Unit (RTU) and a Fanuc R-2000IC/210F robot equipped with End of Arm Tooling (EOAT). The RTU is an electric servo-driven linear axis that shuttles the robot along a single axis between multiple pick and place points. The Fanuc robot manipulates several axes to properly position the EOAT to pick modules and place modules at various locations around the work envelope.

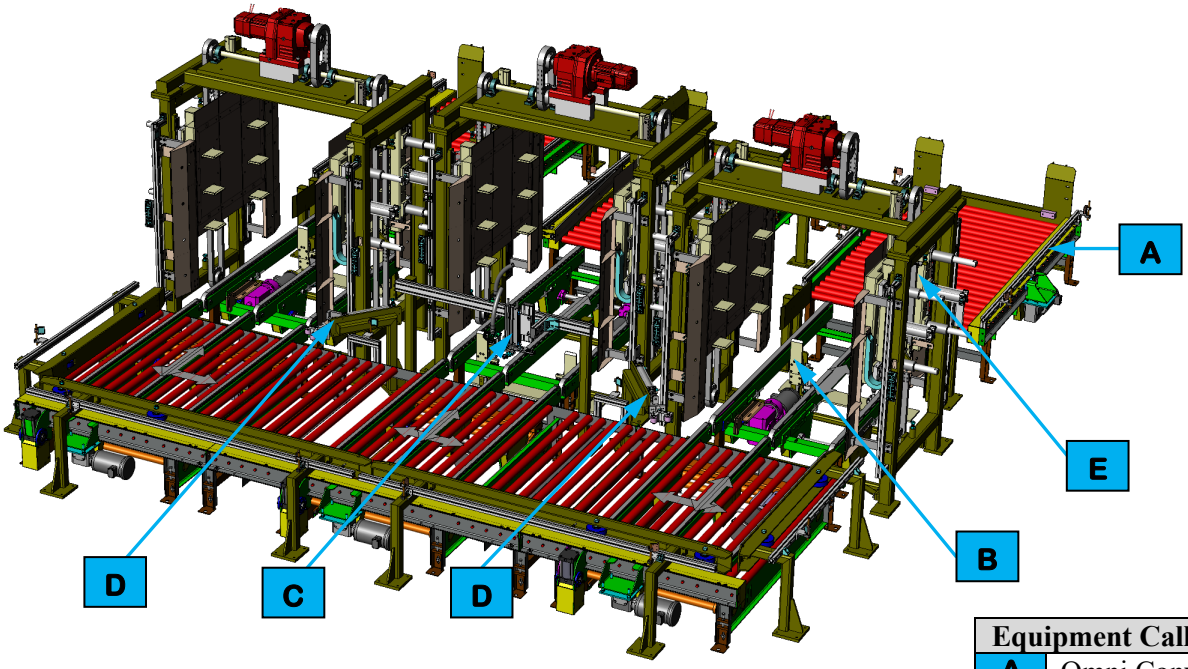
The EOAT is a mechanical gripping mechanism. When the Module Transfer Robot lowers the EOAT onto a module assembly in a pallet, locator keys help guide the EOAT onto the module. Once in position, a pair of pneumatic air cylinders actuate gripper fingers to close under the module ICB top plate lifting lugs. Pepperl & Fuchs background suppression sensors are positioned over each corner of the module and are used to detect if the module is not gripped correctly (the module is tilted, crooked, or in some way is not level). When the EOAT has correctly gripped the module, the Module Unload Robot manipulates the EOAT to pick the module straight off the pallet. The EOAT features two Nexen rod locks that engage in the event of a loss of air pressure to prevent the EOAT from dropping the module. The Module Unload Robot then moves the EOAT over an empty slot in an appropriate tray on the Dunnage Conveyors (either 2P or 3P, depending on the module type). A fifth background suppression sensor is positioned such that when the EOAT is located over the tray the sensor verifies that the slot is empty so that one module is not accidentally placed on top of another. When the slot is verified as being empty the Module Unload Robot lowers the EOAT, the air cylinders actuate the gripper fingers open, and the EOAT releases the module to the tray. The Module Unload Robot then moves the EOAT clear.

REFERENCE

For more information about the robot, refer to the equipment supplier documentation (Fanuc Generation VI – Robot Transport Unit (RTU) Mechanical Assembly pg. 3-9, Operation and Maintenance Manual, Fanuc Robot R-2000 iC Operator's Manual pg. 26-65).

3.11.4. EX300T01, T02, T03 Dunnage Conveyors

The Dunnage Conveyors (see callouts **C**, **D**, and **E** in *Figure 3-16*; and callout **A** in *Figure 3-17*) transport stacks of empty trays into the work cell, singulate the trays out of the stack one at a time, shuttle the trays to 2P and 3P load positions, shuttle the trays to stacking mechanisms that stack the trays, and shuttle the stacks of trays to positions where AGVs can retrieve the stacks and take them to further processing downstream in other equipment.



Equipment Callouts in Figure 3-17	
A	Omni Conveyor System
B	Pallet Stop
C	Pallet Flag Actuator
D	Crowder
E	Carrier Stacker

Figure 3-17. Dunnage Conveyor equipment layout.

3.11.4.1. Omni Conveyor System

The Omni conveyor system (see callout **A** in *Figure 3-17*) utilizes third-party equipment to convey stacks of trays and single trays around the station work envelope. Powered conveyor sections are used to pull trays into and out of the work cell. Each powered conveyor section has its own motor and motor starter.

> **REFERENCE**
>
> ***For more information about the conveyor equipment, refer to the equipment supplier documentation (Omni Chain Driven Live Roller Conveyor Straight and Curve Technical Handbook pg. 3-10).***

3.11.4.2. Pallet Stop

The Pallet Stop (see callout **B** in *Figure 3-17*) is located inside of each of the Carrier Stackers and is used to stop the forward travel of trays. Each Pallet Stop features two pneumatic cylinders that elevate lift plates along linear guide rails. Attached to the lift plates are stop blades that, when raised, prevent a tray from continuing along the Dunnage Conveyor.

When a tray or stack of trays is ready to be conveyed through the Carrier Stacker, the pneumatic cylinders lower the lift plates so that the stop blades are clear of the tray(s).

3.11.4.3. Pallet Flag Actuator

The Pallet Flag Actuator (see callout **C** in *Figure 3-17*) is located along the empty tray Dunnage Conveyor and is used to toggle a flag on the side of the tray that identifies the tray as being either a 2P or a 3P. The mechanism waits over an empty tray until either the 2P or 3P tray load position is empty. Once the tray load position is empty, the mechanism engages to toggle the flag to the appropriate designation for the load position. After the flag has been toggled the tray is conveyed to the empty load position.

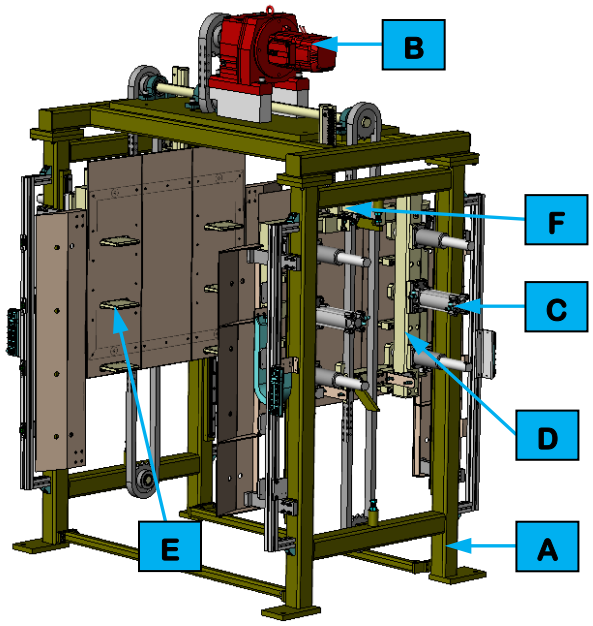
The mechanism utilizes a pneumatic air cylinder to lower the equipment to a work position and to raise the equipment clear. When lowered, two pneumatic slide tables (one in the X-axis, one in the Y-axis) move a push block as needed to change the tray flag appropriately. After the tray flag has been toggled the air cylinder raises the equipment clear.

3.11.4.4. Crowders

The Crowders (see callout **D** in *Figure 3-17*) are located at the 2P and 3P tray load positions and are used to crowd a tray into the corner of the load position and hold the tray square. Each Crowder utilizes a pneumatic air cylinder that extends a swivel yoke equipped with a pair of rollers.

3.11.4.5. Carrier Stackers

The Carrier Stackers (see callout **E** in *Figure 3-17, Figure 3-18*) are used to stack trays full of modules and to strip single empty trays from a stack. There are three Carrier Stackers: one for 2P trays, one for 3P trays, and one for empty trays. Each Carrier Stacker functions similarly.



Equipment Callouts in Figure 3-18	
A	Weldment Frame
B	Gearmotor
C	Air Cylinder
D	Lifting Frame
E	Lifting Fork
F	Ratchet

Figure 3-18. Carrier Stacker equipment layout.

Each Carrier Stacker is mounted to a weldment frame (see callout **A** in *Figure 3-18*) with tooling along the sides and a SEW Eurodrive gearmotor (see callout **B** in *Figure 3-18*) on top that turns a drive shaft with sprockets on the shaft ends. The sprockets drive roller chains that raise and lower tooling along linear guide rails on two sides of the weldment frame.

Pairs of air cylinders (see callout **C** in ***Figure 3-18***) on the two sides of the Carrier Stacker push against lifting frames (see callout **D** in ***Figure 3-18***) with attached lifting forks (see callout **E** in ***Figure 3-18***). The lifting forks are used to engage the top three trays in a stack.

Through-beam sensors along the front of the Carrier Stacker are used to detect the number of trays currently in a stack. The maximum number of trays that can be stacked is four.

There are two types of locking mechanisms to prevent unwanted (or unsafe) vertical motions. The first type is a brake in the gearmotor, preventing motion output. The second type is through ratcheting mechanisms (see callout **F** in ***Figure 3-18***) on the two sides of the Carrier Stacker. Each of the ratcheting mechanisms utilizes an air cylinder to advance a pawl into a rack that locks the entire mechanism in place (air cylinder retracts to pivot the pawl into the rack). The cylinder keeps the pawl engaged until the mechanism needs to raise or lower. The cylinder then extends to pivot the pawl clear to allow the motion to occur, and then retracts to pivot the pawl to engage once the motion is completed. In the event of a sudden drop in air pressure, the act of exhausting the pressure retracts the cylinder and automatically engages the pawl to prevent the mechanism from crashing downward.

The Carrier Stacker functions in the following manner to stack trays. To put a tray on the bottom of a stack, first the Carrier Stacker lowers to the correct position (position depends on the number of trays in the stack). The lifting forks are then extended to engage the trays already present. The Carrier Stacker raises to the correct position (position depends on the number of trays in the stack). The incoming tray is then conveyed under the stack. When the incoming tray is in position, the Carrier Stacker lowers to set the stack of trays onto the incoming tray. The lifting forks remain extended to support the upper trays until the stack is ready to be released. At that time the lifting forks are retracted, the Pallet Stop lowers, and the stack is conveyed out of the work cell.

The Carrier Stacker functions in the following manner to singulate trays. To release the tray from the bottom of a stack, first the Carrier Stacker lowers to the correct position (position depends on the number of trays in the stack). The lifting forks are then extended to engage the upper trays. The Carrier Stacker raises to the correct position (position depends on the number of trays in the stack). The bottom tray (not held by the lifting forks) is then released from under the stack. When the outgoing tray is clear, the Carrier Stacker lowers to set the stack of trays onto the conveyor. The lifting forks remain extended to support the trays.

3.11.5. EX350T01 Exit Conveyance

The Exit Conveyance equipment (see callout **F** in ***Figure 3-16***) uses four roller chain conveyor sections to transport pallets away from the Module Transfer work cell and then downstream to EX500 Module Return VTU. Cushioned stops are located throughout the conveyance with RFID tag readers at decision points and work positions. Pneumatic-actuated pallet lift-and-transfer units are used to transfer the pallets from one perpendicular conveyor section to another.

REFERENCE	***For more information about the conveyance equipment, refer to the equipment supplier documentation (Bosch Belt Section BS 2 pg. 4-7, Bosch BS 2C-…, BS 2R… Belt Sections Assembly Instructions pg. 13-15, Bosch HQ 2U Lift Transverse Unit Assembly Instructions pg. 12-14, Bosch PE 2X Positioning Unit Assembly Instructions pg. 11-14).***

3.11.6. EX400 Set In/Out

The Set In/Out position (see callout **G** in ***Figure 3-16***) is provided to allow operators to manually load or unload modules to/from pallets. The position includes a bank of controls that an operator uses for interface, a short section of roller chain conveyor, and pneumatic-actuated pallet lift-and-transfer units used to transfer the pallets from one perpendicular conveyor section to another. An RFID reader at the position reads the module bar code and the pallet RFID and joins the two (marries) or divorces the two. Refer to your company operating procedures for detailed information regarding the use of this position.

More information on Set in/out can be found in Chapter 4 sections ***4.3.8 Loading (or Unloading) Components***, ***4.3.9 Removing Rejects***, and ***4.3.10 Reintroducing Parts***.

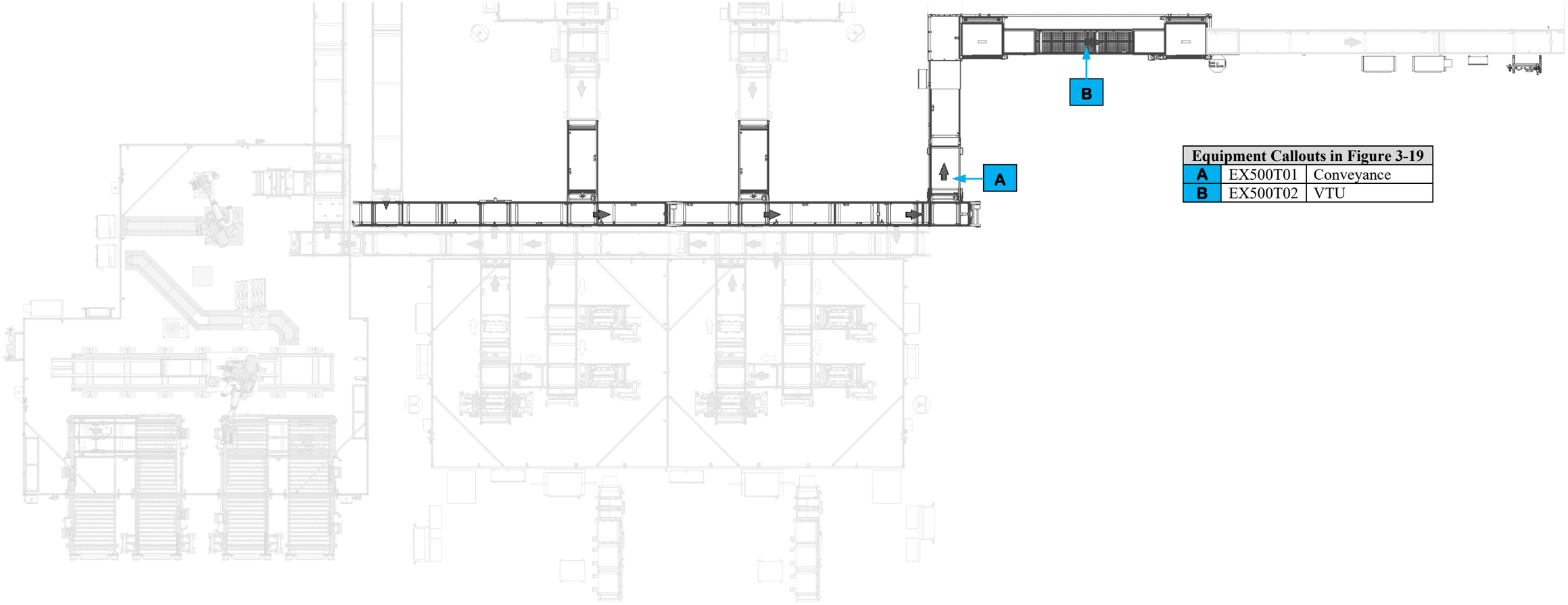
3.11.7. BOM Check

The BOM Check position (see callout **H** in ***Figure 3-16***) is used to look up all the components installed in a module on a pallet to confirm that the correct components are present and that all operations have been successfully completed. The position includes a North Coast hex ring light and a Matrox GTR camera mounted above the EX270T01 Entry Conveyance. The ring light illuminates the camera field of view. The camera captures an image of the module bar code so that the system can read the bar code and look up the associated data. If the data is correct, the module is processed by the Module Transfer work cell. If the data is incorrect, the pallet with the module is released to the EX400 Set In/Out position so that the module can be removed from the pallet.

REFERENCE	***For more information about the bar code camera, refer to the equipment supplier documentation (Matrox Iris GTR Install and Technical Manual pg. 10-20).***

3.12. MODULE RETURN VTU (EX500) EQUIPMENT

Module Return VTU (see ***Figure 3-19***) transports pallets with modules from EX110 Pulse Phase Thermography to the EX190 conveyor that services EX140 Module Electrical Test and transports empty pallets from EX280 to EX010 where the pallets can be loaded with new module assemblies.



Equipment Callouts in Figure 3-19		
A	EX500T01	Conveyance
B	EX500T02	VTU

Figure 3-19. Module Return VTU equipment layout.

3.12.1. Sequence of Operation

Module Return VTU completes the following operations during a cycle.

1. A pallet is transferred to the EX500T01 Conveyance from either EX110 Pulse Phase Thermography or EX280 Module Transfer.
2. The EX500T01 Conveyance transports the pallet downstream.
3. If the pallet contains a module from EX110, the pallet is transferred to the EX190 Entry Conveyance where the pallet is then transferred to the EX140 Entry Conveyance.
4. If the pallet is empty, the EX500T01 Conveyance transports the pallet to the EX500T02 VTU.
5. EX500T02 VTU transports the pallet to EX010 to begin the Module Final Assembly sequence again.

For more detailed sequences, refer to the ATS timing charts provided to your company.

3.12.2. EX500T01 Conveyance

The Conveyance Equipment (see callout **A** in ***Figure 3-19***) uses roller chain conveyor sections to transport pallets downstream. Cushioned stops are located throughout the conveyance with RFID tag readers at decision points and work positions. Pneumatic-actuated pallet lift-and-transfer units are used to transfer the pallets from one perpendicular conveyor section to another.

REFERENCE 	***For more information about the conveyance equipment, refer to the equipment supplier documentation (Bosch Belt Section BS 2 pg. 4-7, Bosch BS 2C-…, BS 2R… Belt Sections Assembly Instructions pg. 13-15, Bosch HQ 2U Lift Transverse Unit Assembly Instructions pg. 12-14, Bosch PE 2X Positioning Unit Assembly Instructions pg. 11-14).***

3.12.3. EX500T02 VTU

The VTU (see callout **B** in ***Figure 3-19***) consists of proprietary Bosch Vertical Transfer Modules (elevators) connected by a section of overhead roller chain conveyor. The first elevator raises each pallet (one at a time) to the overhead conveyor section. The overhead conveyor section transports the pallet to the second elevator. The second elevator lowers each pallet back to the main conveyor height. The pallet is then transferred to EX010 Module Input VTU.

The VTU provides an area where AGVs, forklifts, and personnel can move under and between the various work zones.

REFERENCE 	***For more information about the VTU equipment, refer to the equipment supplier documentation (Bosch TSplus Vertical Transfer Module Model VT2 Installation and Maintenance pg. 7-8, 10).***

4. SYSTEM OPERATION

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4.1. OPERATOR INTERFACE DEVICES

4.1.1. Summary

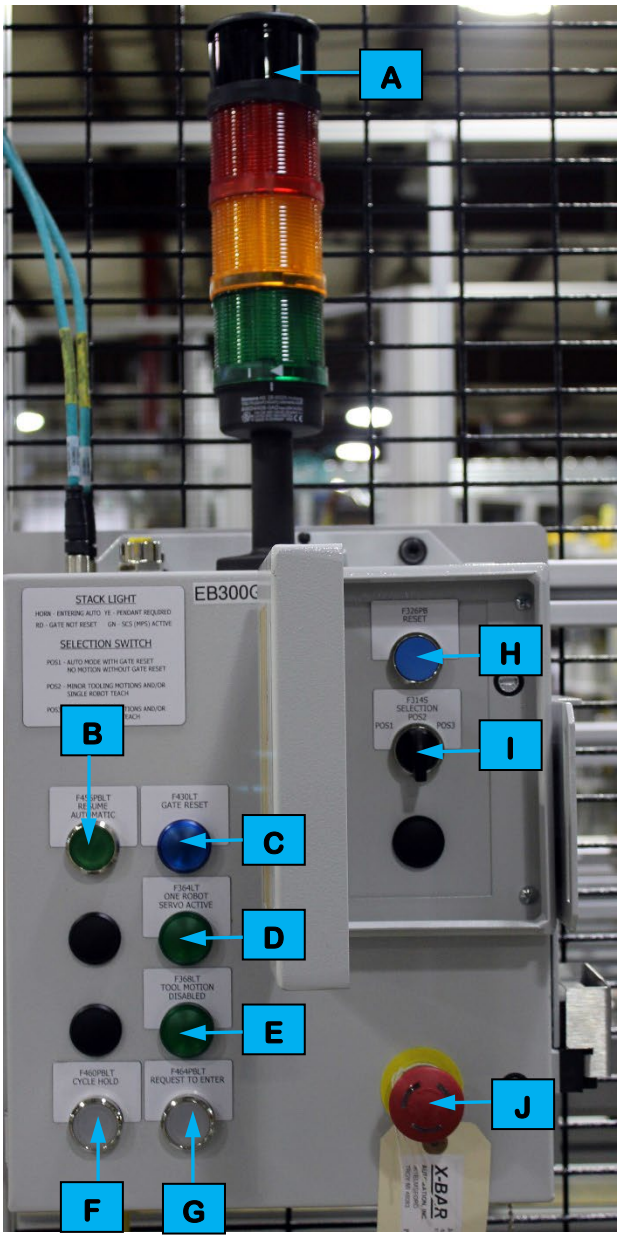
The following table identifies the common interface devices that are located at each of the Cells.

COMMON INTERFACE DEVICE TABLE						
	Module Input VTU (EX010)	**Post Tab Bend (EX020)**	**Tab Weld (EX070)**	**Module Cover Install (EX190)**	**Module Transfer (EX280)**	**Module Output VTU (EX500)**
Entrance Gate Box	-	-	✓	✓	✓	-
HMI	-	✓	-	✓	✓	-
PHMI	✓	-	✓	-	-	✓
Safety Device Junction Box	-	-	-	✓	✓	-
PDP	✓	✓	✓	✓	✓	✓
MCP	✓	✓	✓	✓	✓	✓
IDCP	✓	✓	✓	✓	✓	✓
Armorstart Motor Starter	✓	✓	✓	✓	✓	✓
Lockable Disable Box	✓	✓	-	-	-	✓
Main Air Supply Equipment	✓	✓	✓	✓	✓	✓
Station/Device Air Processing	✓	✓	✓	✓	✓	✓
Servo Control Panel	✓	-	✓	-	-	✓
Robot Controller	-	-	-	✓	✓	-
Chiller	-	-	✓	-	-	-
Laser Generator	-	-	✓	-	-	-
Dust Collector	-	-	✓	-	-	-
Conveyor Pull Cord	-	-	-	✓	✓	-

4.1.2. Entrance Gate Box

Each cell has an entrance gate box (see ***Figure 4-1***) at each guard door. Each gate box provides numerous controls, used as follows.

> **NOTE** ***Consult your GM-UAW Lockout training for a proper understanding of the MPS system. Chapter 4 details the procedure for using the Gate Box.***



Device Callouts in Figure 4-1	
A	Stack Light indicators
B	RESUME AUTOMATIC button
C	Gate Reset indicator
D	One Robot Servo Active indicator
E	Tool Motion Disabled indicator
F	CYCLE HOLD button
G	REQUEST TO ENTER button
H	RESET button
I	SELECTION toggle switch
J	E-STOP button

Figure 4-1. An illustration of an entrance gate box.

Stack Light Indicators

On top of the entrance gate box is a stack light (see **A** in ***Figure 4-1***) with three colored indicator lights and a horn. The lights and horn are used to indicate the status of the gate reset relay and the MPS system. When activated, each indicator identifies the following condition:

- Red Indicator (Flashing) – gate is not reset
- Yellow Indicator (Solid) – hazardous motion has been enabled and pendant is required
- Green Indicator (Solid) – MPS system is active, all hazardous motion has been disabled
- Horn – entering automatic mode

RESUME AUTOMATIC button

The RESUME AUTOMATIC button (see **B** in ***Figure 4-1***) is used to restart the cell after the safety system is reset and all other control devices have been placed in the proper state for automatic operation. An indicator light inside the button can illuminate solid, flash off and on, or go dark to indicate the following:

- Steady On – all stations are in auto
- Normal Flash – all stations are ready for auto
- Rapid Flash – at least one station is not in auto or is not ready for auto
- Off – no stations are in auto or are not ready for auto

Gate Reset Indicator

The Gate Reset indicator (see **C** in ***Figure 4-1***) illuminates to indicate the gate is closed and reset.

One Robot Servo Active Indicator

The One Robot Servo Active indicator (see **D** in ***Figure 4-1***) illuminates to indicate the gate is not reset, one of the robot servo contactors has been successfully enabled, an any other robots are disabled by the Entrance Gate Box.

Tool Motion Disabled Indicator

The Tool Motion Disabled indicator (see **E** in ***Figure 4-1***) illuminates to indicate when the gate is not reset and the tool outputs are disabled by the entrance gate box.

CYCLE HOLD Button

The CYCLE HOLD button (see **F** in ***Figure 4-1***) stops the cell after the cycle has been completed. Inside the button is a white indicator that flashes when the button is pressed and turns solid when the cell has come to rest at the end of the cycle. The indicator will also flash if the Position Selector is not in “Pos1” after closing and resetting the Entrance Gate Box.

REQUEST TO ENTER Button

The REQUEST TO ENTER button (see **G** in ***Figure 4-1***) stops the cell after the cycle has been completed. Inside the button is a white indicator that flashes when the button is pressed and turns solid when the cell has come to rest at the end of the cycle. Once the cycle is complete and all devices have come to a stop and the button is solid, the gate can be opened. The indicator will also flash if the Position Selector is not in “Pos1” after closing and resetting the Entrance Gate Box.

RESET Button

The RESET button (see H in *Figure 4-1*) re-energizes the gate reset function once the gate has been closed and the Fortress Interlocks slide switch has been re-inserted into the gate box.

SELECTION Toggle Switch

The three-position selector switch (see I in *Figure 4-1*) allows maintenance personnel to selectively enable or disable hazardous and non-hazardous tooling motions within the cell for routine maintenance tasks. The selector switch provides the following levels of control:

- Pos1 – allows automatic operation if the gate is reset; disables all tooling motion with the gate open. The switch must be in this position for automatic mode.
- Pos2 – allows only non-hazardous (minor) tooling motion within the cell and/or single robot teach.
- Pos3 – allows all tooling motion within the cell, with hazardous (major) motion requiring the use of an enabling pendant. This position also allows all robot teach.

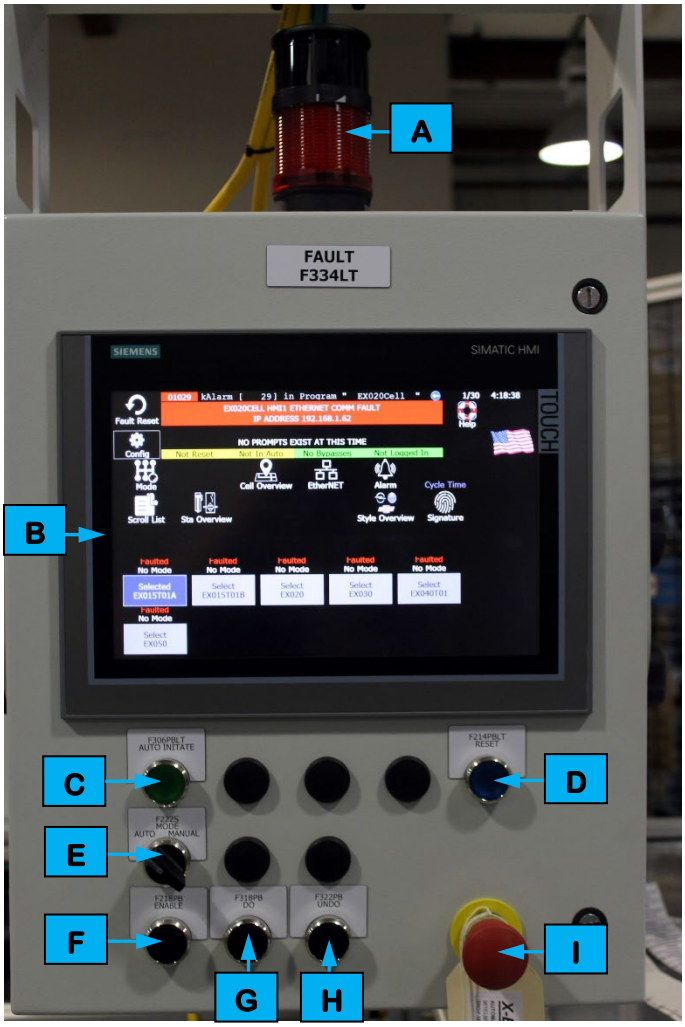
The selector switch does not affect non-motion output power, such as indicators, vacuum, and horns.

E-STOP Button

The EMERGENCY STOP button (see J in *Figure 4-1*) immediately removes control power from the cell. The EMERGENCY STOP button requires the button to be pulled back out after it has been pressed in. After pressing an EMERGENCY STOP button, follow the recovery procedure outlined in Chapter 4.

4.1.3. HMI

Most cells have their own HMI terminal (see ***Figure 4-2***) that provides operator interface with the equipment. The devices contained within the terminal are detailed in the section that follows.



Device Callouts in Figure 4-2	
A	Stack Light indicators
B	Touch Panel
C	AUTO INITIATE button
D	RESET button
E	AUTO/MANUAL key
F	ENABLE button
G	DO button
H	UNDO button
I	E-STOP button

Figure 4-2. An illustration of a remote HMI terminal.

Stack Light Indicators

A tower with a stack light provides visual indicators as to the status of the equipment. The red light illuminates when a fault is present.

Touch Panel

A Siemens Simatic Touch Panel provides the main means of operator interface with the equipment. The Touch Panel features a touch-sensitive screen that displays control and setup screens. More detailed information on these screens can be found at ***4.2 HMI Screens***.

AUTO INITIATE Button

The AUTO INITIATE button begins an automatic cycle (if conditions allow). An indicator light inside the button can illuminate steady, flash off and on, or go dark to indicate the following:

- Steady On – all stations are in auto
- Normal Flash – all stations are ready for auto
- Rapid Flash – at least one station is not in auto and is not ready for auto
- Off – no stations are in auto and are not ready for auto

RESET Button

The RESET button enables a power reset. An indicator light inside the button can illuminate steady, flash, or go dark to indicate the following:

- Steady On – power is reset
- Flashing – ready for reset
- Off – not ready for reset
- **AUTO/MANUAL Key**
- The AUTO/MANUAL key toggles the cell between automatic mode and manual mode. In manual mode, many of the interlocks are overridden to allow for more complete control of the equipment. While the interlocks are overridden, certain hazards are present. As such, the switch should typically be set to AUTO and the key removed and retained by authorized maintenance personnel.

ENABLE Button

The ENABLE button permits minor tooling motion while gates are open. Hold the button with one hand and use the other to press the DO button in conjunction with the Scroll List screen to initiate an action.

DO Button

The DO button initiates an action prompted on the cell HMI (if conditions allow). In Manual Mode, the DO button also will perform a manual action highlighted on the Scroll List screen if the action is mechanically clear.

UNDO Button

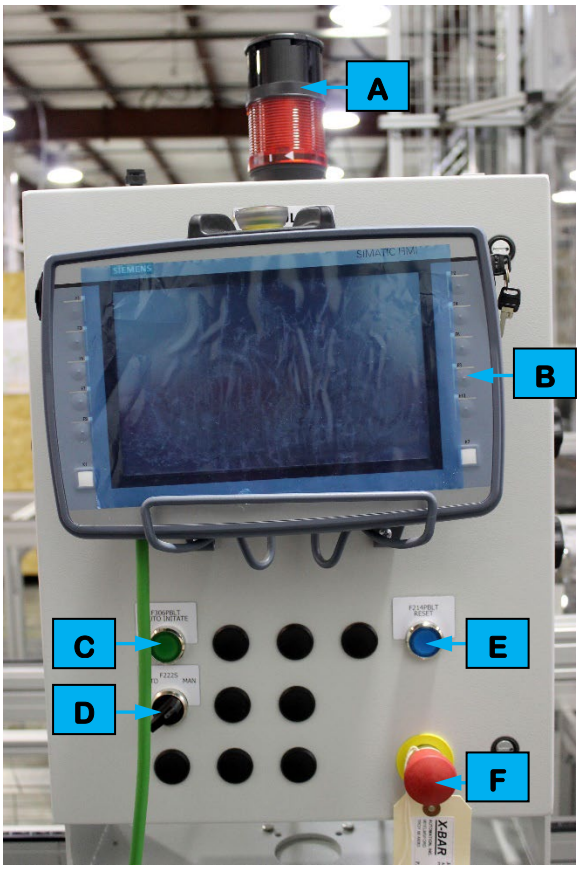
The UNDO button undoes the action prompted on the cell HMI (if conditions allow). In Manual mode, the UNDO button will also perform the inverse manual action highlighted on the Scroll List screen if the action is mechanically clear.

E-STOP Button

The EMERGENCY STOP button immediately removes control power from the cell. The EMERGENCY STOP button requires the button to be pulled back out after it has been pressed in. After pressing an EMERGENCY STOP button, follow the recovery procedure outlined in ***4.3.5 Recovering from an Emergency Stop***.

4.1.4. Portable HMI

Some cells have an enclosure that houses a Portable HMI (PHMI, see ***Figure 4-3***). Controls and indicators on the enclosure are duplicates of those located elsewhere in the system. These duplicated controls can be activated from the most convenient location.



Device Callouts in Figure 4-3	
A	Stack Light Indicator
B	Mobile Panel
C	AUTO INITIATE button
D	AUTO/MANUAL selector
E	RESET button
F	E-STOP button

Figure 4-3. An illustration of a portable HMI enclosure.

In addition to a connection port for the PHMI, the enclosure features the following controls and indicators.

Stack Light Indicator

The red stack light illuminates when a fault is present.

Mobile Panel

The PHMI is an HMI that is small enough to carry and allows a person to get closer to the equipment for manual operation. The PHMI has a built-in enabling pendant to enable/disable tool motion. The PHMI manually controls only tooling motion and is not a robot teach pendant.

AUTO INITIATE Button

The AUTO INITIATE button begins an automatic cycle (if conditions allow). An indicator light inside the button can illuminate steady, flash off and on, or go dark to indicate the following:

- Steady On – all stations are in auto
- Normal Flash – all stations are ready for auto
- Rapid Flash – at least one station is not in auto and is not ready for auto
- Off – no stations are in auto and are not ready for auto

AUTO/MANUAL Select

The AUTO/MANUAL key toggles the cell between automatic mode and manual mode. In manual mode, many of the interlocks are overridden to allow for more complete control of the equipment. While the interlocks are overridden, certain hazards are present. As such, the switch should typically be set to AUTO and the key removed and retained by authorized maintenance personnel.

RESET Button

The RESET button enables a power reset. An indicator light inside the button can illuminate steady, flash, or go dark to indicate the following:

- Steady On – power is reset
- Flashing – ready for reset
- Off – not ready for reset

E-STOP Button

The EMERGENCY STOP button immediately removes control power from the cell. The EMERGENCY STOP button requires the button to be pulled back out after it has been pressed in. After pressing an EMERGENCY STOP button, follow the recovery procedure outlined in *4.3.5 Recovering from an Emergency Stop*.

4.1.5. Safety Device Junction Box

The Safety Device Junction Box provides connectivity and interface from the Main Control Panel to the cell by picking up wiring for light screens, safety mats, and auxiliary power for valve manifolds. The junction box features the following controls and indicators.

Amber Light

An amber indicator light sits atop the junction box and is used to identify when the cell safety circuit is muted.

Override Active Indicator

An override active indicator light illuminates whenever the AUTO/OVERRIDE key is set to OVERRIDE.

AUTO/OVERRIDE Key

The AUTO/OVERRIDE key is used to toggle the operating mode of the light screens and other safety devices. The override function can only be used for 120- seconds at a time. The switch must be held in the OVERRIDE position.

RESET GUARDS Button

The RESET GUARDS button is used to reset the guard safety circuit.

4.1.6. Power Distribution Panel

The Power Distribution Panel (PDP) supplies AC power to all robots, motors, and other devices in the cell. The PDP also supplies 120 VAC power to various cell components. The PDP is supplied from the plant bus. A main disconnect switch (identified as Lockout Point E-1) is used to enable and disable control power. Indicator lights on the front of the panel illuminate to identify when the processor power is enabled and when the control power is enabled. Refer to the ECPL placards on each PDP for information about locking out the cell energy sources.

4.1.7. MCP

The Main Control Panel (MCP) is a proprietary enclosure housing the cell processor, Ethernet module, and other miscellaneous components. The MCP is a proprietary "PLC-in-a-box" from Allen-Bradley.

4.1.8. Integrated Drive Contactor Panel

Power is distributed from the cell PDP to an Integrated Drive Contactor Panel (IDCP). This enclosure houses the safety contactors that enable power to the cell conveyors. The enclosure has an independent disconnect switch that can be used to disrupt power to all cell conveyors. Refer to the ECPL placards on each PDP for information about locking out the cell energy sources.

4.1.9. Armorstart Motor Starter

Each conveyor in each cell has a separate motor starter that is used to enable or disable power to the individual conveyor motor. The motor starter is a proprietary device with a rotary disconnect. A lockout hole in the handle allows a lock to be installed for energy control purposes. Refer to the ECPL placards on each PDP for information about locking out a conveyor motor.

4.1.10. Lockable Disable Box

These boxes allow power to be shut off for specific sections of a cell, preventing tool motion. The switches are designed to accommodate a padlock when in the disabled position for lockout/tagout activities. Lockable disable boxes are located on the VTU units of EX020 and EX500, as well as EX020.

4.1.11. Main Air Supply Equipment

Each cell requires compressed air and has its own air processing equipment that processes air supplied from the plant and distributes the processed air to the cell equipment. The air processing equipment has a shutoff valve (Lockout Point A-1) that removes the flow of processed air from the plant through the cell equipment. Turning the valve to the off position disconnects air pressure to the cell valve packs and vents the pressure through a muffler. A lockout hole in the handle of the valve allows a lock to be installed for energy control purposes. Refer to the ECPL placards on each PDP for information about locking out the cell energy sources.

4.1.12. Station/Device Air Processing Equipment

Specific devices, and groups of devices, have independent air shutoff valves that can be used to disconnect the air supply from only the associated equipment. Turning the valve to the off position disconnects air pressure to the devices and vents the pressure through a muffler. A lockout hole in the handle of the valve allows a lock to be installed for energy control purposes. Refer to the ECPL placards on each PDP for information about locking out the cell energy sources.

4.1.13. Servo Control Panel

Designated cells have a dedicated control panel that provides complete energy control and monitoring of all the servo motors within the cell. The outside of the panel enclosure features indicators that illuminate to identify when control power is on. A fused disconnect is located on the outside of the enclosure and is used to enable or disable control power for the associated servo drives. Refer to the GM standards and to the ATS electrical drawings for more information about the contactor panel equipment and functionality. Refer to the ECPL placards on each PDP for information about locking out the cell energy sources.

4.1.14. Robot Controller

Each robot has its own proprietary controller. Each controller features an electrical disconnect and a pneumatic disconnect (for robot end of arm tooling that utilizes vacuum equipment). Power is distributed from the cell Power Distribution Panel (Lockout Point E-1) to the robot controller. The robot controller distributes power to the robot. During normal cycling, the robot controller is automatically directed by the cell processor. By removing automatic control from the cell processor, interface buttons and other controls provide manual control of the robot. To remove power from the entire robot (480V), turn the electrical disconnect switch and pneumatic shutoff valve to off and install locks. Refer to the ECPL placard at the cell for more information.

REFERENCE

For more information about the robot equipment, refer to the equipment supplier documentation (Fanuc Robot R-2000iC Mechanical Unit Operator's Manual pg. 26-65).

4.1.15. Chiller

A Riedel chiller pumps coolant through the EX070 laser heads to keep the tooling cool. The chiller is a proprietary device with its own controls and interface devices.

REFERENCE

For more information about the chiller equipment, refer to the equipment supplier documentation (Riedel Chiller Operating Instructions pg. 12).

4.1.16. Laser Generator

A Trumpf laser generator has a fiber cable that provides a connection to a laser welding head inside of a semi-light-tight chamber. The laser generator and associated equipment is located around the outer perimeter of the chamber. The laser generator supplies the energy for the laser head to cycle. The laser generator is a proprietary device with its own controls and interface devices.

REFERENCE

For more information about the laser equipment, refer to the equipment supplier documentation (Trumpf Operator's Manual TruDisk 1000-8002 pg. 1-1 – 1-35).

4.1.17. Dust Collector

A Donaldson Torit evacuation system removes debris and fumes from the laser chamber. The evacuation system includes a duct spark cooler to mitigate sparks in the collection system by creating turbulence in the air flow stream. The dust collector is a proprietary device with its own controls and interface devices.

REFERENCE 	***For more information about the dust collector equipment, refer to the equipment supplier documentation (Donaldson Torit Downflo Oval DFO 1-1 to 3-3 Installation and Operation Manual pg. 2-3).***

4.1.18. Conveyor Pull Cord

Each of the dunnage conveyors at EX190 and EX280 have a conveyor pull cord that is used to indicate the loading or unloading of dunnage at a conveyor. Pull cords are utilized when loading and unloading is done manually. Stack lights are used in conjunction with the pull cords to indicate status.

4.2. HMI SCREENS

4.2.1. Summary

The following table identifies the HMI screens that are used at each of the Cells.

COMMON HMI SCREEN TABLE						
	Module Input VTU (EX010)	**Post Tab Bend (EX020)**	**Tab Weld (EX070)**	**Module Cover Install (EX190)**	**Module Transfer (EX280)**	**Module Output VTU (EX500)**
Select	✓	✓	✓	✓	✓	✓
Help		✓	✓	✓	✓	
Config		✓	✓	✓	✓	
Mode		✓	✓	✓	✓	
Cell Overview		✓	✓	✓	✓	
Cell Power & IO Overview		✓	✓	✓	✓	
Station (Tool) Overview		✓	✓	✓	✓	
Scroll List		✓	✓	✓	✓	
Ethernet Overview		✓	✓	✓	✓	
Ethernet Device		✓	✓	✓	✓	
Ethernet Linear		✓	✓	✓	✓	
Ethernet Switch Port		✓	✓	✓	✓	
Ethernet Switch		✓	✓	✓	✓	
Alarm		✓	✓	✓	✓	
Maintenance History		✓	✓	✓	✓	
Throughput Overview		✓	✓	✓	✓	
Station Throughput		✓	✓	✓	✓	
Style Overview		✓	✓	✓	✓	
Signature		✓	✓	✓	✓	
Robot				✓	✓	
Laser Function			✓			
Power Meter			✓			
Laser Config			✓			
Laser Status			✓			
Laser Mode			✓			
Laser Teach			✓			
Laser Handshakes			✓			
Servo			✓			
Service			✓	✓	✓	

The following flow chart identifies the screen navigation paths.

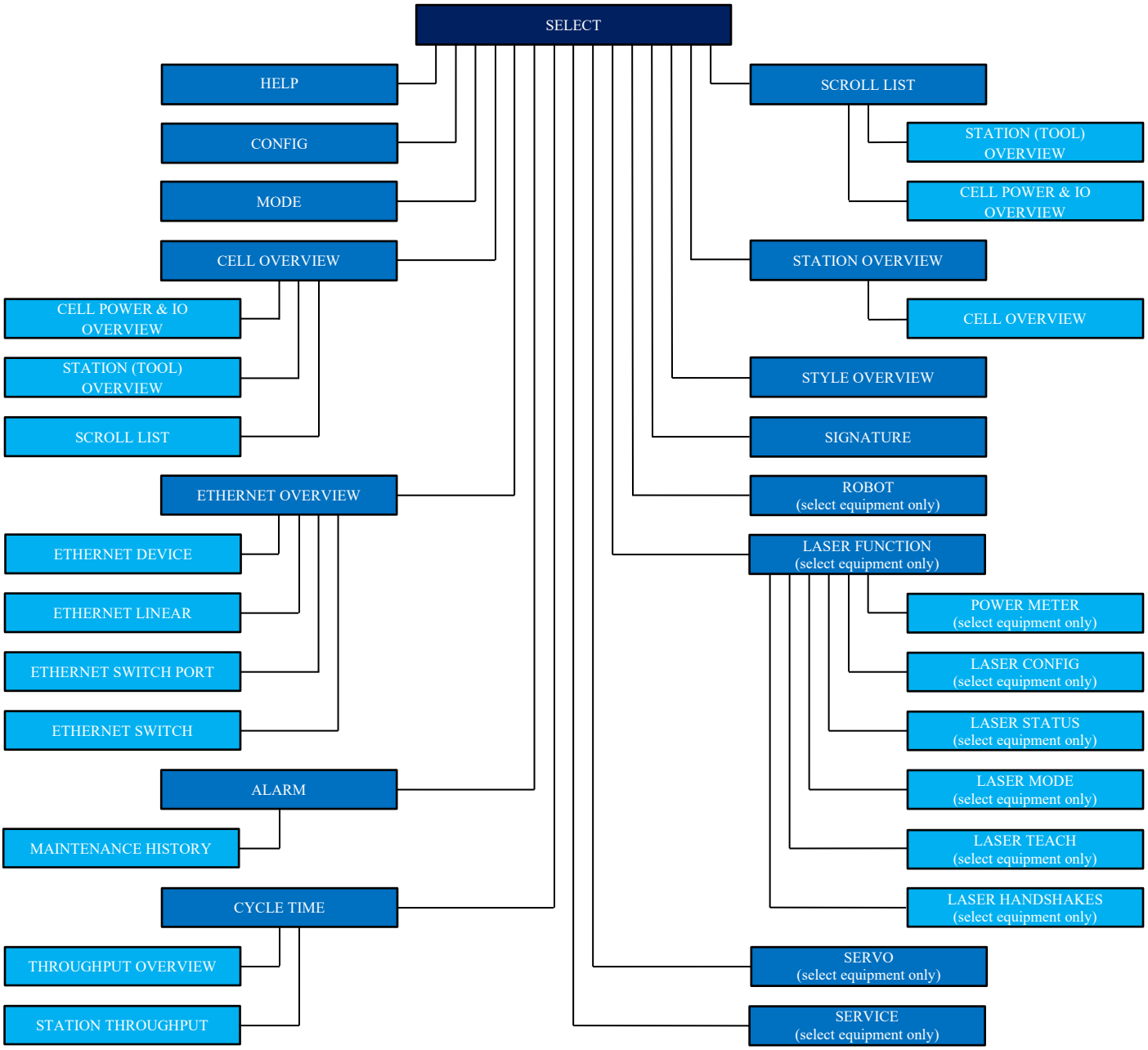


Figure 4-4. Screen navigation flow chart.

4.2.2. Screen Header

Each screen that displays on the touch panel features a common header (see ***Figure 4-5***).

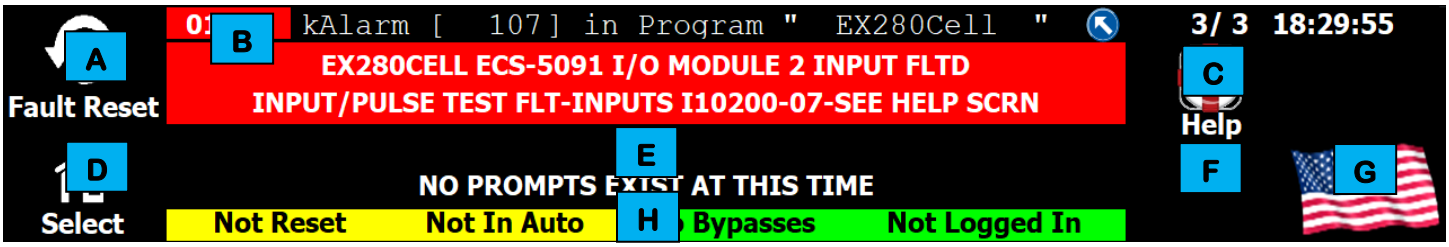


Figure 4-5. An illustration of an example screen header.

Each header features several areas of information and control, used as follows:

A This touch-button clears the alarm message detailed on the screen.

B This part of the header details the highest priority alarm. When an alarm displays, this area details the message number, message detail, program issuing the message, and the message itself. When no alarms are active, this area displays the screen name. Critical alarms that indicate the machine is stopped display in red.

C This touch-button (when available) navigates to a Help screen that may provide further details regarding the alarm message. When no alarm is active, the area displays the date and time.

D The function of this button varies and can be used for the following, depending upon what screen is displayed:

Select Screen – Navigates to the Select screen.
Config Screen – Navigates to the Config screen.
Return – Navigates back to the previously displayed screen.

E This part of the header details operator prompts. When a prompt displays (in blue or yellow), this area details the message number, message detail, program issuing the message, and the message itself. When no prompts are active "*NO PROMPTS EXIST AT THIS TIME*" is displayed.

F This touch-button (when available) returns to the previous screen.

G This touch-button toggles the language displayed on the touch panel.

H This area of the header (bottom) displays various states, depending upon the selections on the screen below. States displayed in this area include: *Gates OK*, *Bypasses Present*, and *All Processes On*.

4.2.3. Select Screen

Touching the **SELECT** button on the top of any screen navigates directly to a screen (see ***Figure 4-6***) that provides a menu of the screens available at the terminal.

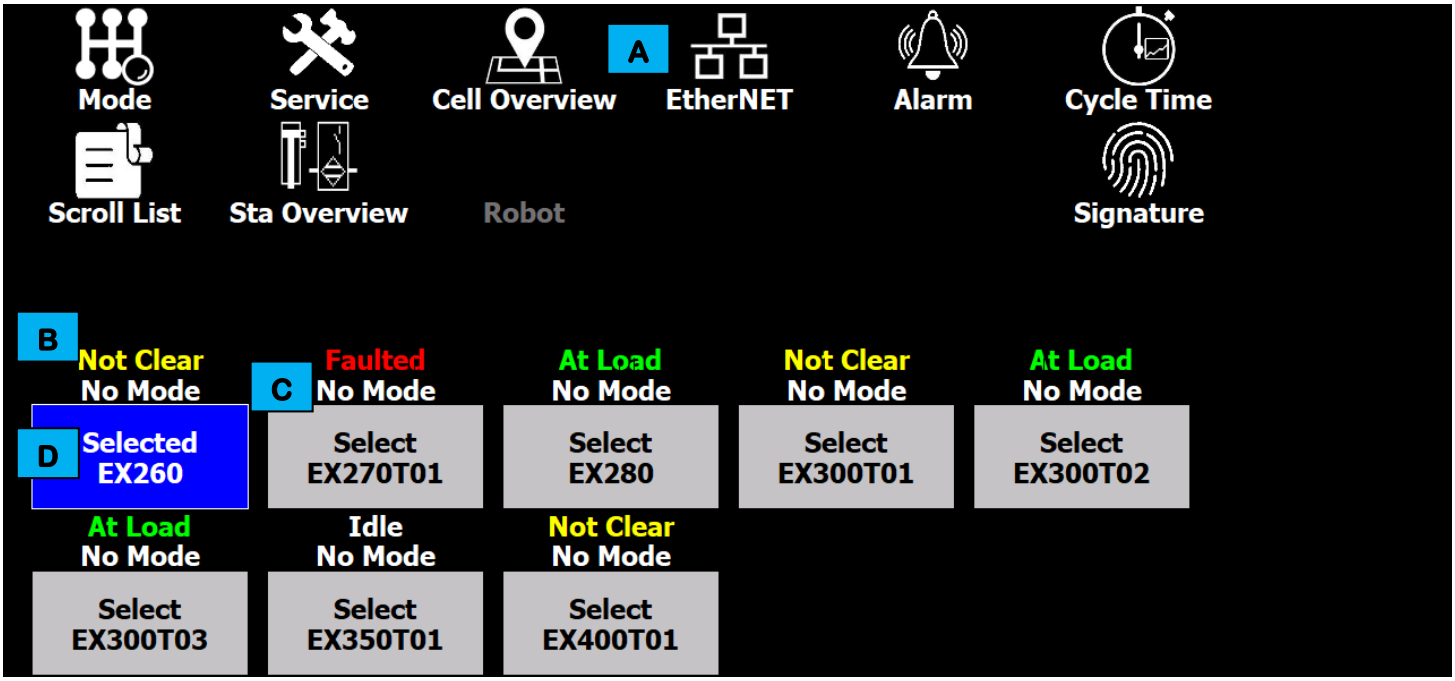


Figure 4-6. An illustration of an example Select screen.

Each Select screen features several areas of information and control, used as follows:

- **A** These touch-buttons open the indicated screen. The button availability varies with the control program selected at the bottom of the screen.
- **B** This area of the screen identifies the status of the station, such as *Faulted* or *At Load*.
- **C** This area of the screen identifies the current state or mode of the station, such as *Manual* or *Auto*.
- **D** This indicator identifies the PLC HMI program operating the HMI.

4.2.4. Help Screen

When available, touching the **HELP** button on the screen header navigates to a screen that provides further details regarding the fault or warning message displayed in the header. The screen is for informational use.

4.2.5. Config Screen

Touching the **CONFIG** button on the Select screen navigates directly to a screen (see ***Figure 4-7***) that can be used to change the HMI date and time and to close the HMI application.

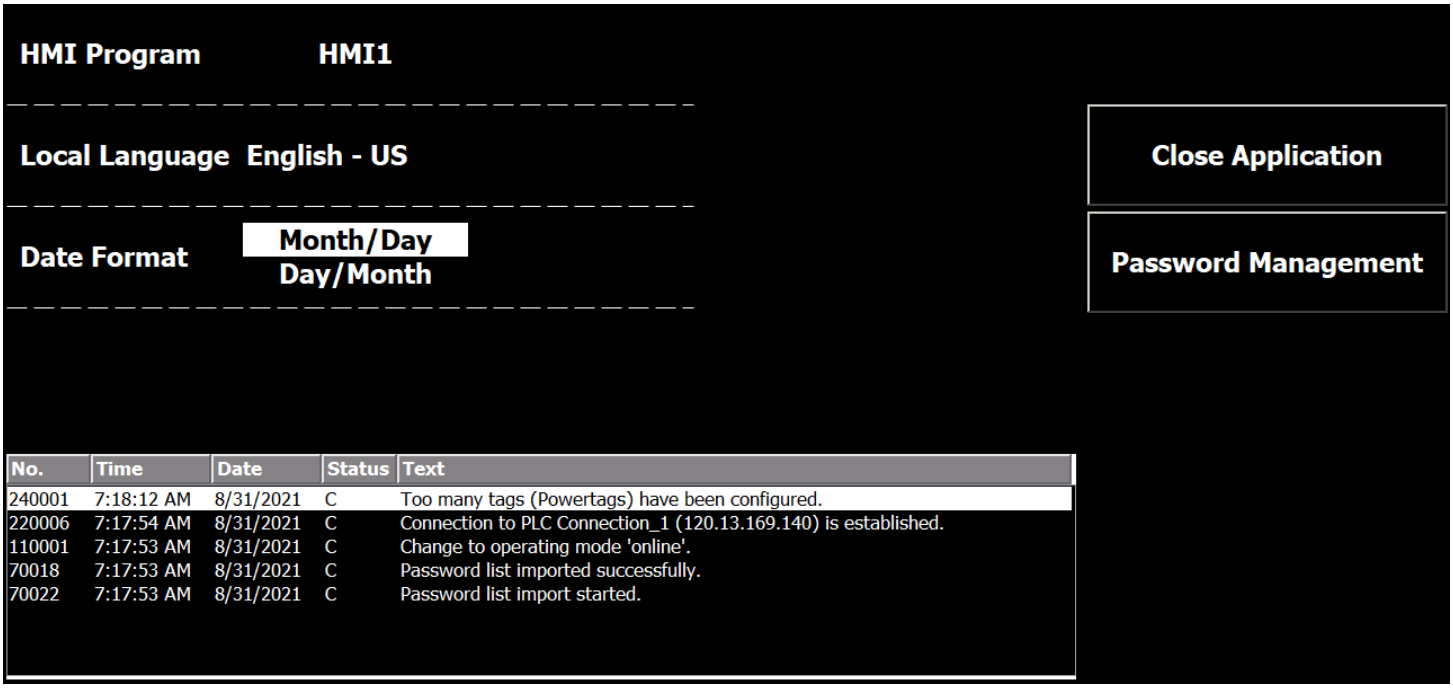


Figure 4-7. An illustration of an example Config screen.

4.2.6. Mode Screen

Touching the **MODE** button on the Select screen navigates directly to a screen (see ***Figure 4-8***) that can be used to toggle the system operating mode.

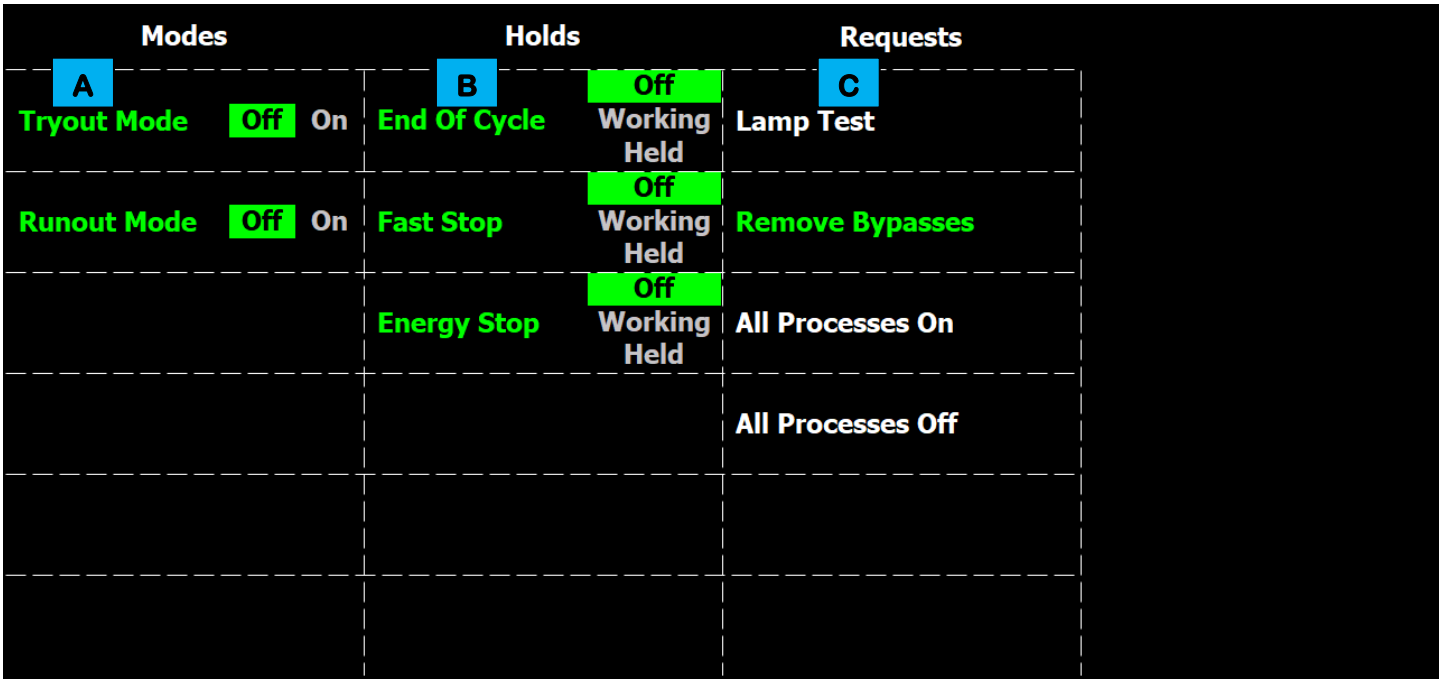


Figure 4-8. An illustration of an example Mode screen.

Each Mode screen features several areas of information and control, used as follows:

A This column provides selection of the following modes:
- *Tryout Mode* – When active, the area devices actuate through their cycles without using parts. This mode simulates the area actions without performing any actual work on the parts. This function should only be necessary during setup and for troubleshooting.
- *Runout Mode* – When active, new pallets of parts are no longer presented to the area, allowing the pallets currently in the area to complete processing. Once the pallets currently in the area have completed processing, the area comes to a stop.

B This column provides selection of the following holds:
- *End of Cycle* – When activated, the area completes the current cycle and then comes to a controlled stop.
- *Fast Stop* – When activated, the area equipment terminates the current cycle and comes to a stop.
- *Energy Stop* – When activated, the system comes to a controlled stop for a low-energy shutdown, such as over a weekend.

C This column provides selection of the following actions:
- *Lamp Test* – When activated, the various physical indicator lights and audible devices associated with the system (stack lights, button indicators, etc.) are enabled. All devices remain enabled while the button is touched and return to their live states once the button is released. This function is useful for checking for dead light bulbs.
- *Remove Bypasses* – When activated, all bypasses available are removed from the equipment.
- *All Processes On* – When activated, all available processes are enabled.
- *All Processes Off* – When activated, all available processes are disabled.

4.2.7. Cell Overview Screen

Touching the **CELL OVERVIEW** button on the Select screen navigates directly to a screen (see ***Figure 4-9***) that provides a graphical representation of the cell. It identifies the operational or faulted state of the cell level equipment and if stations within that cell have an active fault.

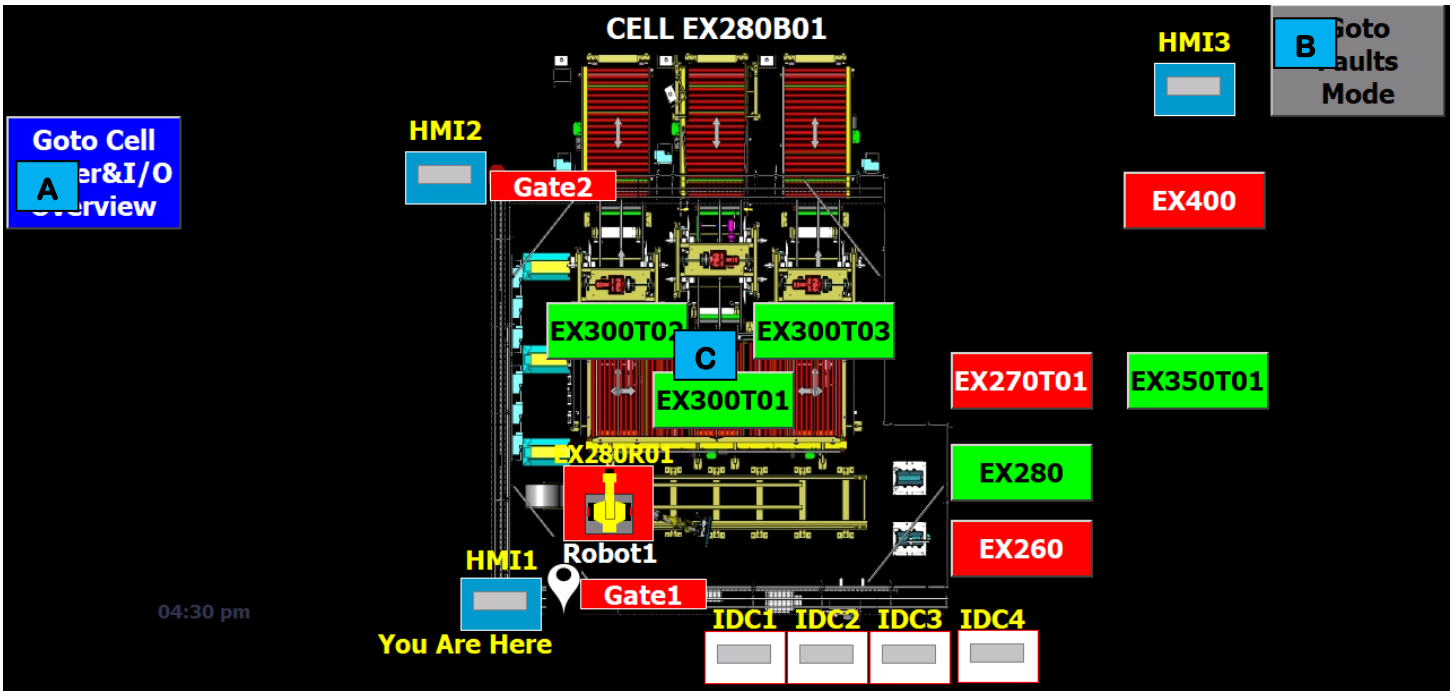


Figure 4-9. An illustration of an example Cell Overview screen.

Each Cell Overview screen features several areas of information and control, used as follows.

A This touch-button displays the Cell Power & I/O Overview screen.

B This indicator identifies the state of the cell control program. Green denotes the equipment is operational. Red denotes an active fault.
The indicator also serves as a button with multiple actions, depending on the screen set up. When `Goto Faults Mode` is active (blue button, touching the indicator displays the related fault message in the screen header. When `Goto Faults Mode` is inactive (gray button), touching the button navigates to the Station (Tool) Overview screen.

C Touch any of the buttons containing the name of a station to toggle the display to the associated area.

4.2.8. Cell Power & IO Overview Screen

Touching the **GOTO CELL POWER&IO OVERVIEW** button on the Cell Overview screen navigates directly to a screen (see *Figure 4-10*) that identifies the status of the cell power supplies and safe I/O blocks.

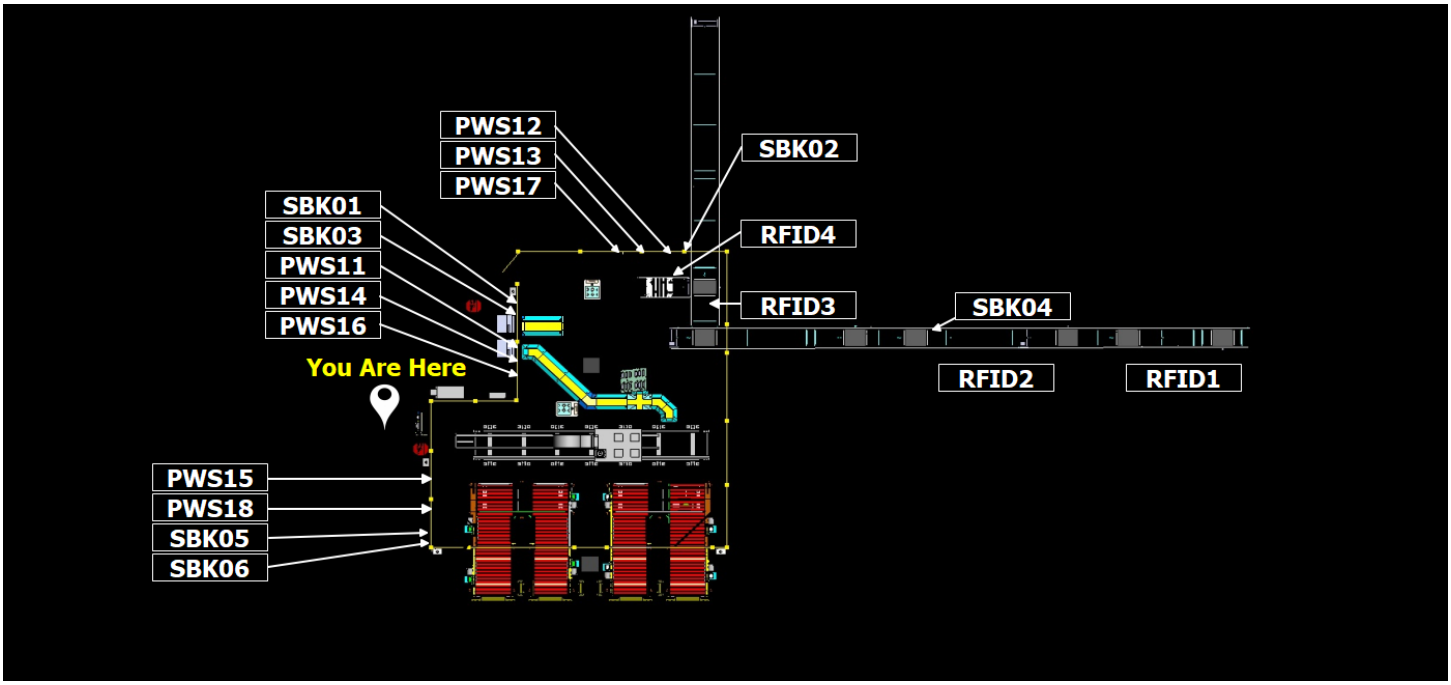


Figure 4-10. An illustration of an example Cell Power and I/O screen.

The screen is a display only. Black indicators identify a non-faulted state. Red indicators identify devices with power or other faults.

4.2.9. Station (Tool) Overview Screen

Touching the **STA OVERVIEW** button on the Select screen navigates directly to a screen (see ***Figure 4-11***) that displays station data.

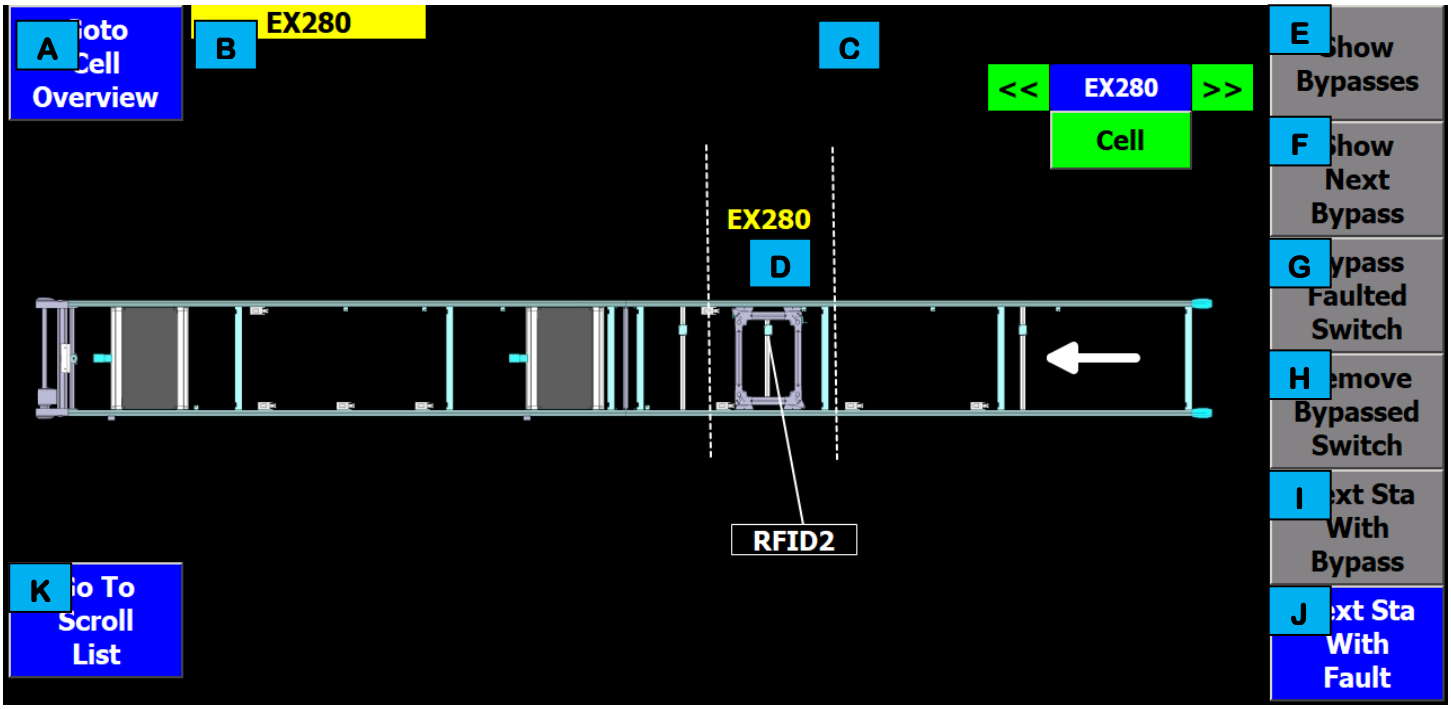


Figure 4-11. An illustration of an example Station Overview screen.

Each Station Overview screen features several areas of information and control, used as follows.

- **A** This touch-button displays a screen that provides a graphic representation (with state identifiers) of the area controlled by the PanelView HMI.
- **B** This indicator identifies which station is being displayed.
- **C** This indicator identifies the number of bypasses present. When no bypasses are present the indicator is not visible.
- **D** This area of the screen provides a graphical representation of the station. When an indicator is flashing red, the display is showing where the faulted device that is causing the currently displayed alarm message in the banner area is located.
- **E** This touch-button function changes depending on the presence of bypassed sensors. When the button is gray, none of the sensors on the station are bypassed. When the button is blue, it can be pressed to display the first bypassed sensor on the station. The accompanying alarm message will be shown in the alarm banner and the indicator in area **D** will illuminate red.
- **F** If more than one sensor is bypassed, this touch-button will cycle the screen display to show the next bypass.
- **G** If a faulted sensor has been configured in the PLC code as able to be bypassed, this touch-button will override the faulted device switch. The machine will default to the device fault timer for continued operation.
- **H** This touch-button removes an override from the displayed bypassed device switch.
- **I** This touch-button will select the next station with an active bypass. The Station Overview screen for the next station will replace the graphics shown for the currently selected Station Overview screen.
- **J** This touch-button selects the next station with an active alarm. The Station Overview screen for the next station will replace the graphics shown for the currently selected Station Overview screen.

K This touch-button opens a screen that can be used to determine mechanism states and manually actuate devices.

4.2.10. Scroll List Screen

Touching the **SCROLL LIST** button on the Select screen navigates directly to a screen (see ***Figure 4-12***) that identifies the current state of devices and provides the ability to manually actuate device functions within the selected station.

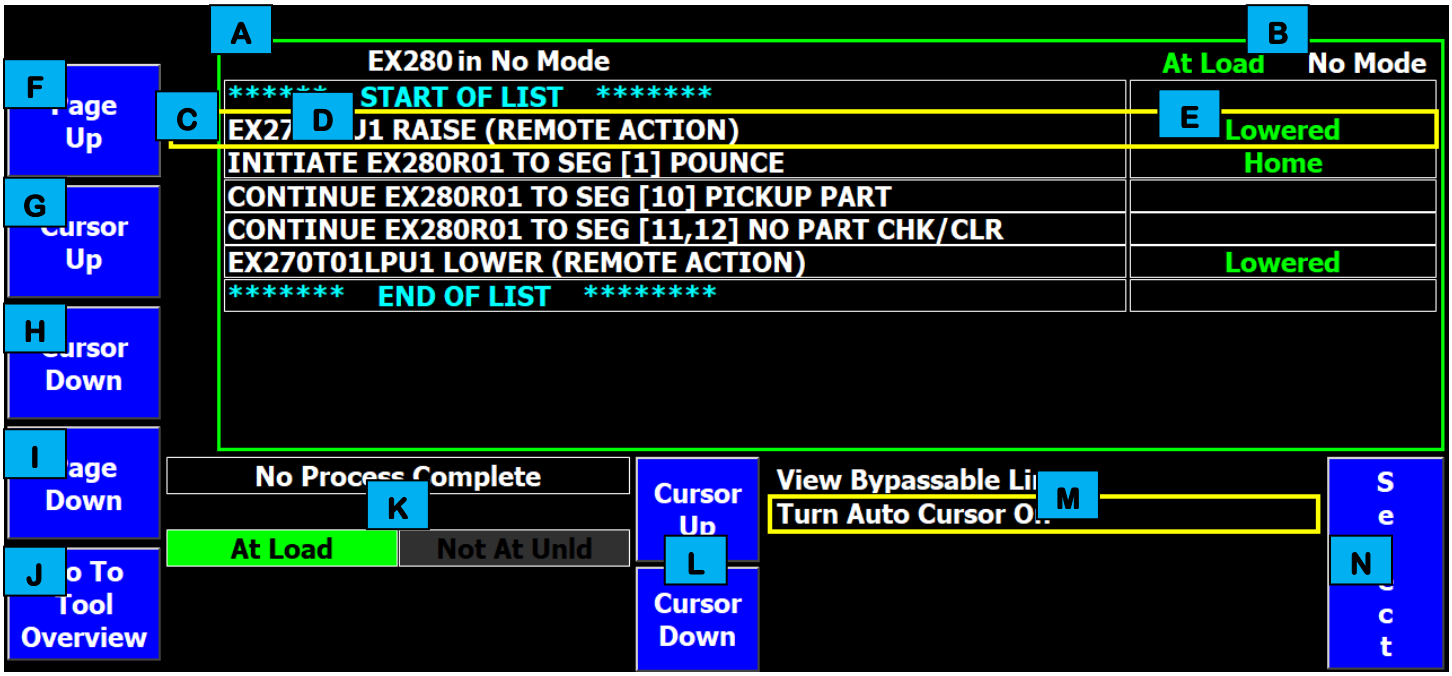


Figure 4-12. An illustration of an example Scroll List screen.

Each Scroll List screen features several areas of information and control, used as follows.

A This indicator identifies the selected station and if the scroll list is enabled (blue). When the scroll list is disabled, it will either prompt the operator (yellow) (area **D**) to re-enable the scroll list or display red, indicating another HMI has manual control of the station.

B These indicators identify the current state and mode of the station. The program mode must be set to Manual for the screen to be operational. The switch on the HMI cabinet must also be set to Manual.

C This row uses indicators to identify if a motion is clear (green) or is unavailable (black). Attempting to actuate a non-clear motion will display a prompt as to what tooling interference is restricting operation.

D This row lists the sequential actions for the station, one page at a time. A yellow box denotes the selected action. Use the touch-buttons on the left side of the screen [items **F** through **I**] for list navigation.

E This row identifies the current state of each action.

F This touch-button scrolls the action list [area **D**] up one page.

G This touch-button scrolls the action selector [top] upward one action.

H This touch-button scrolls the action selector [top] down one action.

I This touch-button scrolls the action list [area **D**] down one page.

J This touch-button displays the selected station Tool Overview screen.

K This area uses built-in and user-configurable indicators to identify the progress of the station cycle.

L These touch-buttons scroll the Scroll List Function List (bottom) selector up or down, one option at a time.

M This area lists the options for the selected action, one page at a time. A yellow box denotes the selected function. Use the **SELECT** button [item **N**] to interface with the option (interface in top list).

N This touch-button chooses the selected function [item **M**].

4.2.11. EtherNet Overview Screen

Touching the **ETHERNET** button on the Select screen navigates directly to a screen (see ***Figure 4-13***) that identifies the current state of each EtherNet connection at the cell.

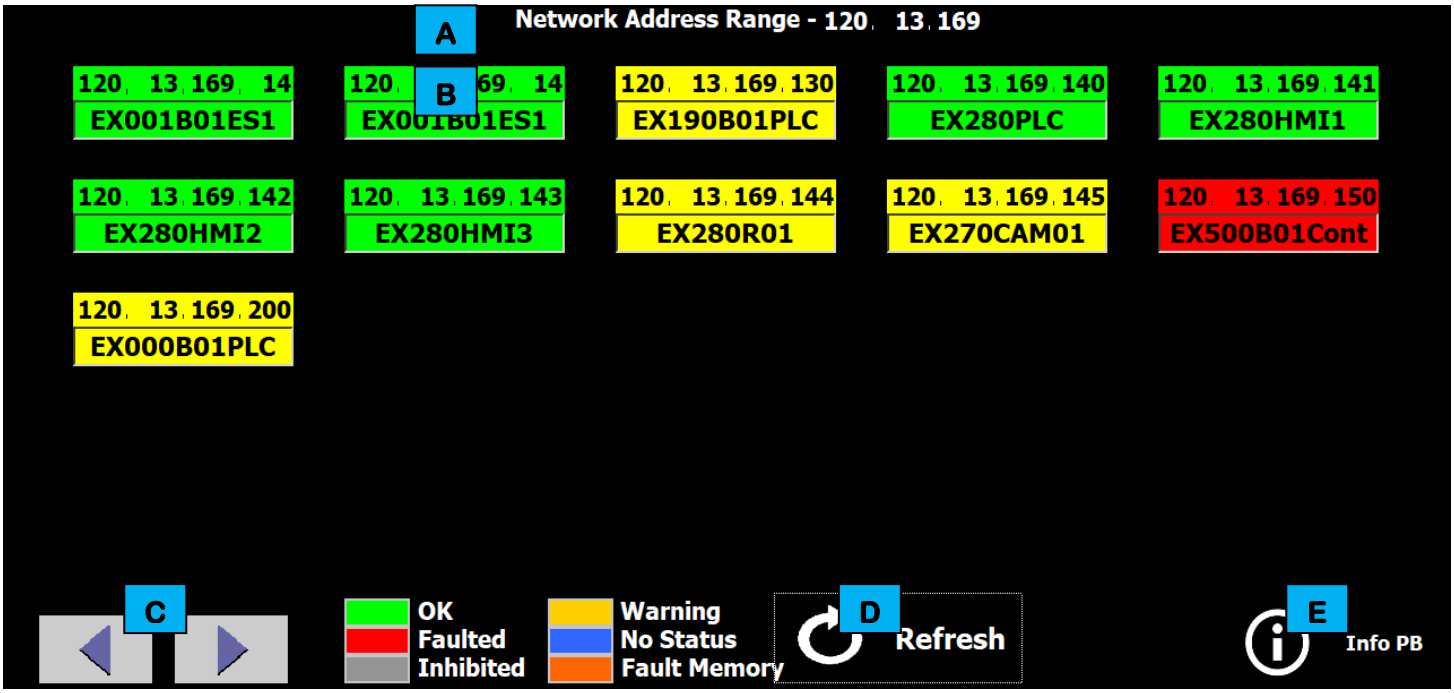


Figure 4-13. An illustration of an example EtherNet Overview screen.

Each EtherNet Overview screen features several areas of information and control, used as follows.

A This area of the screen identifies the EtherNet network currently displayed.

B Each device features a two-part indicator. The top of the indicator identifies the node number associated with the device. The bottom of the indicator identifies the device program name. The bottom of the screen identifies the meaning of each indicator color.
Touching a device displays a selection menu that provides access to the additional EtherNet screens (Device, Linear, Switch Port, and Switch).

C These buttons are used to scroll through the complete list of EtherNet device connections.

D This button refreshes the connection statuses.

E This button displays helpful information about the screen and buttons. Touching the button once displays the information fields. Touching the button again turns the information fields off.

4.2.12. EtherNet Device Screen

From the EtherNet Overview screen, touch an EtherNet device to display a popup menu. From the menu, touch the **SHOW DEVICE DETAILS** button. The EtherNet Device screen (see *Figure 4-14*) displays the detailed device status.

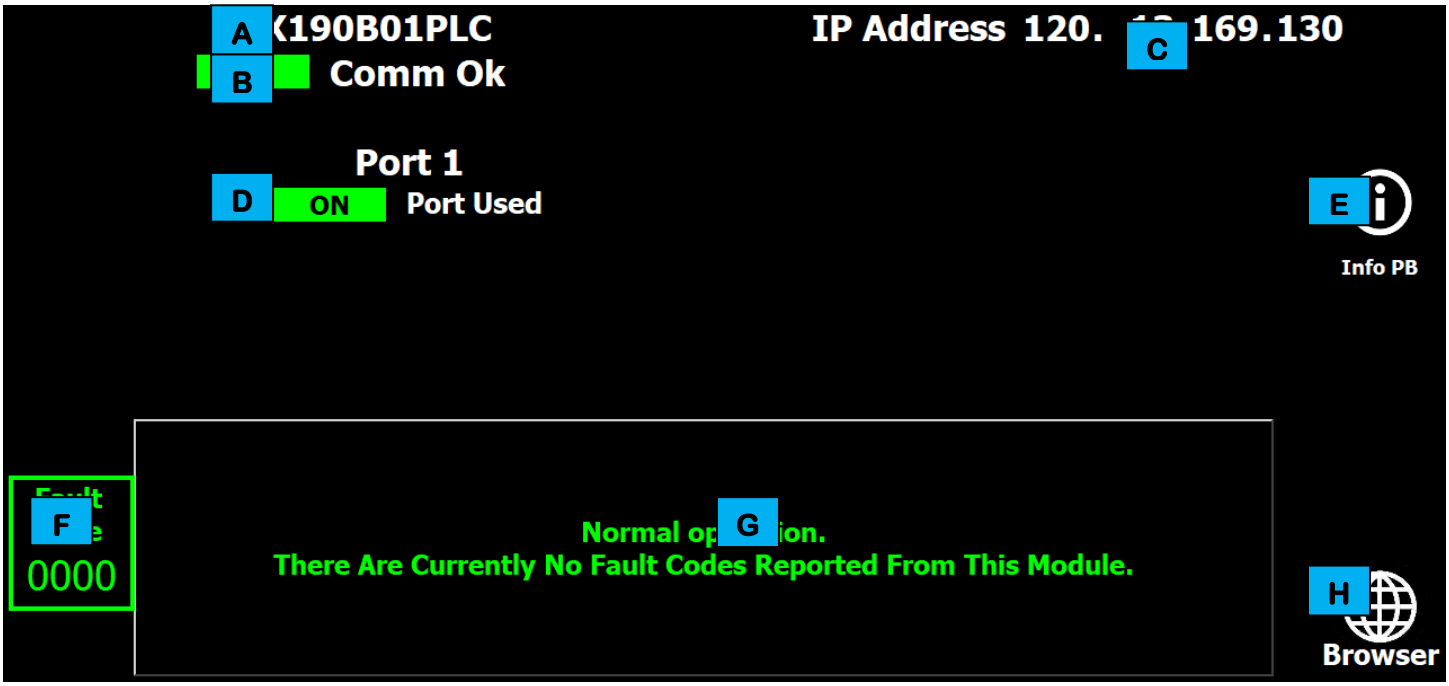


Figure 4-14. An illustration of an example EtherNet Device screen.

Each EtherNet Device screen features several areas of information and control, used as follows.

- **A** This field displays the device name.
- **B** This field displays the overall device status.
- **C** These fields display the device addresses.
- **D** These fields display the status of the ports.
- **E** This button displays helpful information about the screen and buttons. Touching the button once displays the information fields. Touching the button again turns the information fields off.
- **F** This field displays the current fault message code number.
- **G** This field displays the current fault message.
- **H** Some (but not all) devices have an internal web server. Touching this button provides access to that server.

4.2.13. EtherNet Linear Screen

From the EtherNet Overview screen, touch an EtherNet device to display a popup menu. From the menu, touch the **SHOW LINEAR NETWORK** button. The EtherNet Linear screen (see ***Figure 4-15***) displays devices as they are connected on the network.

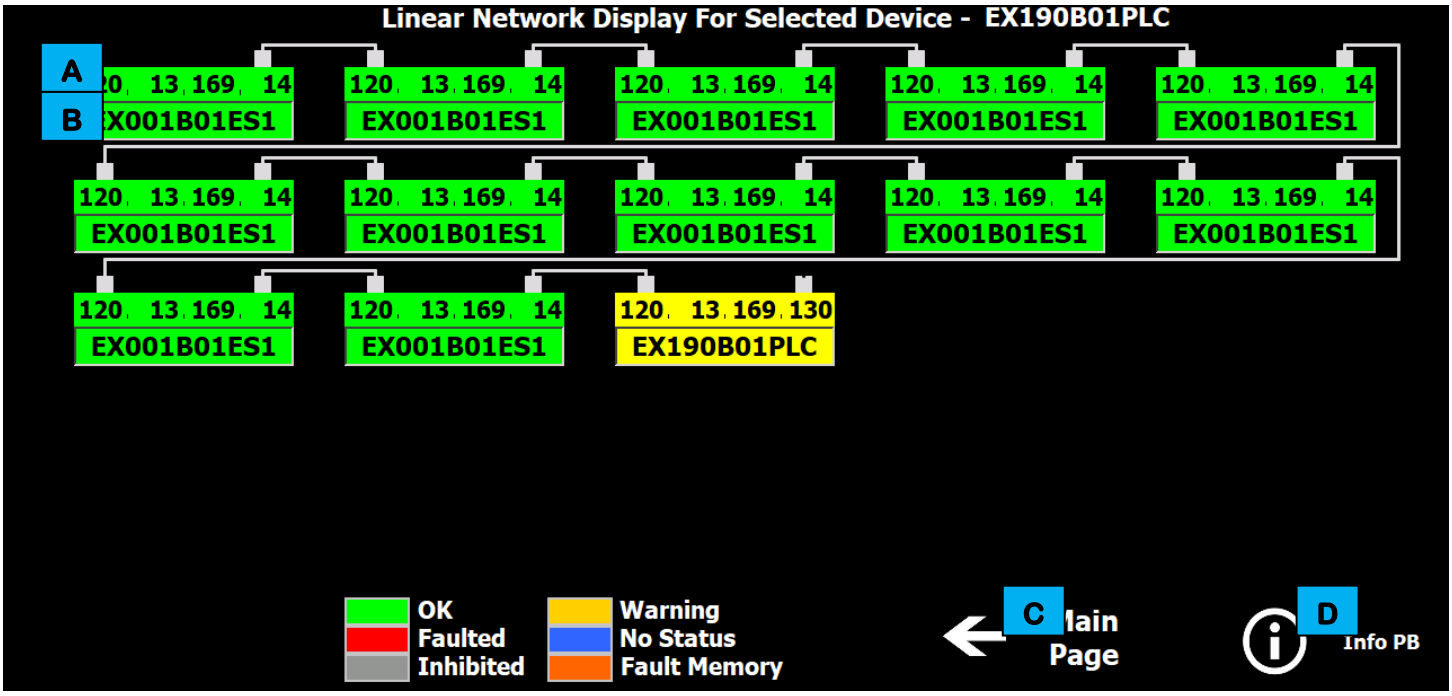


Figure 4-15. An illustration of an example EtherNet Linear screen.

Each EtherNet Linear screen features several areas of information and control, used as follows.

- **A** This field identifies the device IP address.
- **B** This field identifies the device name.
- **C** This button navigates back to the main page.
- **D** This button displays helpful information about the screen and buttons. Touching the button once displays the information fields. Touching the button again turns the information fields off.

4.2.14. EtherNet Switch Port Screen

From the EtherNet Overview screen, touch an EtherNet device to display a popup menu. From the menu, touch the **SHOW PORTS & DEVICES** button. The EtherNet Switch Port screen (see ***Figure 4-16***) shows the switch port status with connected device status.

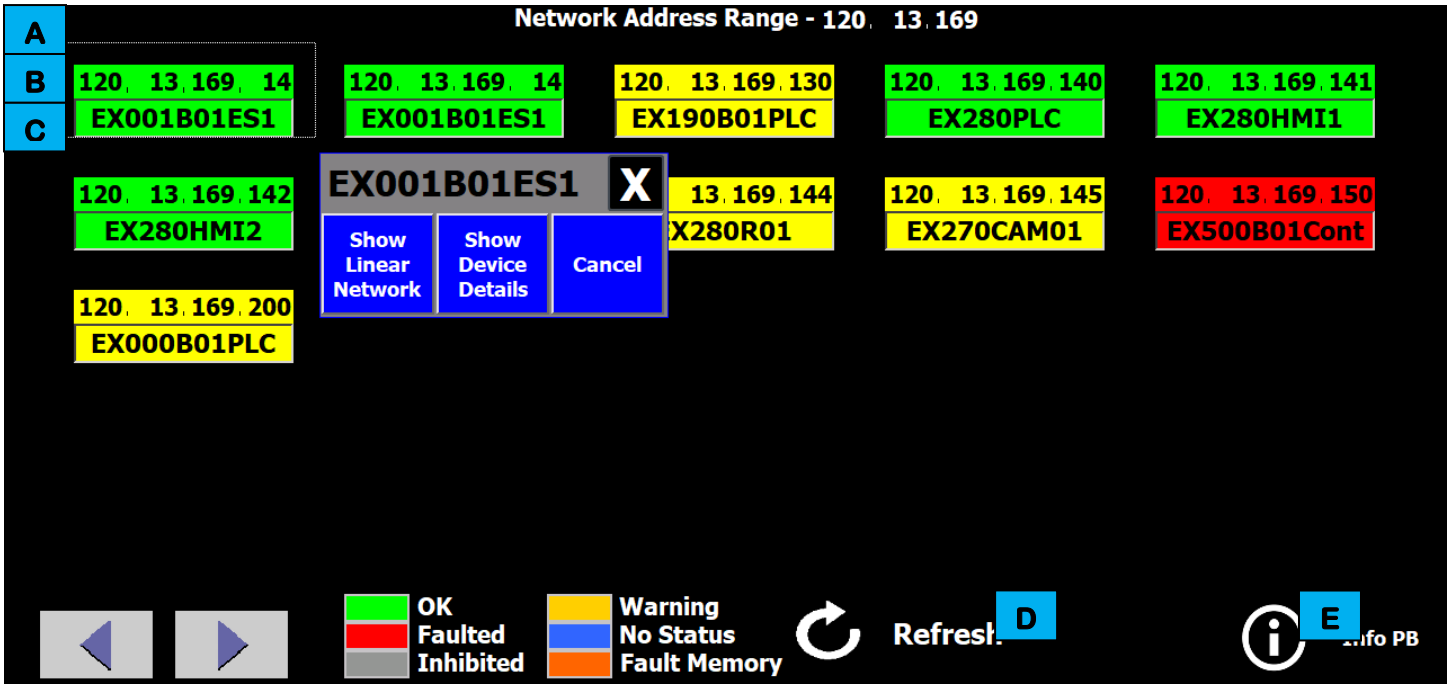


Figure 4-16. An illustration of an example EtherNet Switch Port screen.

Each EtherNet Switch Port screen features several areas of information and control, used as follows.

- **A** This field identifies the port that the device is attached to.
- **B** This field identifies the device IP address.
- **C** This field identifies the device name.
- **D** This button navigates back to the main page.
- **E** This button displays helpful information about the screen and buttons. Touching the button once displays the information fields. Touching the button again turns the information fields off.

4.2.15. Alarm Screen

Touching the **Alarm Screen** button on the Select screen navigates directly to a screen (see *Figure 4-17*) that identifies currently active alarms.

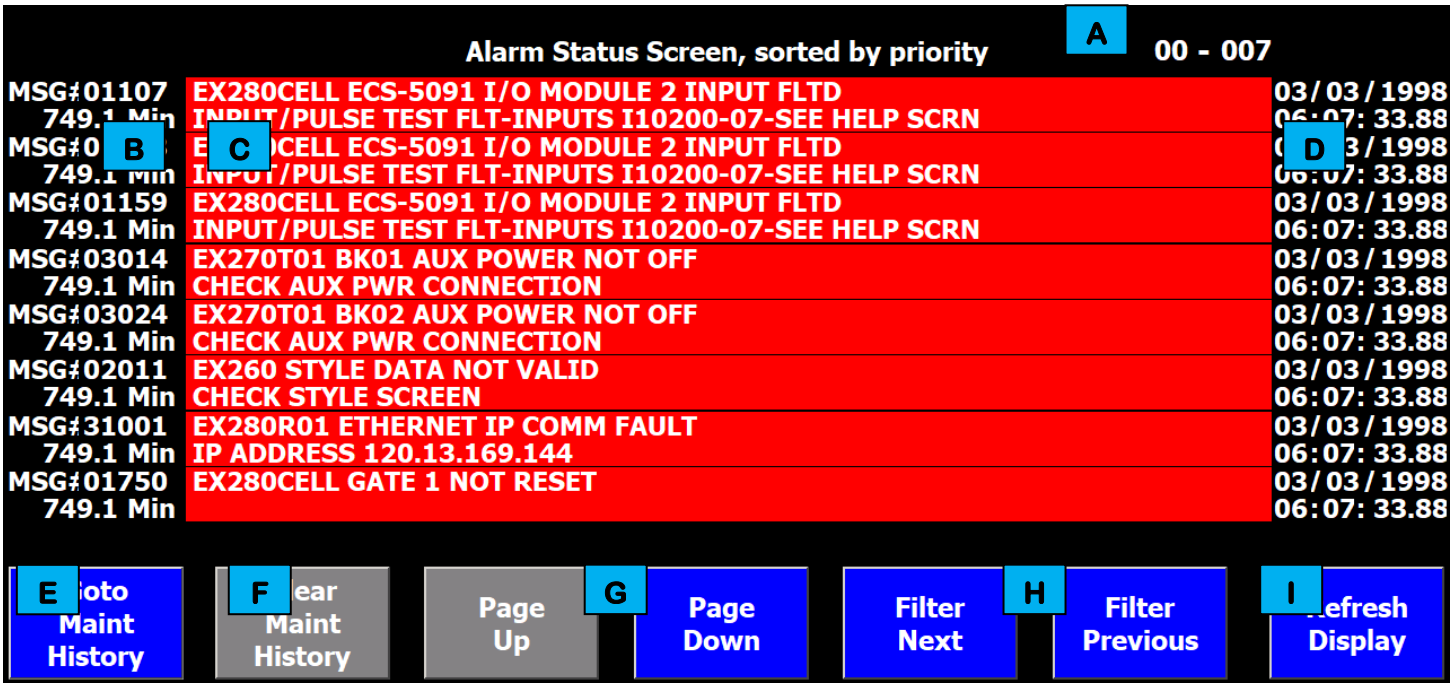


Figure 4-17. An illustration of an example Alarm screen.

Each Alarm screen features several areas of information and control, used as follows.

- **A** This area identifies the range of pages of alarm messages or if the PLC is regenerating the alarm list.
- **B** This area lists the alarm number associated with the message and the time elapsed since the alarm occurred.
- **C** This area lists the current alarm messages, with the highest priority at the top and descending in order.
- **D** This area lists the time and data of the alarm occurrence.
- **E** This touch-button opens a screen that displays past alarm messages.
- **F** This touch-button is not used on the active Alarm screen.
- **G** These touch-buttons scroll up or down through the list of alarms until the highest priority alarm is displayed first or the lowest priority alarm is displayed last.
- **H** These touch-buttons toggle filters used to sort the alarms listed.
- **I** This touch-button refreshes the messages on the screen to identify the highest priority alarm.

4.2.16. Maintenance History Screen

Touching the **GOTO MAINT HISTORY** button on the Alarm screen navigates directly to a screen (see ***Figure 4-18***) that lists alarms that have previously occurred.

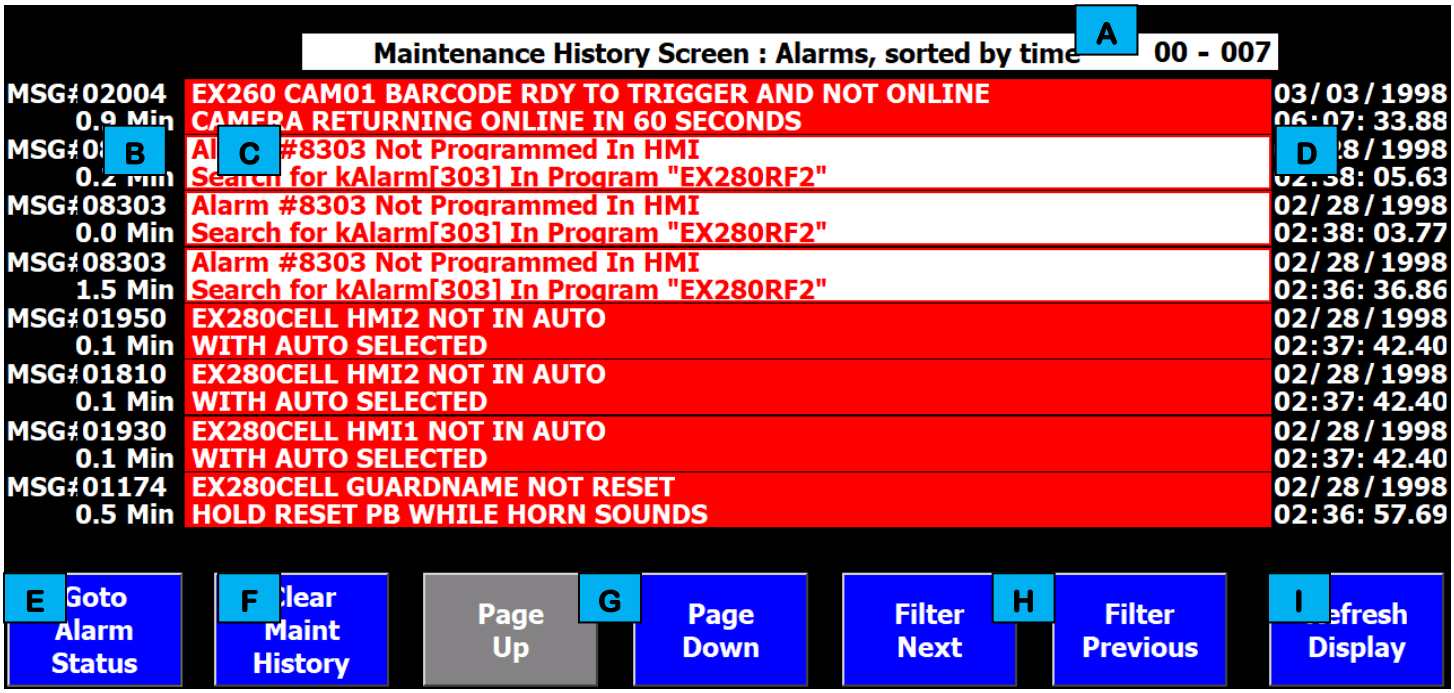


Figure 4-18. An illustration of an example Maintenance History screen.

Each Maintenance History screen features several areas of information and control, used as follows.

- **A** This area of the screen indicates historical alarms are being displayed, what filter is applied to the alarm messages, and what portion of the alarm history is being displayed. It also shows if the PLC is currently regenerating the alarm list.
- **B** This area of the screen lists the alarm number associated with the message and the time elapsed since the alarm occurred. Each alarm displayed on the screen has its own alarm number and elapsed time indicator.
- **C** This area of the screen lists the historical alarm messages, with the most recent at the top and descending in order. Up to eight messages can be displayed.
- **D** This area of the screen indicates when the alarm was initially active.
- **E** This touch-button returns to the active Alarm screen.
- **F** This touch-button erases the data on the Maintenance History screen (historical fault data).
- **G** These touch-buttons scroll up and down through the list of alarms (from oldest to most recent) until the newest alarm is displayed first.
- **H** These touch-buttons allow the historical alarms to be sorted by priority or time.
- **I** This touch-button refreshes the messages on the screen to identify the latest recovered alarms.

4.2.17. Throughput Overview Screen

Touching the **CYCLE TIME** button on the Select screen navigates directly to a screen (see ***Figure 4-19***) that displays data about the system cycle.

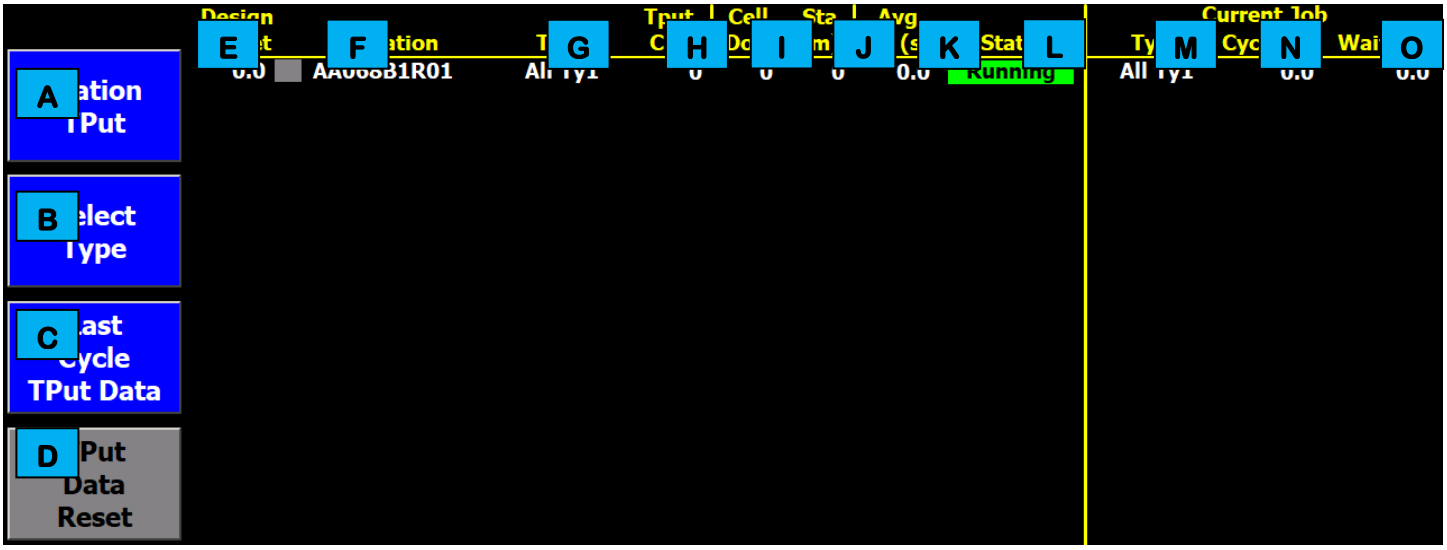


Figure 4-19. An illustration of an example Throughput Overview screen.

Each Throughput Overview screen features several areas of information and control, used as follows.

- **A** This touch-button opens a screen that provides more detailed cycle data for a single station.
- **B** This touch-button displays a dialog menu that allows the list to display for all types or for a specific type. Touch the **CLOSE** button in the dialog to close the menu.
- **C** This touch-button toggles the data fields (items **M**, **N**, and **O**) to display either the current cycle data or the last cycle data.
- **D** This touch-button resets the data on the screen.
- **E** This column identifies the programmed cycle times.
- **F** This column identifies the station names.
- **G** This column identifies the type of part (toggled by the **SELECT TYPE** button).
- **H** This column identifies the quantity produced.
- **I** This column identifies the number of minutes of faulted system downtime.
- **J** This column identifies the number of minutes of faulted station downtime.
- **K** This column identifies the average cycle time.
- **L** This column identifies the current status.
- **M** This column identifies the current/last type of part.
- **N** This column identifies the current/last cycle time.
- **O** This column identifies the current/last wait time.

4.2.18. Station Throughput Screen

Touching the **STATION TPUT** button on the Throughput Overview screen navigates directly to a screen (see ***Figure 4-20***) that displays detailed production data for a specific station.

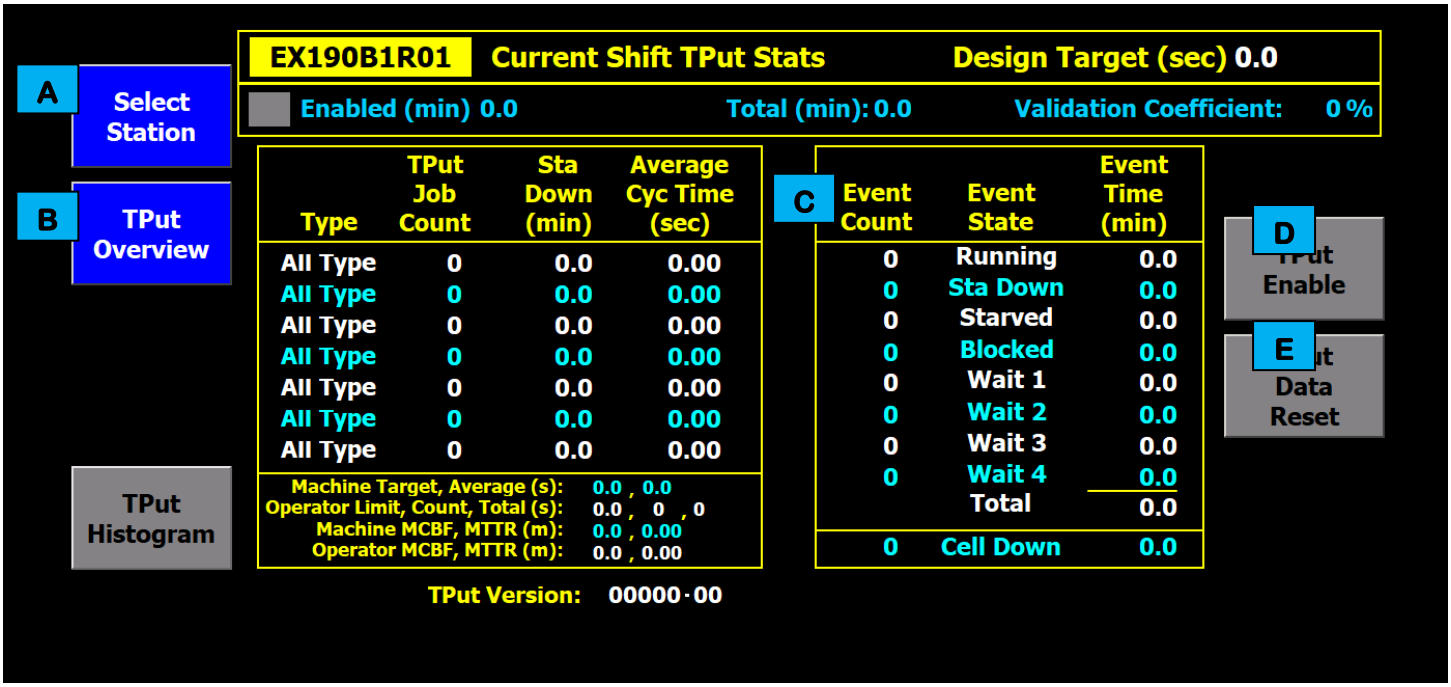


Figure 4-20. An illustration of an example Station Throughput screen.

Each Station Throughput screen features several areas of information and control, used as follows.

- **A** This touch-button changes the station currently displaying data.
- **B** This touch-button returns to the Throughput Overview screen.
- **C** This area of the screen displays detailed production statistics.
- **D** This touch-button toggles the station data collection on or off.
- **E** This touch-button resets the station data on the screen.

4.2.19. Style Overview Screen

Touching the **STYLE OVERVIEW** button on the Select screen navigates directly to a screen (see ***Figure 4-21***) that displays style data. Touch the **EDIT** button to change a part number as needed. Touch the **Populate** button to distribute the changes throughout the system. Refer to your company operating procedures for the proper use of this screen.

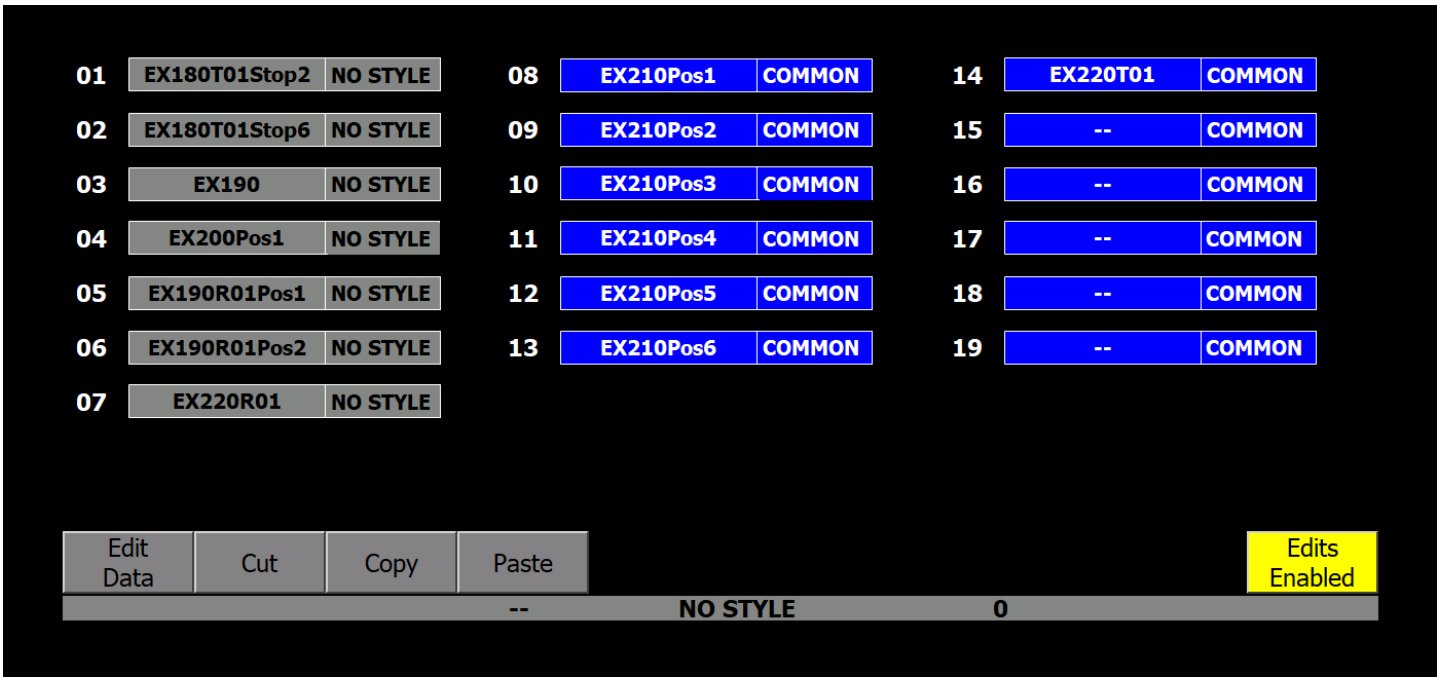


Figure 4-21. An illustration of an example Style Overview screen.

4.2.20. Signature Screen

Touching the **SIGNATURE** button on the Select screen navigates directly to a screen (see ***Figure 4-22***) that identifies the status of the safety-type devices associated with the cell. Refer to your company operating procedures for more information about this screen.

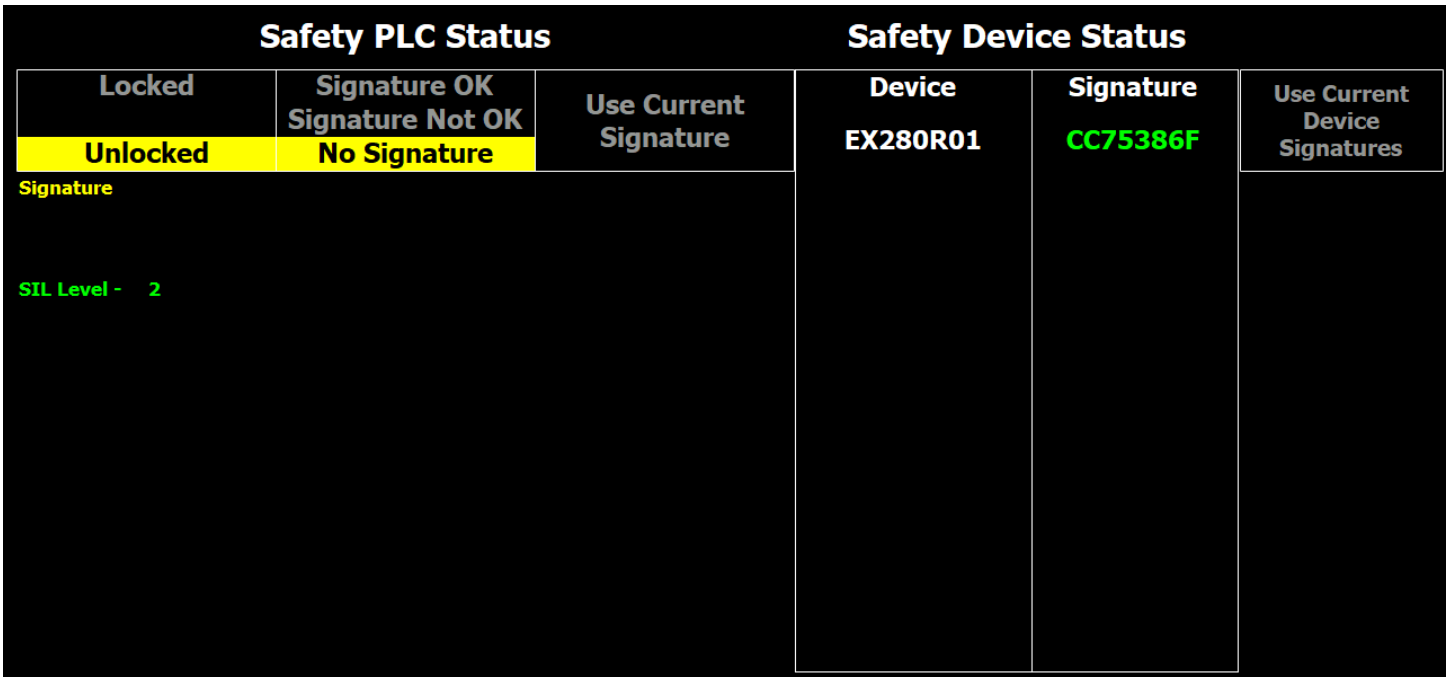


Figure 4-22. An illustration of an example Signature screen.

4.2.21. Robot Screen

Touching the **ROBOT** button on the Select screen navigates directly to a screen (see ***Figure 4-23***) that provides interface with the cell robot(s).

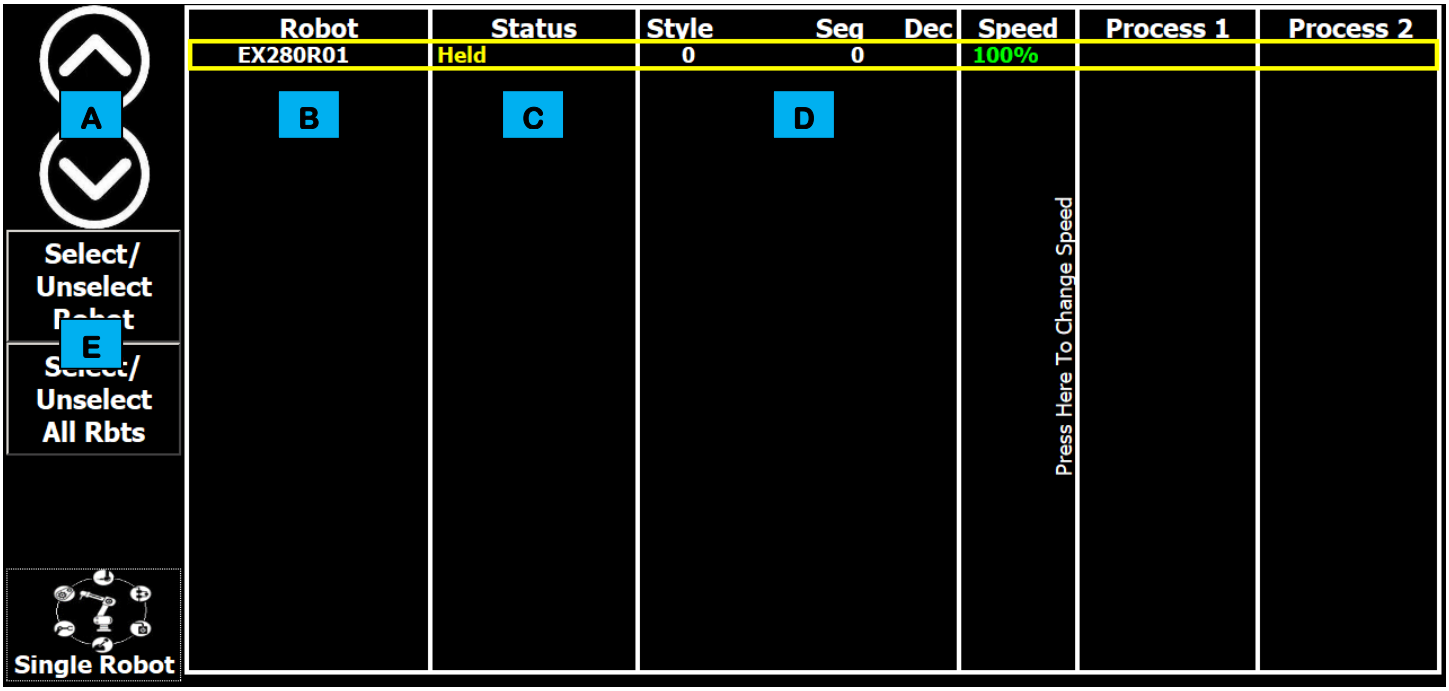


Figure 4-23. An illustration of an example Robot screen.

Each Robot screen features several areas of information and control, used as follows.

- **A** These touch-buttons scroll the robot selection field up or down.
- **B** These fields identify the robot names.
- **C** These fields identify the robot status, such as: `At Home`, or `Held`.
- **D** These fields identify the robot style and the motion segment the robot is in (where the robot is).
- **E** These touch-buttons select or de-select the robot.

4.2.22. Laser Function Screen

Touching the **LASER** button on the Select screen navigates directly to a screen (see ***Figure 4-24***) that is used to interface with the laser.

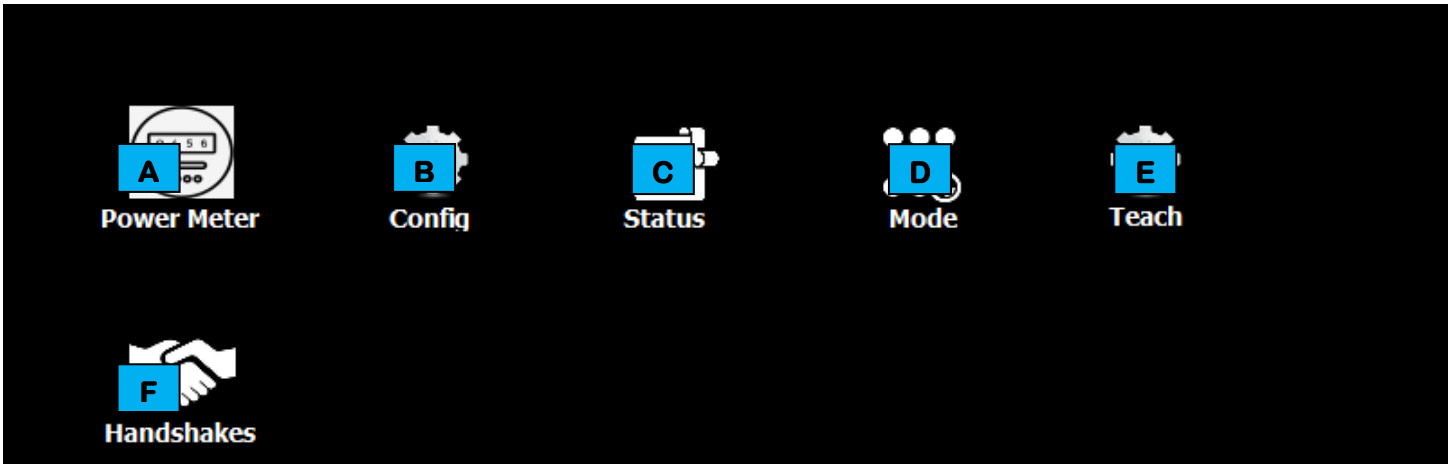


Figure 4-24. An illustration of an example Laser Function screen.

The Laser Function screen features several areas of information and control, used as follows.

- **A** This button navigates to the Power Meter screen. Refer to ***4.2.23 Power Meter Screen*** for more information.
- **B** This button navigates to the Configuration screen. Refer to ***4.2.24 Laser Configuration Screen*** for more information.
- **C** This button navigates to the Laser Status screen. Refer to ***4.2.25 Laser Status Screen*** for more information.
- **D** This button navigates to the Laser Mode screen. Refer to ***4.2.26 Laser Mode Screen*** for more information.
- **E** This button navigates to the Laser Teach screen. Refer to ***4.2.27 Laser Teach Screen*** for more information.
- **F** This button navigates to the Laser Handshakes screen. Refer to ***4.2.28 Laser Handshakes Screen*** for more information.

4.2.23. Power Meter Screen

Touching the **POWER METER** button on the Laser Function screen navigates directly to a screen (see ***Figure 4-25***) that provides interface with the power of the laser.

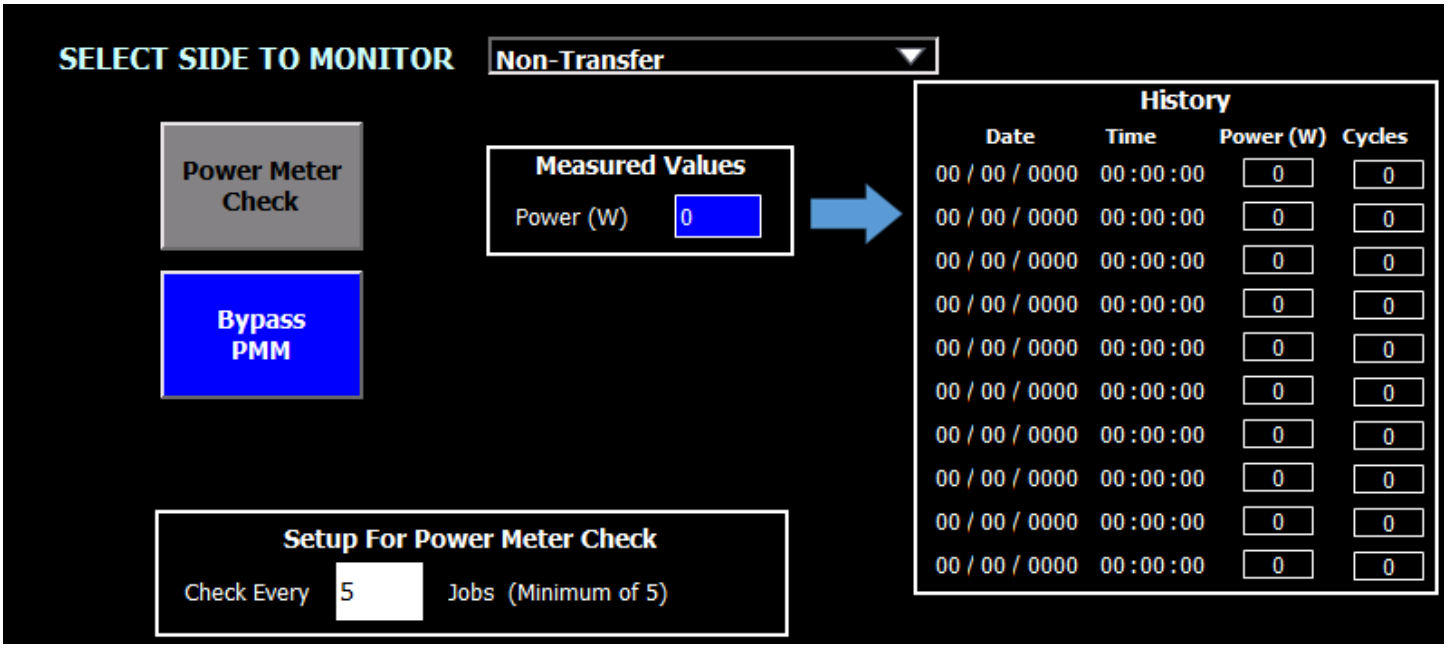


Figure 4-25. An illustration of an example Power Meter screen.

The screen is standardized but most features have been disabled. Only the **POWER METER CHECK** button is currently used. After touching the button, you must press the DO button to acknowledge. The servo must be at the home position before touching the button. After acknowledging, the servo moves to the Trumpf power meter and the laser fires into the meter. Monitor the results on the Trumpf interface. The servo returns to the home position after the power meter cycle is complete.

4.2.24. Laser Configuration Screen

Touching the **CONFIG** button on the Laser Function screen navigates directly to a screen (see ***Figure 4-31***) that provides interface with the laser fiber connections.

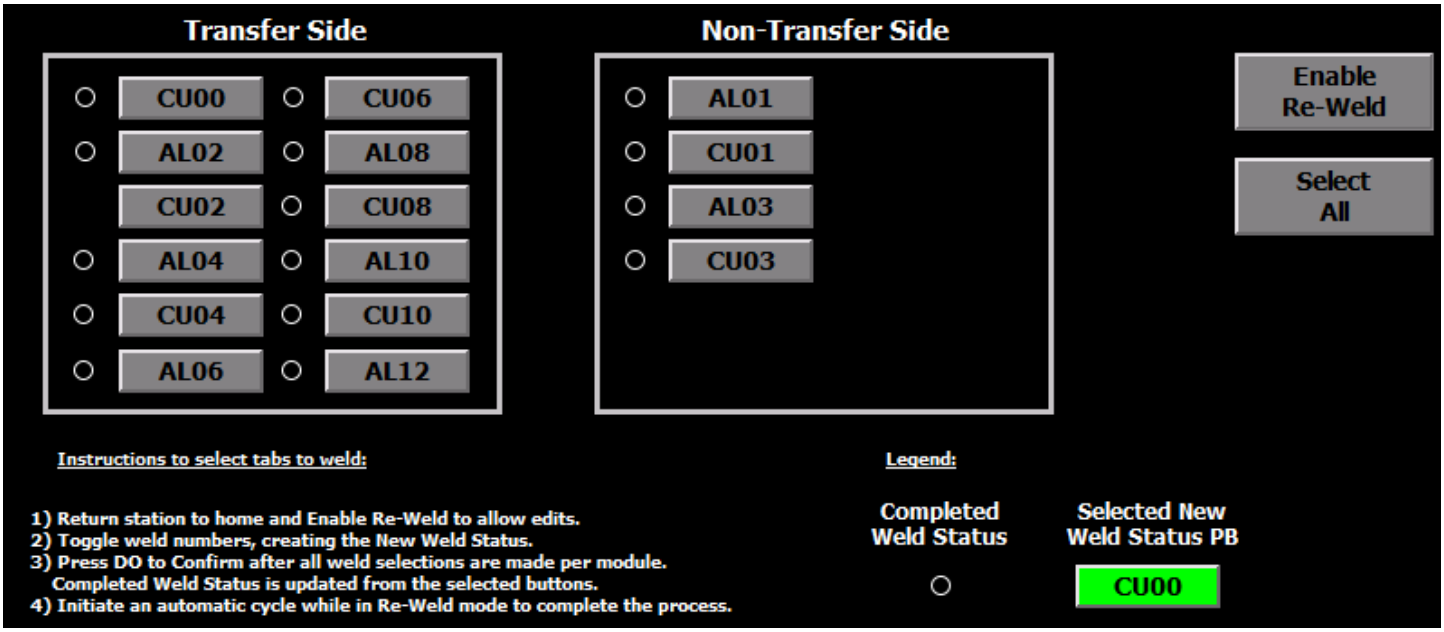


Figure 4-26. An illustration of an example Laser Configuration screen.

4.2.25. Laser Status Screen

Touching the **STATUS** button on the Laser Function screen navigates directly to a screen (see ***Figure 4-27***) that identifies the laser status of the laser generator and chiller.

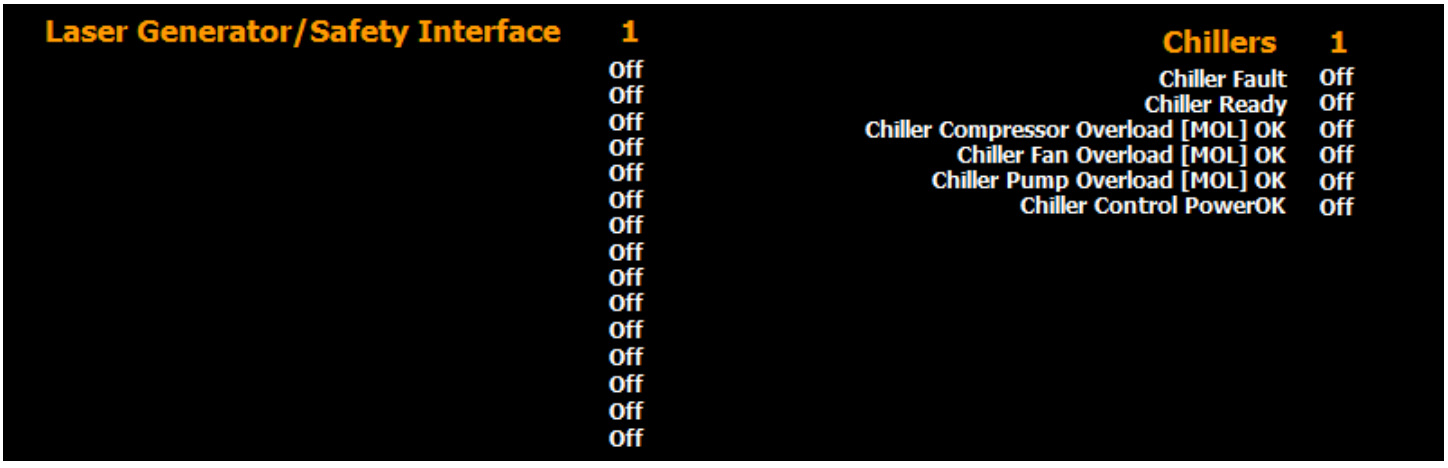


Figure 4-27. An illustration of an example Laser Status screen.

The laser generator and chiller each have their own area of the screen with associated states. The right column in each area identifies the status of each associated state (either On or Off).

4.2.26. Laser Mode Screen

Touching the **MODE** button on the Laser Function screen navigates directly to a screen (see ***Figure 4-28***) that is not currently used. The chiller and laser are both manually operated and therefore the functionality of this screen has been disabled.

Figure 4-28. An illustration of an example Laser Mode screen.

4.2.27. Laser Teach Screen

Touching the **MODE** button on the Laser Function screen navigates directly to a screen (see ***Figure 4-29***) that identifies each of the weld positions and provides the ability to change the weld coordinate.

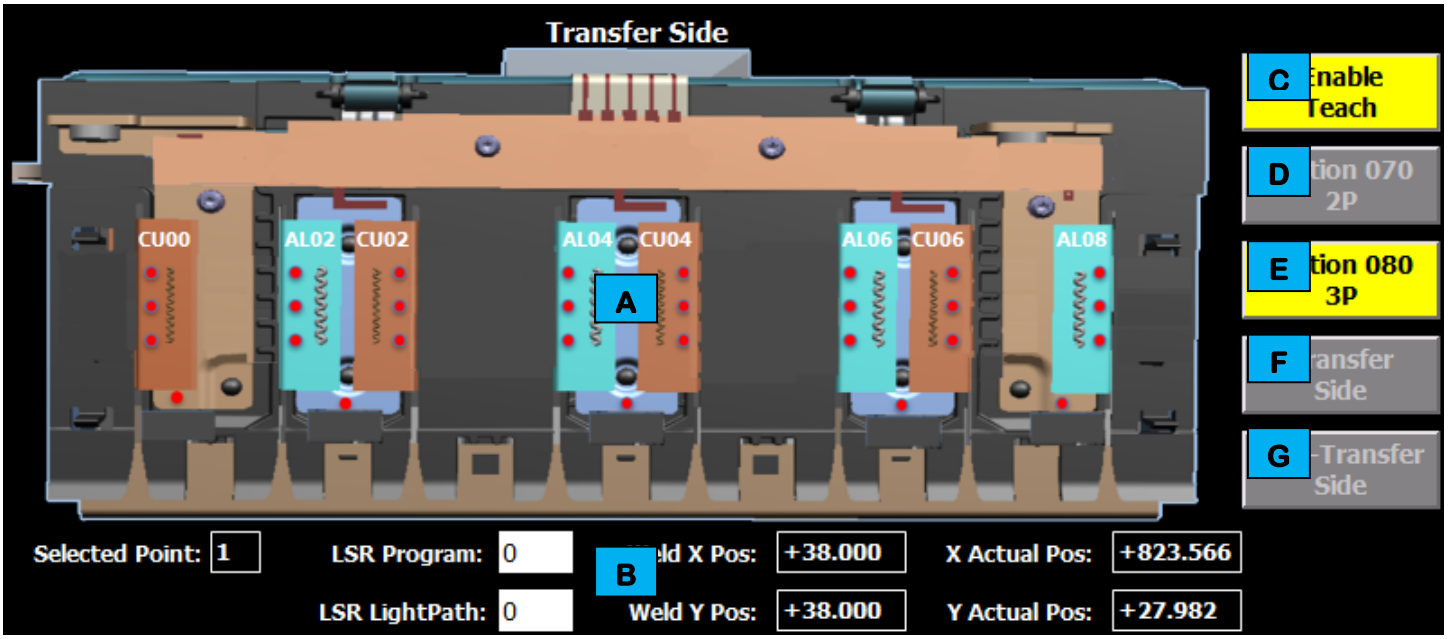


Figure 4-29. An illustration of an example Laser Teach screen.

The Laser Teach screen features several areas of information and control, used as follows.

A This area of the screen identifies each of the weld locations with a red dot.

B This area of the screen displays the weld data and coordinates of a selected weld point.

C This button allows you to teach a new weld location.

D This button toggles to the Station 70 welder.

E This button toggles to the Station 80 welder.

F This button toggles to the transfer side of the part.

G This button toggles to the non-transfer side of the part.

4.2.28. Laser Handshakes Screen

Touching the **HANDSHAKES** button on the Laser Function screen navigates directly to a screen (see ***Figure 4-30***) that identifies the active laser inputs and outputs. The screen is for informational purposes only.

Figure 4-30. An illustration of an example Laser Handshakes screen.

4.2.29. Servo/VFD Screen

Touching the **SERVO/VFD** button on the Select screen navigates directly to a screen (see ***Figure 4-31***) that provides interface with the cell servo motor.

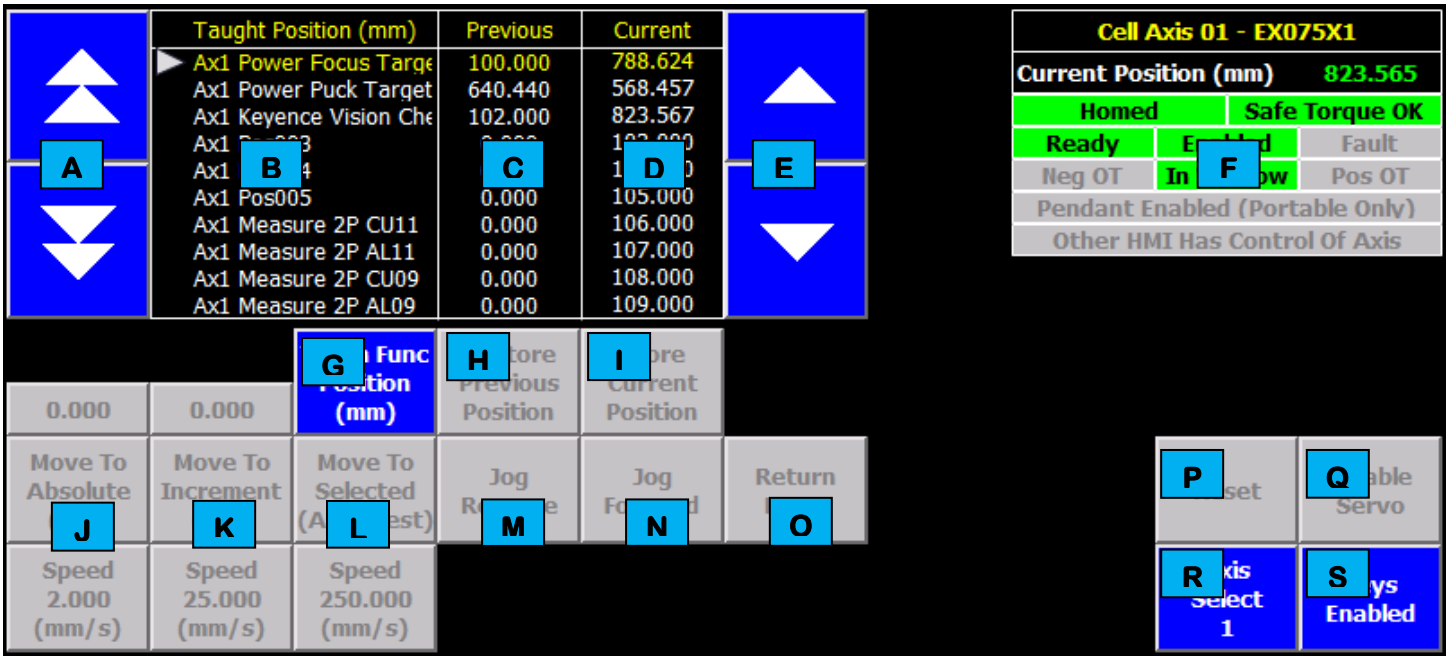


Figure 4-31. An illustration of an example Servo/VFD screen.

Each Servo/VFD screen features several areas of information and control, used as follows.

- **A** These buttons move the position selector (▶) up and down the list of positions (**B**), one page at a time.
- **B** This area of the screen lists the servo motor positions. The currently selected position is identified with a right arrow (▶).
- **C** This area of the screen lists the last stored coordinate for each servo motor position.
- **D** This area of the screen lists the current coordinate for each servo motor position.
- **E** These buttons move the position selector (▶) up and down the list of positions (**B**), one line at a time.
- **F** These indicators identify specific motor states.
- **G** This button scrolls through the settings that can be taught (position, speed, acceleration deceleration).
- **H** This button restores the settings to the previously taught setting (the value as it appears in Column **C**).
- **I** This button saves the live coordinate as the stored coordinate for the selected servo motor position (in area **B**). Press the DO button on the HMI for confirmation.
- **J** This area of the screen provides the ability to move the servo motor to a specific coordinate. Touch the field to manually enter a specific coordinate. Touch the **MOVE TO ABSOLUTE** button to force the servo motor to move the entered coordinate. Press the DO button on the HMI to complete the move.
- **K** This area of the screen provides the ability to move the servo motor in specific increments. Touch the field to manually enter a specific increment amount. Touch the **MOVE TO INCREMENT** button to force the servo motor to move only the amount manually entered. Press the DO button on the HMI to complete the move.
- **L** This touch-button sends the servo motor to the stored coordinate of the currently selected position (in area **B**). Press the DO button on the HMI to complete the move.
- **M** This touch-button jogs the servo motor backward. The servo motor jogs for the duration that the button is held. Press the DO button on the HMI to complete the move.

N This touch-button jogs the servo motor forward. The servo motor jogs for the duration that the button is held. Press the DO button on the HMI to complete the move.

O This touch-button sends the servo motor to the stored home position (when the button is blue (enabled)). Press the DO button on the HMI to complete the move.

P This touch-button resets the servo motor after a fault (when the button is blue (enabled)).

Q This touch-button enables or disables the servo motor power (when the button is blue (enabled)).

R This touch-button toggles which servo motor is controlled. Touching the button changes the selection between servo axis 1 and servo axis 2.

S This touch-button toggles control of the servo motor. When the button is gray, the servo motor is under automatic control and is directed by the processor. Touching the button enables the screen buttons and removes auto mode from the servo.

4.2.30. Service Screen

Touching the **SERVICE** button on the Select screen navigates directly to a screen (see ***Figure 4-32***) that can be used to manually interface with the cell cycle and process equipment.

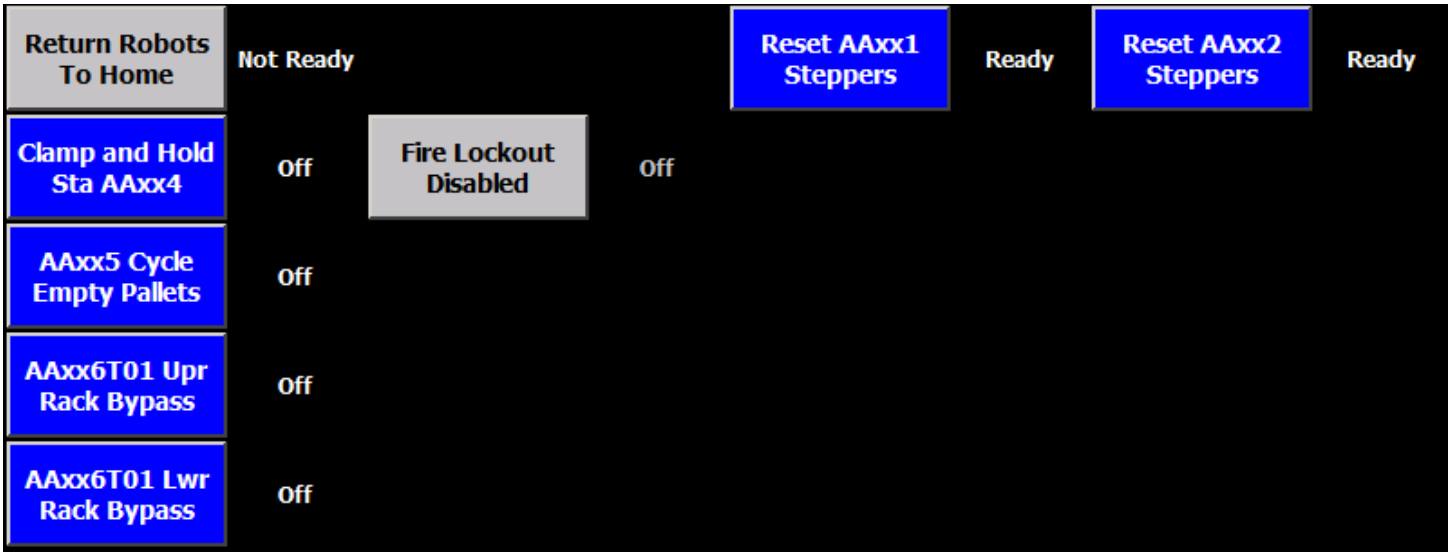


Figure 4-32. An illustration of an example Service screen.

4.3. COMMON OPERATING PROCEDURES

Only trained operators are to operate the line. Operators use this section to operate the line daily. This section describes the procedures for inspecting, starting, running, stopping, shutting down, emergency stopping, and recovering from faults on the line.

4.3.1. Inspecting the Line

The following checklist outlines actions that, when completed, help to ensure the proper and safe operation of the equipment. This checklist should be used prior to startup of each cell, such as at the beginning of the day or a shift. Complete the following checks to ensure proper cell operation:

- Ensure that all cell operators have been thoroughly trained and instructed in safety procedures and in cell operation. Do not allow untrained personnel to operate the cell.
- Ensure the cell air supply shutoff valve (Lockout Point A-1) is on.

- Ensure the PDP main disconnect switch (Lockout Point E-1) is in the on position.
- Ensure that all mechanisms are clear for cell operation.
- Ensure that all necessary safety guards and doors are closed.
- Ensure that all safety mechanisms are in proper working order.
- Ensure that all mechanical devices have had proper preventive maintenance and are properly cleaned.
- Ensure that no one is working on, or near, cell devices.

4.3.2. Starting an Automatic Cycle

Use the following procedure to start a cell in auto mode. After completing this procedure, the cell will be started and cycling. To start an auto cycle in one of the cells:

1. Ensure all enclosure disconnects are not disabled and that control power is present. Ensure the cell pneumatic equipment is enabled and up to pressure.
2. A reset is required of all equipment. If the equipment is appropriately located, the RESET button on the HMI terminal will be flashing blue. If the button is not flashing, the equipment is not appropriately located. Check the equipment status on the touch screens.
3. When the equipment is appropriately located and the RESET button is flashing blue, press the RESET button. After the equipment resets the blue button indicator illuminates steady.
4. Turn the AUTO/MANUAL key switch on the HMI terminal to the MANUAL position. Navigate to the Scroll List screen, select ***** START OF LIST ***** in the Function List, and press the DO button to drive all equipment to the load positions.
5. Return the AUTO/MANUAL key switch to the AUTO position.
6. If any faults are displayed at the top of the screen, touch the Fault Reset button in the screen header to reset each fault.
7. Check the indicator in the AUTO INITIATE button. All mode selector switches on the system must be set to auto before the cycle can be started. If the green indicator in the button is dark or is rapidly flashing, one or more stations are not ready for auto. Use the alarm messages to identify why the cell and stations within the cell may not be ready for auto.
8. When the AUTO INITIATE button indicator is flashing steadily (not rapidly), press and hold the button. The alarm horn sounds three times and the cell initiates auto mode. Release the button after the alarm horn ceases. The indicator illuminates steady.

4.3.3. Stopping a Cycle

There are two methods for stopping the cycle at the cell: cycle stopping, and emergency stopping.

4.3.3.1. Cycle Stop

Cycle stopping is the normal and preferred means of stopping the cell. To safely stop the cell, navigate to the Service screen and touch the **PREPARE FOR STOP** button. The cell completes the current cycle and then comes to a stop.

4.3.3.2. Emergency Stop

Push a red mushroom EMERGENCY STOP button in to immediately interrupt control power in the cell.

WARNING!

Press an EMERGENCY STOP ***button to immediately stop movement of all mechanisms. Ensure that all movement has stopped before entering the cell. Follow procedures taught in your GM-UAW Lockout class. Severe injury or death may occur if this warning is not followed.***

4.3.4. Shutting Down

Use the following procedure to shut down a cell. Use this procedure any time a cell needs to be completely powered down, such as for maintenance. To completely shut down a cell:

NOTE

To shut down the entire MFA Line, this procedure must be completed on each of the cells until no power remains in the line.

1. Safely stop the cell by navigating to the Service screen and touching the **PREPARE FOR STOP** button. The cell completes its current cycle and then comes to a stop.
2. Turn the MAIN DISCONNECT switch (Lockout Point E-1) to the off position at the PDP main control panel. Verify that the CONTROL POWER ON indicator is dark at the main control panel and at the cell operator interface.
3. If necessary, push the air processing equipment air dump and turn the air shutoff valve (Lockout Point A-1) to the off position to remove pneumatic energy.
4. If maintenance is to be performed, refer to the Hazardous Energy Guidelines section in Chapter 5.

4.3.5. Recovering from an Emergency Stop

WARNING!

Press an EMERGENCY STOP ***button to immediately stop movement of all mechanisms. Ensure that all movement has stopped before entering the cell. Follow procedures taught in your GM-UAW Lockout class. Severe injury or death may occur if this warning is not followed.***

Complete the following steps to recover after an EMERGENCY STOP button has been pressed:

1. Visually confirm the status of the devices. If the equipment is in a recoverable position (no collisions will result upon movement), pull out the EMERGENCY STOP button that was depressed.
2. If any faults are displayed at the top of the screen, touch the **FAULT RESET** button in the screen header to reset each fault.
3. Check the indicator in the AUTO INITIATE button. If the green indicator in the button is dark or is rapidly flashing, one or more stations are not ready for auto. Use the alarm messages to identify why the cell and stations within the cell may not be ready for auto.
4. When the AUTO INITIATE button indicator is flashing steadily (not rapidly), press and hold the button. The alarm horn sounds three times and the cell initiates auto mode.
5. Release the button after the alarm horn ceases. The indicator illuminates steady.

4.3.6. Recovering from a Fault

A fault occurs anytime there is an interruption in the automatic cycle. There are various conditions that can result in fault, such as: the failure of a sensor, a part blockage or jam, or any number of other situations.

When a fault occurs, the cell cycle is stopped, and the operator is alerted to the situation. The HMI provides a detailed fault message with the associated fault number and I/O (when applicable). In some situations, the fault message also provides recovery information.

For most faults, recovery is to remove any jam, reset the system, and resume automatic operations. Refer to Chapter 6 for more specific information.

4.3.7. Opening and Closing an Entrance Gate

Each cell is surrounded by guarding to protect operators from moving equipment. Entrance gates are placed in areas where access inside the cell guarding may be necessary. Each entrance gate has an Entrance Gate Box, located beside the gate, that is used to interface with the cell safety circuit to properly open and close an entrance gate.

Opening a Gate

To open a gate at a cell, complete the following steps:

1. At the gate control box, press the CYCLE HOLD button. Inside the button, an indicator light flashes to acknowledge the hold. The cell continues to operate until it reaches the end of the current cycle. Once the cycle has stopped, the indicator light illuminates solid.
2. Open the box door and turn the SELECTION switch to the appropriate position. Refer to ***4.1.2 Entrance Gate Box*** and your GM-UAW Lockout Training for more information.
3. Grasp the handle on the gate and slide the bar out of the interlock switch.
4. Control energy is removed from the safety circuit at the cell, preventing the movement of any equipment. Apply a personal safety lock to the entrance gate control box.
5. Verify the MPS is active. Follow the procedures taught in your GM- UAW Lockout Training class. Check for the green stack light to be illuminated. If the yellow stack light illuminates, enter with a pendant. If the green light or yellow light is not illuminated, the cell is not safe. Do not enter the cell. Follow full lockout procedures.
6. When the required tasks within the cell guarding are complete continue with the next procedure, Closing a Gate.

NOTE	***Each slide bar has a safety feature that allows the bar to be opened from the inside of the guarding, preventing any person from becoming locked inside.***

Closing a Gate

After the required tasks within the cell guarding are complete, ensure all personnel are outside of the guarding and then complete the following steps to close the gate:

1. Verify that no other personnel are inside the guarding and then close the gate. Pull the slide bar so that it engages the interlock switch.
2. If used, remove the pendant and insert the pendant plug.
3. Remove the personal lock from the entrance gate control box.
4. Press the RESET button. The gate reset indicator illuminates blue.

5. Turn the SELECTION switch to pos1.
6. Close the box door. If the mode selector switch at the HMI is still in automatic, look for the green RESUME AUTOMATIC button to be flashing. Press and hold the RESUME AUTOMATIC button for three seconds until the cell horn stops sounding. Release the button. Once automatic mode has resumed, an indicator light illuminates solid inside the button.

4.3.8. Loading (or Unloading) Components

Parts and components can be loaded onto conveyor systems throughout the line. The following section details how to introduce these components.

4.3.8.1. Module Cover Install (EX190) Dunnage Loading/Unloading

Operator grasps a pull cord at end of the conveyor and pulls cord associated with the conveyor where dunnage is being loaded or removed. When the pull cord has been activated, the system is notified of dunnage being loaded or unloaded. The operator then loads dunnage with full trays to the input side of the conveyor or unloads dunnage full of empty trays from the output side of the conveyor.

4.3.8.2. Module Transfer (EX280) Dunnage Loading/Unloading

Operator grasps a pull cord at end of the conveyor and pulls cord associated with the conveyor where dunnage is being loaded or removed. When the pull cord has been activated, the system is notified of dunnage being loaded or unloaded. The operator then loads dunnage with full trays to the input side of the conveyor or unloads dunnage full of empty trays from the output side of the conveyor.

4.3.9. Removing Rejects

Parts or components can be rejected from the MFA line due to failure to meet parameters or conditions. The following details how to remove these components.

4.3.9.1. Module Input VTU (EX005) Removing Rejects

If the module is a reject, EX010T01 transports the associated pallet to EX005T01 Set Out where an Operator divorces the reject from the pallet and removes the rejected module.

4.3.9.2. Post Tab Bend (EX050) Removing Rejects

If a part is rejected at the vision inspection at EX020 or EX030, the Set In/Out position at EX050 is provided to allow operators to manually unload modules from pallets. An RFID reader at the position reads the module bar code and the pallet RFID and divorces the two.

4.3.9.3. Module Transfer (EX400) Removing Rejects

If a part is rejected at the BOM Check station, the Set In/Out position at EX400 is provided to allow operators to manually unload modules from pallets. An RFID reader at the position reads the module bar code and the pallet RFID and divorces the two.

4.3.10. Reintroducing Parts

Certain parts or components can be reintroduced at various locations on the MFA line with some conditions. The following section details how to reintroduce these components.

4.3.10.1. Module Input VTU (EX010) Part Reintroduction

The Set In/Out position at EX005 is provided to allow Operators to manually load modules to pallets. An RFID reader at the position reads the module bar code and the pallet RFID and joins (marries) the two.

4.3.10.2. Post Tab Bend (EX050) Part Reintroduction

The Set In/Out position at EX050 is provided to allow operators to manually load modules to pallets. An RFID reader at the position reads the module bar code and the pallet RFID and joins (marries) the two.

4.3.10.3. Module Transfer (EX400) Part Reintroduction

The Set In/Out position at EX400 is provided to allow operators to manually load modules to pallets. An RFID reader at the position reads the module bar code and the pallet RFID and joins (marries) the two.

4.4. MODES OF OPERATION

Each cell has several modes of operation, explained in detail in the paragraphs that follow.

4.4.1. Auto Mode

Auto mode is the standard operating mode for a cell. While in auto mode, the cell processor directs and monitors the operation of the associated equipment.

When there is an interruption in the cycle (such as the occurrence of a fault), auto mode is not typically dropped. If recovery is possible without manual operator intervention, the automatic cycle resumes upon recovery. If the fault was severe, such as a utility loss or a communication fault, one or more of the stations within the cell may have lost automatic mode. Once the fault has been corrected, refer to ***4.3.2 Starting an Automatic Cycle*** to restore operation.

The AUTO/MANUAL key switch on the cell operator interface toggles the cell mode.

4.4.2. Manual Mode

Manual mode provides the ability to individually move mechanisms using the operator interface. Manual mode can be used for fault recovery, troubleshooting, setup, and for numerous other reasons.

There are three sections that follow: entering manual mode, example manual motion, and example manual cycling. Complete the steps as necessary for the desired manual operations.

4.4.2.1. Entering Manual Mode

The following steps detail the operations required to operate the machine in manual mode.

1. Turn the AUTO/MANUAL key switch to the MANUAL position on the operator interface terminal.
2. On the operator interface touch screen, touch the **SELECT** button in the screen header.
3. After the Select screen displays, touch the **SCROLL LIST** button.
4. Utilize the Scroll List screen and the DO button on the operator interface terminal for manual operations.

4.4.2.2. Example Manual Motion

In this example, a Lift Transfer Unit (LTU) needs to be lowered. Complete the steps that follow to manually lower the LTU. Use this procedure as a guide to manually move devices.

1. Complete the procedure in ***4.4.2.1 Entering Manual Mode***.
2. Touch the **PAGE DOWN** button repeatedly until `Lower LTU` is displayed.

3. Touch the **CURSOR UP** or **CURSOR DOWN** button as needed to select `Lower LTU`. A yellow box highlights the selected action.
4. Press the DO button on the operator interface terminal.
5. If no other manual actions are needed, touch the **SELECT** button at the top of the screen. Return the AUTO/MANUAL key switch to AUTO and follow the procedure in ***4.3.2 Starting an Automatic Cycle***.
6. If additional manual actions are needed, repeat Steps 2 through 5 for the action and option.

4.4.2.3. Example Manual Cycling

The steps that follow detail the operations required to perform an example cycle manually. Use this procedure as a guide for manually cycling a cell.

1. Complete the procedure in ***4.4.2.1 Entering Manual Mode***.
2. With ***** `START OF LIST` ***** highlighted, use the Scroll List Function List **CURSOR UP** or **CURSOR DOWN** button until `Turn Auto Cursor On` is displayed and selected with the yellow box.
3. Touch the **SELECT** button on the screen. The cell is now prepared to step through the complete cycle manually.
4. Press the DO button on the operator interface terminal. The Scroll List cursor automatically advances to the next step. Each press of the DO button completes each step of the sequence.

4.4.3. Tryout Mode

Tryout mode is provided to allow the cell mechanisms to cycle without running any parts. Tryout mode is used for setup and recovery to verify the cell process is operational. Complete the following steps to toggle cell operation to tryout mode.

1. Remove all parts from the cell. Tryout mode is not available if sensors detect parts in the cell.
2. On the operator interface touch screen, touch the **SELECT** button in the screen header.
3. After the Select screen displays, touch the **MODE** button.
4. After the Mode screen displays, touch the **TRYOUT MODE ON** button.
5. Put the operator interface AUTO/MANUAL key switch in the AUTO position and initiate automatic mode. Refer to the procedure in ***4.3.2 Starting an Automatic Cycle***.
6. To cancel tryout mode, stop the cell using **END OF CYCLE HOLD** (refer to ***4.4.5 End of Cycle Hold Mode***), move the operator interface AUTO/MANUAL key switch to the MANUAL position, and touch the **TRYOUT MODE ON** button again.

4.4.4. Runout Mode

Runout mode is provided to allow a cell to complete the assembly of the remaining product without beginning production of anything new. Runout mode is used to empty the cell of product. Complete the following steps to toggle the cell operation to runout mode.

1. On the operator interface touch screen, touch the **SELECT** button in the screen header.
2. After the Select screen displays, touch the **MODE** button.
3. After the Mode screen displays, touch the **RUNOUT MODE ON** button.
4. To cancel runout mode, touch the **RUNOUT MODE ON** button again.

4.4.5. End of Cycle Hold Mode

End of Cycle Hold mode is provided to bring a cell to a controlled stop and to the end of the current cycle. Complete the following steps to toggle the cell operation to end of cycle hold mode.

1. On the operator interface touch screen, touch the **SELECT** button in the screen header.
2. After the Select screen displays, touch the **MODE** button.
3. After the Mode screen displays, touch the **END OF CYCLE HOLD** button.
4. To cancel End of Cycle Hold mode, touch the **END OF CYCLE OFF** button.

4.5. SYSTEM BACKUP

All connected systems (i.e., PDPs, HMIs, Robot Controllers, and Laser Controllers) within the MFA system will be interlinked with GM's system for backup and recovery and will automatically backup data according to GM specifications and requirements.

5. MAINTENANCE

Table of Contents

5.1. GENERAL SERVICE GUIDELINES

Review the necessary sections of this User Manual and any relevant third-party device manufacturer literature before attempting to service the system. In addition to the general safety rules at the beginning of this Operation and Maintenance Manual, use the following guidelines when cleaning, servicing, or adjusting system mechanisms:

- Entering or servicing the controls enclosure while it is still electrically or pneumatically activated is extremely hazardous.

WARNING!

Press an EMERGENCY STOP button to immediately stop movement of all mechanisms. Ensure that all movement has stopped before entering the cell for maintenance. Severe injury or death may occur if this warning is not followed.

- Do not perform service work alone. Do not attempt internal service or adjustment unless another person capable of rendering first aid is present.
- Do not substitute parts or modify equipment. Due to the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the product.

- Shut off electrical power and air pressure to the cell before servicing it, unless otherwise specified.
- Follow the general safety rules found at the beginning of this manual.
- Before troubleshooting or servicing the cell, make sure to have up-to-date drawings.
- Never enter or reach into an enclosure without the presence of another person capable of rendering aid.
- Do not wear metal items such as rings, metal necklaces, watches, and jewelry. They are electrical hazards. Wear medical alert jewelry with caution.
- Wear approved safety glasses.
- Use insulated tools when working with electrical equipment.
- When the repair is complete, check that all fittings and connections are tight.
- Use approved fuse pullers when changing fuses (or remove electrical power).
- Never use jumper wires or fuse substitutes to replace fuses.
- For continued fire protection, replace the line fuses only with fuses of the same voltage and current rating and type. Do not use repaired fuses or short-circuited fuse holders.
- Be prepared for proper handling of electrical fires by always keeping dry powder or carbon dioxide extinguishers handy.
- Do not use compressed air to clean cell devices. Use only clean cloths or a vacuum cleaner. Compressed air causes dirt and lubricants to become airborne, potentially contaminating sensitive tooling and products under assembly.
- Do not apply lubricants in a spray form. Apply lubricants by brush, oil can, cloth, or grease gun.

5.2. HAZARDOUS ENERGY GUIDELINES

This section describes the energy in the cell, its potential dangers, and the proper precautions that must be observed when working on the cell.

The system utilizes both pneumatic and electrical energy to provide automated motion. Both energy sources pose the potential for serious injury or death through contact, either directly or indirectly. Any time mechanical, electrical, or pneumatic adjustments are required, whenever preventive maintenance is to be performed, or at any other time where unsafe conditions may be present, always remove hazardous energy from the cell.

Electrical circuits carry relatively high voltages within the cell. Electrical hazards may result from damaged or broken wires and open electrical boxes or control panels. In the event of these or other kinds of electrical hazards, stop the equipment and disable power at the MAIN DISCONNECT switch. Do not enable power to the cell until an electrical technician has corrected the problem.

Pneumatic circuits carry relatively high pressures within the cell. Crushing or pinching injuries may be incurred from devices actuated by this compressed air. Compressed air injected into the bloodstream through a skin puncture may also cause severe injuries, as can debris propelled by uncontrolled compressed air. When working on devices in the pneumatic circuit (including the hoses and connectors), place the air processing equipment shutoff valve in the off position and vent the pneumatic circuit by pressing an EMERGENCY STOP button.

5.3. LOCKOUT/TAGOUT

Any time maintenance is to be performed on the cell, all cell energy sources must be locked out and tagged. The next section details the procedure to use when locking out and tagging the energy sources. This section describes the proper locks and tags that should be used.

Lock Considerations – When performing a lockout tagout procedure, proper locks should be installed. A good lock should:

- Be provided by the employer to ensure standardization and eliminate the use of inferior locks
- Be made by a reputable manufacturer
- Be standardized with all other locks used for lockouts (same size, shape, and color)
- Withstand heat, cold, and humidity
- Be strong enough that it cannot be removed with heavy force
- Not be a combination lock, must have a key
- Have only one key, held by one person
- Not be able to be opened by any other means than by key

Tag Considerations – When performing a lockout tagout procedure, proper tags should be attached to the locks. A good tag should:

- Feature a clear warning
- Be easy to read (both legible and clearly worded)
- Contain the identification mark of the individual who installed the tag
- Be durable and able to withstand extreme temperatures, fumes, and caustic chemicals
- Be secure enough to withstand accidental removal (not tear off)
- Be secured with something like a nylon cable tie that is self-locking, can be attached by hand, can resist release with less than 50-pounds of pressure, and cannot be reused

NOTE

A tag can never be substituted for a lock. A tag is a visual warning but does not provide vital physical protection.

5.3.1. Lock, Tag, and Try Procedure

Any time maintenance is to be performed on the cell, the following steps must be completed to ensure the safety of all personnel. For the most up-to-date information regarding lockout, always refer to the energy control lockout placard on the front of the cell PDP main control panel. In general, complete the following steps to lockout the primary energy sources in a cell:

1. Safely stop the cell by navigating to the Service (or Maintenance) screen and touching the **PREPARE FOR STOP** button. The cell completes its current cycle and then comes to a stop.
2. Turn the main disconnect switch (Lockout Point E-1) to the off position at the PDP main control panel. Verify that the POWER ON indicator is dark at the main control panel and at the cell operator interface.
3. Install a lock and tag to the switch detailing the time and date of the lockout, the reason for the lockout, and the person responsible for the lockout.

4. Push in on and turn the air processing equipment shutoff valve (Lockout Point A-1) to the off position to disconnect the cell pneumatic supply. Install a lock and tag detailing the time and date of the lockout, the reason for the lockout, and the person responsible for the lockout.
5. Make sure to lockout any other primary energy control sources identified on the cell lockout placard before performing any maintenance activities.
6. Check the cell operator interface for indicator illumination. If any indicators are illuminated, electrical energy is still present.
7. At the air processing equipment, check the pressure gage and ensure no residual pressure is present.
8. With the cell safely locked out, tagged out, and verified, maintenance can begin. When maintenance is complete, close all guard doors and remove the locks and tags. Refer to Chapter 4 for startup information.

5.3.2. Additional Safety Recommendations

The following actions will contribute to the safety of all personnel:

- A lockout/tagout center should be established under the control of one individual
- All locks and tags should be of the same type and stored and distributed by the individual responsible for the lockout/tagout center
- Technicians should retrieve locks and tags from the responsible person and then should install them on the system themselves
- When service spans a shift change, the new technician should install new locks and tags before the previous technician removes the previous locks and tags
- After removing locks and tags, return them to the lockout/tagout center

5.4. PREVENTIVE MAINTENANCE

Preventive maintenance must be performed at established intervals to keep the Module Final Assembly Line equipment operating at peak performance. Follow your company preventive maintenance program when performing these activities. In addition to the maintenance activities already established by your company for commonly used equipment, ATS has provided preventive maintenance instructions specific to components critical to the equipment operation. The documents provided are as follows:

Job Plan File Name	Device	Task Description	Task Frequency
ATS_BOSCH CONVEYOR_7.1_REV1	Bosch Conveyor	Clean motor	Weekly
		Inspect roller chain	Monthly
		Inspect toothed belt	Weekly
		Clean LTU belts	Monthly
		Inspect LTU idler rollers	Monthly
		Inspect LTU belts	Monthly
ATS_CELL SWAP RACK_7.1_REV1	Cell Swap Rack	Inspect vacuum cups	3 Months
		Lube linear rail cars	6 Months
ATS_LINEAR RAIL EOAT_7.1_REV1	Linear Rail EOAT	Inspect vacuum cups	3 Months
ATS_MAA94702_7.1_REV1	MAA94702	Lube linear rail cars	6 Months
		Inspect vacuum cups	3 Months
		Inspect cable management	6 months
ATS_MAA94704_7.1_REV1	MAA94704	Inspect pump grease level	6 Months
		Inspect toggle press seal	Yearly
		Clean fill fittings	Daily
		Clean pump and reservoir	Daily
		Inspect harnesses	Monthly
		Clean tab guide tooling	Daily
ATS_OMNI DUNNAGE CONVEYORS_7.1_REV1	Omni Conveyors	Inspect chain tension	Monthly
		Inspect bearing seals	Monthly
		Grease vertical guide tubes	Monthly
		Grease chain drive roller bearings	13 Weeks
		Clean pallet trafficking sensors and reflectors	Yearly
		Inspect Air Spring	60 Days
ATS_TAB BEND_7.1_REV1	Tab Bend	Lube linear rail cars	6 Months
ATS_TAB FORM_7.1_REV1	Tab Form	Lube linear rail cars	6 Months
ATS_VACUUM EOAT AND LINEAR RAIL_7.1_REV1	Vacuum EOAT and Linear Rail	Lube linear rail cars	6 Months
		Inspect vacuum cups	3 Months
ATS_VACUUM EOAT_7.1_REV1	Vacuum EOAT	Inspect vacuum cups	3 Months
ATS_VACUUM TOOLING_7.1_REV1	Vacuum Tooling	Inspect vacuum cups	3 Months

5.5. LUBRICATION POINTS

Proper lubrication is required to keep some of the Module Final Assembly Line equipment operating at peak performance. ATS has provided lubrication charts for equipment requiring lubrication. The following charts have been provided in a single Word document:

Chart Name
Module Final Assembly Conveyance (2 pages)
EX020 Post Tab Bend (2 pages)
EX070P1 Tab Weld 1 (2 pages)
EX070P2 Tab Weld 2 (2 pages)
EX190 Module Cover Install (2 pages)
EX280 Module Transfer (3 pages)

5.6. MAINTENANCE TASK INSTRUCTION SHEETS

The Module Final Assembly Line equipment requires periodic maintenance to keep the equipment operating at peak performance. ATS has provided Task Instruction Sheets as guides to completing these maintenance activities. The following Task Instruction Sheets have been provided:

Task Instruction Number	Task Description
1	Replace Tooling Components
2	Teach VTU Servo Positions
3	Laser Enclosure – Camera Maintenance
4	Replace Pneumatic Components
5	Adjust Positive Stops
5	Matrox Camera – Replace or Adjust Camera
8	Adjust Cylinder Flow Controls
9	Dunnage Conveyor Chain-Gearbox Replacement
10	Dunnage Conveyor Transfer Lift Bladder Replacement
12	Dunnage Conveyor Replace-Adjust Lift Sensors
13	Dunnage Conveyor Motor Replacement
14	Dunnage Conveyor Roller Cleaning
15	Dunnage Conveyor Pallet Jam Clearing
18	Sick Light Curtain Adjustment and Replacement
23	Adjust Switches on Robot End Effector
36	Laser Enclosure – Lighting Replacement
37	Laser Enclosure – Wall and Door Repair
38	Laser Enclosure – Perform Light Tight Inspection with Spotlight
40	Riedel Chiller – Flush and Treat Water System
41	Riedel Chiller – Air Filter Cleaning and Replacement
44	Laser General – Troubleshoot Equipment
45	Laser General – General Sweep and Workplace Organization
50	Torit Dust Collector Motor and Fan Replacement
51	Torit Dust Collector Filter Replacement
52	Torit Dust Collector Pressure Valve Replacement
55	Torit Dust Collector Differential Pressure Switch Replacement
56	Torit Dust Collector Verifying Monthly Pressure Drop
57	Torit Dust Collector Bin Emptying
58	Bosch Conveyor – Replace Conveyor Section

59	Bosch Conveyor – Chain Replacement
60	Bosch Conveyor – Lift Transfer Unit Replacement
61	Bosch Conveyor – Lift Positioning Unit Replacement
63	Bosch Conveyor – RFID Antenna Replacement
65	Bosch Conveyor – Motor Replacement
100	Air Line Replacement
101	Replace Sensors
102	Battery Replacement (Fanuc R-2000iC)

5.7. THIRD-PARTY EQUIPMENT MANUALS

The Module Final Assembly Line equipment is comprised of many integrated third-party components. Many of these components have their own documentation. The following table identifies the documentation associated with these third-party components. The electronic files have been provided separate from this manual.

5.7.1. Conveyance Manual References

Tool	Component	Manufacturer	Document File Name(s)
Conveyance	RFID Reader	Siemens	Siemens - SIMATIC Ident RFID systems SIMATIC RF300 System Manual.pdf
Conveyance	Auto Lubricator	Perma	Perma - STAR CONTROL Operating Instructions.pdf
Conveyance	Motor Controller	Allen-Bradley	Allen-Bradley - ArmorStart Distributed Motor Controller User Manual.pdf
Conveyance	Conveyor	Bosch	Bosch Belt Section BS 2.pdf Bosch BS 2C-…, BS 2R-… Belt Sections Assembly Instructions.pdf Bosch HQ 2U Lift Transverse Unit Assembly Instructions.pdf Bosch LU 2 Automatic Lubrication Unit Assembly Instructions.pdf Bosch Mounting Kit LG 2H Liftgate Assembly Instructions.pdf Bosch PE 2X Positioning Unit Assembly Instructions.pdf

5.7.2. EX010 Module Input VTU Manual References

Tool	Component	Manufacturer	Document File Name(s)
EX010T02 VTU	VTU	Bosch	Bosch Tsplus Vertical Transfer Module Model VT2 Installation and Maintenance.pdf

5.7.3. EX070 Tab Weld Manual References

Tool	Component	Manufacturer	Document File Name(s)
Laser Calibration	Calibration Tooling	Trumpf	Trumpf - Operator's Manual CalibrationLine.pdf
Laser Slide Tooling	Laser Profiler	Keyence	Keyence - Laser Profiler LJ-X8000 Series Instruction Manual.pdf
Laser Weld Equipment	Camera	Axis Communications	Axis Communications - Axis M5525-E PTZ Network Camera User Manual.pdf
Laser Weld Equipment	Flame Detector	Minimax	Minimax - Operating Instructions Flame Detector UniVario FMX5000 IR.pdf
Laser Weld Equipment	Chiller	Dimplex	Dimplex - Riedel Chiller Operating Instructions.pdf
Laser Weld Equipment	Laser Equipment	Trumpf	Trumpf - Operator’s Manual TruDisk 1000-8002.pdf
Laser Weld Equipment	Heatless Air Drier	SMC	SMC - Operation Manual Heatless Air Drier.pdf
Laser Weld Equipment	Fume Extractor	Donaldson	Donaldson Torit - Downflo Oval DFO 1-1 to 3-3 Installation and Operation Manual.pdf Donaldson Torit - Delta P Control Installation and Operation Manual.pdf

5.7.4. EX190 Module Cover Install Manual References

Tool	Component	Manufacturer	Document File Name(s)
EX190 Cell	Interlock	Fortress	Fortress - amGardpro Guard Switch Operating Instructions.pdf Fortress – Stainless amGardpro Slidebar Operating Instructions.pdf
EX190R01 Cover Install Robot	Robot	Fanuc	Fanuc - Robot R-2000iC Mechanical Unit Operator's Manual.pdf
EX190R01 Cover Install Robot	Camera	Fanuc	Fanuc - iRVision 2D Camera Application Operator's Manual.pdf
EX220R01 Cover Delivery Robot	Robot	Fanuc	Fanuc - Robot R-2000iC Mechanical Unit Operator's Manual.pdf
EX220R01 Cover Delivery Robot	Camera	Fanuc	Fanuc - iRVision 2D Camera Application Operator's Manual.pdf
EX220R01 Cover Delivery Robot	Robot Transport Unit	Fanuc	Fanuc - Generation VI - Robot Transport Unit (RTU) Mechanical Assembly, Operation and Maintenance Manual.pdf

Tool	Component	Manufacturer	Document File Name(s)
EX220T01/T02 Conveyance	Conveyor	Omni	Omni - (Firestone) Recommended Maintenance and Air Spring Inspection.pdf Omni - Chain Driven Live Roller Conveyor Straight and Curve Technical Handbook.pdf Omni - Chain Lubrication Instructions.pdf Omni - Chain Transfer Inspection And Lubrication Instructions.pdf Omni - General Safety Instructions Technical Handbook.pdf Omni - Notes on Chain Transfer Reducer Removal and Replacement.pdf
EX220T01/T02 Conveyance	Light Curtain	Sick	Sick - deTec4 Prime Safety Light Curtain Operating Instructions.pdf

5.7.5. EX280 Module Transfer Manual References

Tool	Component	Manufacturer	Document File Name(s)
EX280 Cell	Interlock	Fortress	Fortress - amGardpro Guard Switch Operating Instructions.pdf Fortress – Stainless amGardpro Slidebar Operating Instructions.pdf
EX280R01 Module Transfer Robot	Robot	Fanuc	Fanuc - Robot R-2000iC Mechanical Unit Operator's Manual.pdf
EX280R01 Module Transfer Robot	Robot Transport Unit	Fanuc	Fanuc - Generation VI - Robot Transport Unit (RTU) Mechanical Assembly, Operation and Maintenance Manual.pdf
EX300T01/T02/T03 Conveyance	Conveyor	Omni	Omni - (Firestone) Recommended Maintenance and Air Spring Inspection.pdf Omni - Chain Driven Live Roller Conveyor Straight and Curve Technical Handbook.pdf Omni - Chain Lubrication Instructions.pdf Omni - Chain Transfer Inspection And Lubrication Instructions.pdf Omni - General Safety Instructions Technical Handbook.pdf Omni - Notes on Chain Transfer Reducer Removal and Replacement.pdf
EX300T01/T02/T03 Conveyance	Light Curtain	Sick	Sick - deTec4 Prime Safety Light Curtain Operating Instructions.pdf
BOM Check	GTR Camera	Matrox	Matrox Iris GTR Install and Technical Manual

5.7.6. EX500 Module Output VTU Manual References

Tool	Component	Manufacturer	Document File Name(s)
EX500T02 VTU	VTU	Bosch	Bosch Tsplus Vertical Transfer Module Model VT2 Installation and Maintenance.pdf

6. TROUBLESHOOTING

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6.1. GENERAL TROUBLESHOOTING

6.1.1. Part Faults

Part faults occur when the system is out of parts, a reject bin or waste bin is full, or a part is jammed. The following table provides a list of part faults and resolutions.

Fault	Recovery
The system is out of production parts.	Replenish the production parts.
A reject bin is full.	Remove the rejected parts.
A waste bin is full.	Remove the waste.
A device is jammed, or a part is jammed in the device.	Remove the jammed part. ***Refer to 6.1.1.1 Remove a Jammed Part***.

6.1.1.1. Remove a Jammed Part

To remove a jammed part, complete the following steps:

WARNING!

To prevent injury or death, turn electrical power and pneumatic pressure OFF before manually removing jammed parts. Be aware of stored energy sources (such as trapped air pressure, vertical gravity movement, or hot surfaces) that exist in the system after lockout and tagout. Only trained and qualified Technicians should complete this procedure.

CAUTION!

To prevent damage to devices, do not pry jammed parts from a device.

1. Attempt to step or home the faulted device.
2. On the HMI, navigate to the Service screen and touch the **PREPARE FOR STOP** button. The cell completes the current cycle and then comes to a stop.
3. Turn the AUTO/MANUAL key switch to the MANUAL position on the operator interface terminal.
4. On the operator interface touch screen, touch the **SELECT** button in the screen header.
5. After the Select screen displays, touch the **SCROLL LIST** button.
6. Utilize the Scroll List screen and the DO button on the operator interface terminal for manual operations to reverse the device movement and relieve pressure on the part.
7. Open the guard door nearest the faulted device.
8. Carefully remove any parts that are jammed in the device.
9. If necessary, manually move pneumatic devices or servo-actuated devices. Always return devices back to the position they were originally in after moving them.
10. Close the guard door.
11. Turn the AUTO/MANUAL key switch to the AUTO position on the operator interface terminal.
12. Touch the **FAULT RESET** button in the screen header to reset the fault.
13. Check the indicator in the AUTO INITIATE button. If the green indicator in the button is dark or is rapidly flashing, one or more stations are not ready for auto. Use the alarm messages to identify why the cell and stations within the cell may not be ready for auto.
14. When the AUTO INITIATE button indicator is flashing steadily (not rapidly), press and hold the button. The alarm horn sounds three times and the cell initiates auto mode.
15. Release the button after the alarm horn ceases. The indicator illuminates steady.

6.1.2. Moving Device Faults

Moving device faults occur when a device does not complete an expected action and the sensor reports the unexpected condition to the processor. The following table provides a list of moving device faults and resolutions.

Fault	Recovery
A sensor reports an unexpected condition.	• Check the operation of the sensor for signs of abnormal operation. If the sensor is functioning correctly and is secure, inspect the stop in relation to the sensor. Refer to ***6.1.3. Sensor Faults***. • Check the hard stop alignment and inspect for damage. This can prevent the stop from triggering the sensor. Adjust or replace as required. • Check the air pressure. • Check the solenoid valves.
Pneumatic pressure supply is too high, too low, or turned off.	Check the air pressure.
A part is jammed in the tooling.	Remove the jammed part. Refer to ***6.1.1.1 Remove a Jammed Part.***
The gripper is malfunctioning.	Check the gripper for an obstruction or other issue.
A device is damaged.	Repair or replace the damaged device.

6.1.3. Sensor Faults

6.1.3.1. Sensor Type Tests

WARNING!

To prevent injury or death, turn electrical power and pneumatic pressure OFF before working with sensor faults. Be aware of stored energy sources (such as trapped air pressure, vertical gravity movement, or hot surfaces) that exist in the system after lockout and tagout. Only trained and qualified Technicians should complete this procedure.

Sensors monitor the presence and position of parts and tooling. Accurate positioning of sensors is critical to system performance. For more information about sensor locations and functions, refer to the ATS Electrical Drawings and Mechanical Drawings. The following table describes the tests for the sensor function.

Sensor Type	Test
Proximity sensor	Verify the sensor is operational. Pass a flag through the sensing range while observing the LED indicator on the sensor body. If the sensor is functioning correctly, the LED indicator changes state as a flag passes through the sensing range.
Through-beam sensor	Verify the sensor is operational. Pass a flag through the sensing range while observing the LED indicator on the sensor body. If the sensor is functioning correctly, the LED indicator changes state as a flag passes through the sensing range.
Hall effect sensor	Verify the sensor is operational. Manually move the affected device and observe the LED indicator on the sensor body. If the sensor is functioning correctly, the LED indicator changes state as the device moves through calibrated positions.

6.1.3.2. Sensor Fault Troubleshooting

The following table describes sensor faults and possible resolutions.

Device	Fault	Recovery
Sensor	Part is in the wrong location.	Remove the jammed part. Refer to ***6.1.1.1 Remove a Jammed Part***.
	Sensor cable is loose or disconnected.	Secure the cable to the sensor body or input block.
	Sensor is obstructed.	Remove the obstruction.
	Sensor face is dirty.	Clean the sensor.
	Sensor is out of alignment.	Adjust the sensor. Move the sensor to a position where the object is in the field of view. If necessary, adjust the sensor sensitivity.
PLC	Communication error.	• If the sensor is connected to a field device input module (that is, a module that is located in a remote location from the PLC and communicates by means of a network), check the I/O network communication status. In most cases, a communications problem results in many faults being reported. If all network communication is okay, then attempt sensor replacement. • If the sensor is connected directly to the PLC, locate the sensor input address label (on the sensor or cable) and locate that input address LED on the PLC card. If the LED is lit, check that the PLC is in RUN mode. If the LED is not lit, check the sensor cable connections. If sensor cable connections are okay, replace the sensor.

6.1.4. Pneumatic Faults

The following table provides a list of pneumatic faults and resolutions.

Device	Fault	Recovery
Regulator	Air supply regulator pressure is low.	• Make sure the facility air supply is turned ON. • Inspect the air pressure regulator to make sure it is turned ON and is set to the correct pressure. • Check that the air lines are secure and not worn or damaged. • Check for a blockage in the lines. • Check that the regulator is functioning properly. • Check for a malfunctioning solenoid.
Air Pressure	Pressure is not sufficient.	• Check for an incorrect regulator setting, or malfunctioning solenoid. • Adjust the air pressure.
Solenoid	Solenoid is malfunctioning.	Test the solenoid. Refer to ***6.1.6 Solenoid Faults***.

6.1.5. Air Cylinder Faults

The following table provides a list of air cylinder faults and resolutions.

Device	Fault	Recovery
Sensor	Sensor cable is loose or not connected.	• Secure the cables to the sensor body. • Check sensor alignment. • Check for sensor obstruction.
	Sensor is misaligned.	• Adjust the sensor. • Check for loose or disconnected sensor cables or sensor obstruction.
	Sensor is obstructed.	Remove the obstruction.
Air Pressure	Air supply regulator pressure is low.	• Check that the air lines are secure and not worn or damaged. • Check for a blockage in the lines. • Check that the facility air supply is ON and functioning properly. • Check that the regulator is functioning properly. • Check for a malfunctioning solenoid.
	Pressure is not sufficient.	• Adjust the air pressure. • Check for an incorrect regulator setting or malfunctioning solenoid.
	Solenoid is malfunctioning.	Test the solenoid. Refer to ***6.1.6 Solenoid Faults***.
Cylinder or Air Slide	Component is obstructed.	Remove the obstruction.
	Component is malfunctioning.	Replace the component.

6.1.6. Solenoid Faults

WARNING!

Manually activating solenoids causes pneumatic devices to move. To prevent injury, stay clear of moving equipment.

CAUTION!

Manually activating solenoids causes pneumatic devices to move. Equipment damage may result if the moving device contacts other devices, assembly pieces, or supporting structures.

If the system reports a solenoid fault:

- Press and hold the solenoid button. If the solenoid is operating correctly, the air valve spool shifts freely. If the valve is not operating properly, the spool does not shift freely. Replace, or disassemble and clean the valve, and then reassemble.
- If available, check the solenoid valve indicator light. If the light does not illuminate when the output signal is ON, it may be faulty. Temporarily replace the solenoid or test the solenoid.

The following table describes solenoid faults and possible resolutions.

Fault	Possible Cause	Recovery
Valve blows to exhaust when not actuated.	Inlet poppet is not sealing.	• Cycle the valve several times and check if valve air flow flushes the particles out. • Disassemble the valve and check the poppet seat for damage. If there is damage, replace the entire valve body assembly. • Disassemble the valve, clean thoroughly, lubricate lightly, and reassemble.
	Seals are damaged.	• Inspect the seals and replace any that are defective. • Lubricate the seals lightly and reassemble the valve.
	Valve-to-base gasket is damaged.	Rarely does a gasket become defective during normal operation. Do not attempt to continue use with a damaged gasket. Replace immediately.
	Water or oil contamination exists.	• Disassemble the valve. Clean, lightly lubricated, and reassemble. • Check that the supply air is dry, and that the air filter is drained frequently.
Solenoid fails to actuate the valve, but a manual override does actuate the valve.	Pilot cover is loose.	Tighten the cover and check for normal operation.
	Solenoid is damaged.	• Check the coil for electrical continuity. Replace the solenoid if the coil is open. • Check the coil for varnish deposits.
	Solenoid voltage is not adequate.	Use the following steps: 1. Exhaust the air supply to the valve. 2. Attach a voltmeter to the solenoid electrical supply. 3. Actuate the solenoid. If the voltage falls below the allowable operating range, the electrical supply is inadequate.
Solenoid fails to actuate the valve and a manual override also fails to actuate the valve.	Seals are damaged.	• Inspect the seals and replace any that are defective. • Lubricate the seals lightly and reassemble the valve.
	Valve has varnish deposits.	Remove the varnish deposits with a water-soluble detergent or solvent. Do not scrape the varnish off. Avoid chlorinated solvents and abrasive materials.
	Pilot or signal pressure is low.	Increase pilot pressure to the valve.
	Water or oil contamination exists.	• Disassemble the valve. Clean, lightly lubricated, and reassemble. • Check that the supply air is dry, and that the air filter is drained frequently.
Air flow is normal only in actuated position.	Spring return is broken.	Replace the broken return spring.
Solenoid buzzes.	Solenoid is damaged.	• Check the coil for electrical continuity. Replace the solenoid if the coil is open. • Check the coil for varnish deposits.

Fault	Possible Cause	Recovery
	Solenoid voltage is not adequate.	Use the following steps: 1. Exhaust the air supply to the valve. 2. Attach a voltmeter to the solenoid electrical supply. 3. Actuate the solenoid. If the voltage falls below the allowable operating range, the electrical supply is inadequate.
	Valve has varnish deposits.	Remove the varnish deposits with a water-soluble detergent or solvent. Do not scrape the varnish off. Avoid chlorinated solvents and abrasive materials.
Solenoid burns out prematurely.	Valve has varnish deposits.	Remove the varnish deposits with a water-soluble detergent or solvent. Do not scrape the varnish off. Avoid chlorinated solvents and abrasive materials.
	Incorrect voltage at solenoid.	Exhaust the air supply to the valve.
Pilot section blows to exhaust.	Pilot cover is loose.	Tighten the cover and check for normal operation.
	Pilot poppet is not sealing.	• Inspect the poppet and seat for foreign particles or damage. • Replace the pilot insert if the poppet or upper seat is damaged. • Replace the entire pilot housing if the lower seat is damaged. Blow out the pilot air passages to remove any loose dirt particles before installing a new insert. Reassemble.
Poppet chatters.	Air pressure is low.	• Check the air pressure supply. If the pressure falls more than 10% during actuation of the valve, the air supply may be inadequate. • Inspect the system for undersized supply lines, sharp bends in the piping, restrictive fittings, a clogged filter element, or a defective pressure regulator.
	Pilot or signal pressure is low.	Increase pilot pressure to the valve.
	Silencer is damaged.	• Remove silencer to observe if valve performance is improved. • Clean the silencer.
Valve action is sluggish.	Damaged seals on spool valve.	• Inspect and replace defective seals. • Lightly lubricate the seals.
	Valve has varnish deposits.	Remove the varnish deposits with a water-soluble detergent or solvent. Do not scrape the varnish off. Avoid chlorinated solvents and abrasive materials.
	Air pressure is low.	• Check the air pressure supply. If the pressure falls more than 10% during actuation of the valve, the air supply may be inadequate. • Inspect the system for undersized supply lines, sharp bends in the piping, restrictive fittings, a clogged filter element, or a defective pressure regulator.
	Pilot or signal pressure is low.	Increase pilot pressure to the valve.
	Silencer is damaged.	• Remove silencer to observe if valve performance is improved.

Fault	Possible Cause	Recovery
		• Clean the silencer.
	Water or oil contamination exists.	• Disassemble the valve. Clean, lightly lubricated, and reassemble. • Check that the supply air is dry, and that the air filter is drained frequently.

6.1.7. Gripper Faults

The following table describes gripper faults and possible resolutions.

Device	Fault	Recovery
Sensor	Sensor cable is loose or disconnected.	Secure the cable to the sensor body.
	Sensor is misaligned.	Check the operation of the sensor for signs of abnormal operation. If the sensor is functioning correctly and is secure, inspect the stop in relation to the sensor. Refer to ***6.1.3 Sensor Faults***.
	Sensor is obstructed.	Remove the obstruction. Refer to ***6.1.1.1 Remove a Jammed Part***.
Air pressure	Air pressure is low.	• Check that the facility air supply is ON and functioning properly. • Check that the air lines are secure and not worn or damaged. • Check for a blockage in the lines. • Check that the regulator is functioning properly. • Check for a malfunctioning solenoid.
	Solenoid is malfunctioning.	Refer to ***6.1.6 Solenoid Faults***.
Gripper or Rotary Actuator	Component is obstructed.	Remove the obstruction. Refer to ***6.1.1.1 Remove a Jammed Part***.
	Component is malfunctioning or is not set up correctly.	• Adjust or replace the component. • Check the air pressure. • Check the solenoid valves. Refer to ***6.1.6 Solenoid Faults***. • Check the hard stop alignment and inspect for damage. This can prevent the stop from triggering the sensor. Adjust or replace as required.
Cylinder or Air Slide	Component is malfunctioning.	• Check for an obstructed cylinder. Remove the obstruction if required. Remove the obstruction. Refer to ***6.1.1.1 Remove a Jammed Part***. • Replace the component.

6.1.8. Air Pressure Faults

The following table describes air pressure faults and possible resolutions.

Device	Fault	Recovery
Air flow	Air pressure is low.	• Check that the facility air supply is ON and functioning properly. • Check that the air lines are secure and not worn or damaged. • Check for a blockage in the lines. • Check that the regulator is functioning properly.

		• Check for a malfunctioning solenoid.
Solenoid	Solenoid is malfunctioning.	Refer to ***6.1.6 Solenoid Faults***.

6.1.9. Conveyor Faults

The following table describes conveyor faults and possible resolutions.

Device	Fault	Recovery
Fuse	Fuse has failed.	Replace the blown fuse.
Motor	Overload relay has been tripped.	Reset and then restart the motor.
	Motor is receiving power, but it is not running.	Replace the motor.
Gearbox	Motor is running but the conveyor is not.	Replace the gearbox.
Conveying device	Conveying device is obstructed.	Remove the obstruction. Refer to ***6.1.1.1 Remove a Jammed Part***.
	Parts were manually moved out of position during maintenance.	Acknowledge the fault and manually send the conveying device to the next position to reset.
	Timing belt is not functioning properly.	Replace the timing belt.
	Pulleys are not running freely without excessive drag.	Replace the pulleys.
	Servo motor is not functioning properly.	Replace the servo motor.

6.1.10. Servo Motor Faults

The following table describes servo motor faults and possible resolutions.

Fault	Recovery
Servo axis has positive or negative overtravel.	• If possible, open the guard door and manually push the servo away from the travel limit (possible on most axes that do not have a mechanical brake). Jogging off a software over-travel limit may require limits to be temporarily disabled. • Jog the servo in a positive or negative direction using the Servo/VFD screen.
Servo axis is not referenced (homed).	Manually remove any interfering parts, and then home the servo.
Servo emergency all stop triggered.	• Reset the servo. • Verify that the servo power is ON.
Servo axis reset did not complete, or the servo drive DC bus voltage is low.	• Acknowledge the fault, and then reset the servo. Retry the servo. • Verify that the servo power is ON and that the servo is enabled. Retry the servo. • Check the AC fuses. • Check for a communication problem.
Any other fault.	Verify that the servo power is ON and that the servo is enabled. Retry the servo.

6.1.11. Vision Faults

The following table describes vision faults and possible resolutions.

Device	Fault	Recovery
Software	Calibration is required.	Complete the necessary calibration procedure.
Camera	Camera is offline.	Check the power supply.

	Trigger did not finish.	Check the I/O.
	Message did not finish.	Check the Ethernet cable to make sure it is not unplugged or kinked.
Lighting	Lighting is faulty.	Adjust the light settings. Check the power supply. Check that the filter is in position.

6.1.12. Processor Faults

Whenever a fatal processor fault occurs:

- The cell stops completely.
- All indicator lights turn OFF.
- The cell cannot be restarted.

A processor fault may result from power loss to the processor or from a software problem.

To determine the cause of the fault:

1. Open the electrical enclosure door and inspect the status indicator lights on the processor power supply module.
2. Connect a computer terminal to the programmable controller and check for fault codes.
3. Refer to the programmable controller OEM literature for assistance in determining the cause of the fault and appropriate corrective action.
4. Contact ATS if additional assistance is required.

6.2. COMMON FAULTS TROUBLESHOOTING

Specific troubleshooting procedures for common fault types are documented in the GM NOK Checklists. Please refer to these checklists for recovery information.

7. ASSEMBLY AND DISASSEMBLY

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7.1. PALLET LOCATING POSTS

To replace a locating post (see callout **A** in *Figure 7-1*) on a pallet, complete the following steps:

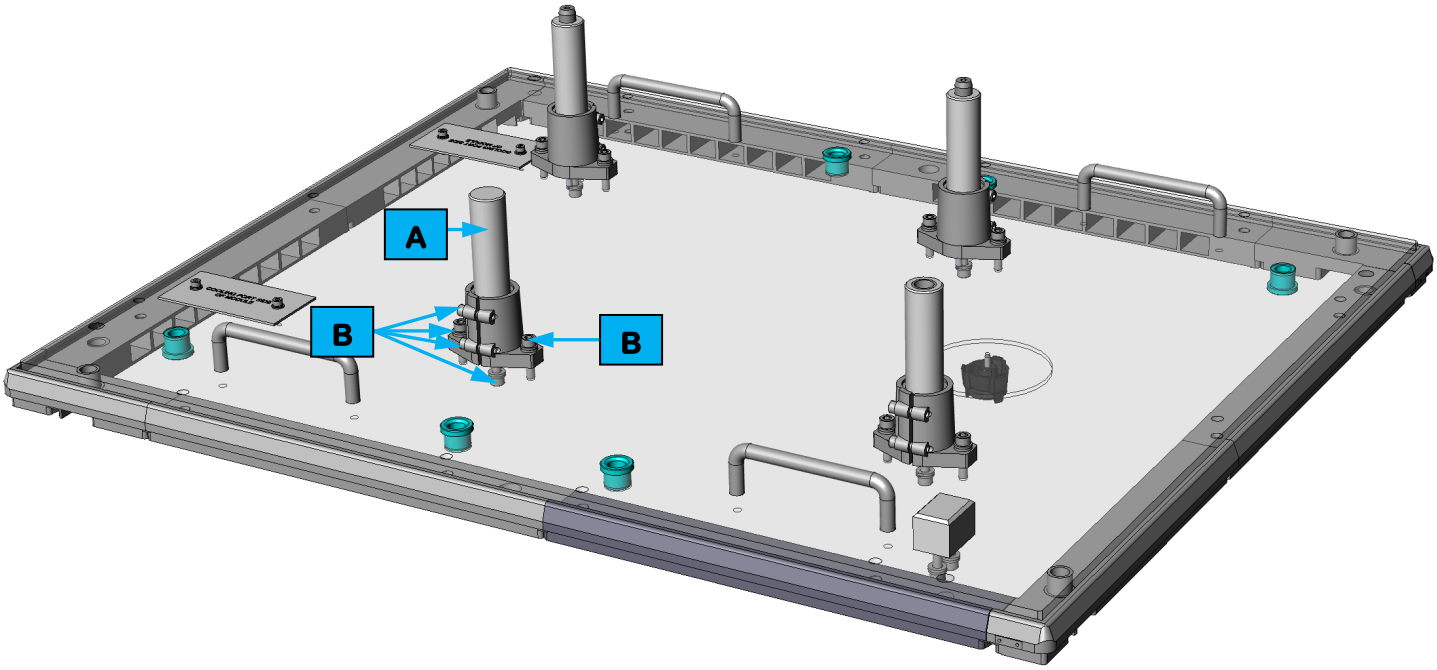

Figure 7-1. An illustration of a pallet.

1. Remove the pallet from the conveyor.
2. Loosen and remove the five bolts (see callout **B** in *Figure 7-1)* securing the locating post.
3. Remove the locating post (see callout **A** in *Figure 7-1*).
4. Replace the locating post.
5. Install and tighten the five bolts to secure the locating post to the pallet.

7.2. EX020 TAB BEND TOOLING

To replace a tab bend tool (see callout **A** in ***Figure 7-2***), complete the following steps:

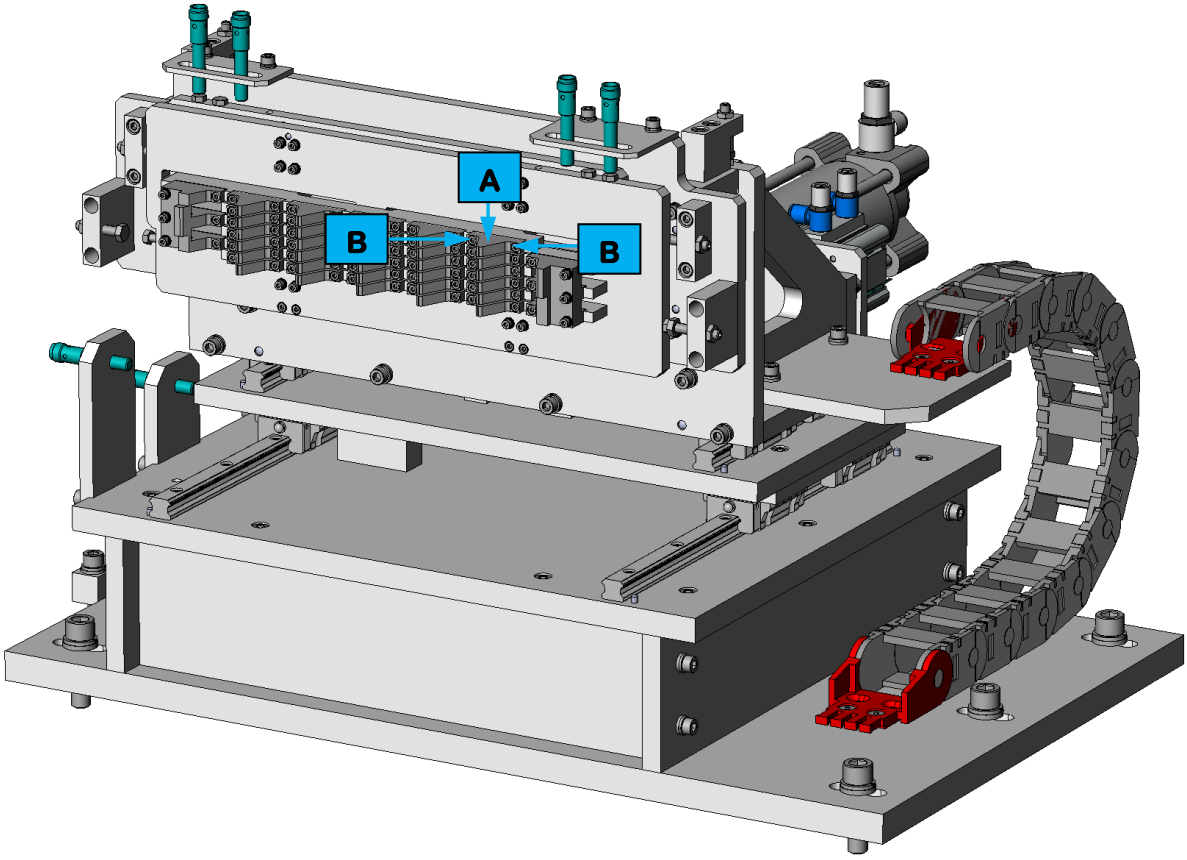

Figure 7-2. An illustration of a tab bend tool.

1. Safely stop the cell by navigating to the Service screen and touching the **PREPARE FOR STOP** button. The cell completes its current cycle and then comes to a stop.
2. Turn the MAIN DISCONNECT switch (Lockout Point E-1) to the off position at the PDP main control panel.
3. Open the cell guard doors.
4. Loosen and remove the bolts (see callout **B** in ***Figure 7-2***) securing the tab bend tool (see callout **A** in ***Figure 7-2***).
5. Remove the tab bend tool.
6. Replace the tab bend tool.
7. Install and tighten the bolts to secure the tab bend tool.
8. Close the cell guard doors.

7.3. EX070 WELD CONTACT TOOLING TOOL BLOCK

To replace a weld contact tooling tool block (see callout **E** in *Figure 7-3*), complete the following steps:

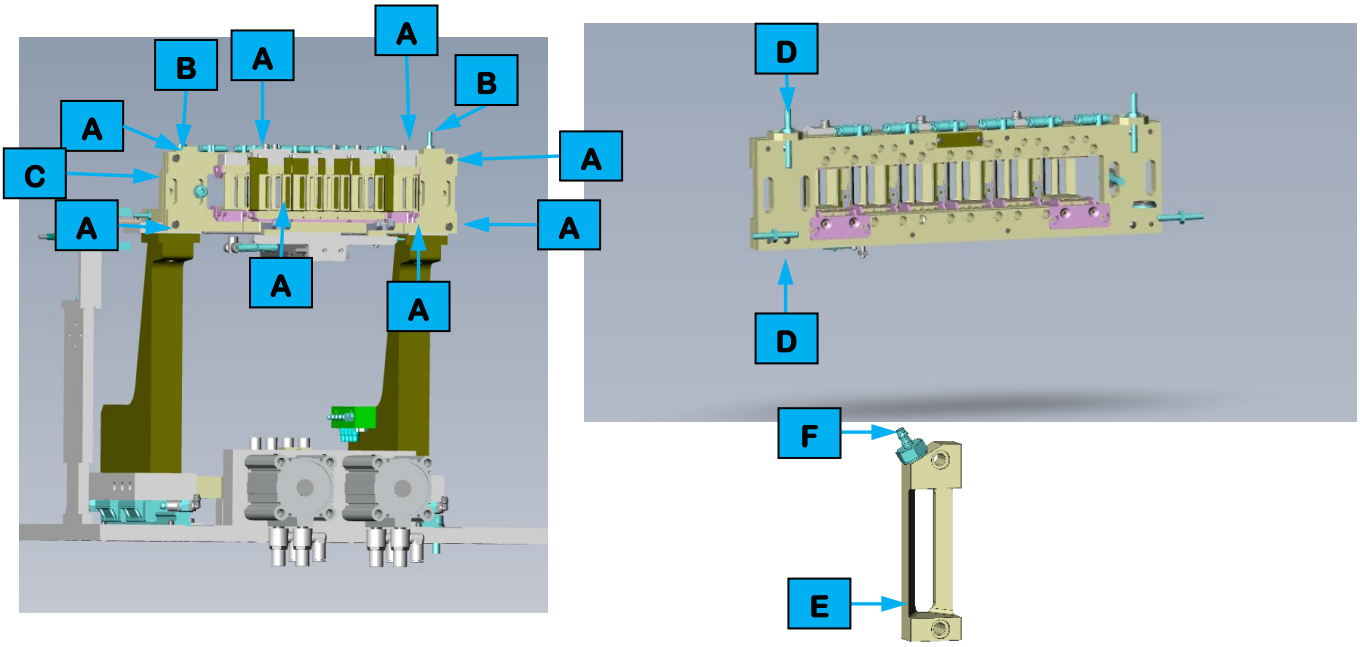

Figure 7-3. Illustrations of the weld contact tool removal.

1. Safely stop the cell by navigating to the Service screen and touching the **PREPARE FOR STOP** button. The cell completes its current cycle and then comes to a stop.
2. Turn the MAIN DISCONNECT switch (Lockout Point E-1) to the off position at the PDP main control panel.
3. Open the cell guard door.
4. Loosen and remove the eight (8) SHCSs (see callout **A** in *Figure 7-3*) that secure the isolating tool bars (see callout **B** in *Figure 7-3*) to the tooling plate (see callout **C** in *Figure 7-3*).
5. Pull the isolating tool bars off the tooling plate.
6. Loosen and remove the two (2) shoulder screws (see callout **D** in *Figure 7-3*) that secure the tool block (see callout **E** in *Figure 7-3*).
7. Remove the tool block.
8. Loosen and remove the fitting (see callout **F** in *Figure 7-3*).
9. Thread the fitting into the new tool block.
10. Secure the tool block with the two (2) shoulder screws.
11. Return the isolating tool bars to the tooling plate and install the eight (8) SHCSs to secure the isolating tool bars.
12. Close the cell guard door.

7.4. EX190 COVER INSTALL ROBOT END OF ARM TOOLING

To replace the end of arm tooling (see callout **A** in *Figure 7-4*) on the Cover Install Robot, complete the following steps:

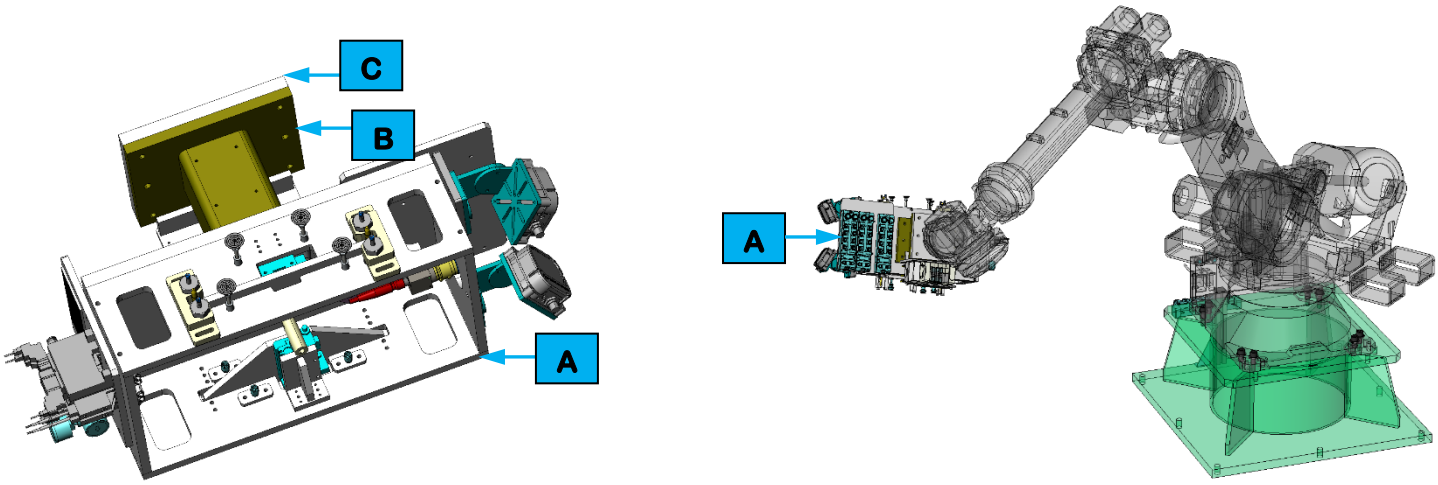

Figure 7-4. Illustrations of the Cover Install Robot end of arm tooling.

1. Safely stop the cell by navigating to the Service screen and touching the **PREPARE FOR STOP** button. The cell completes its current cycle and then comes to a stop.
2. Turn the MAIN DISCONNECT switch (Lockout Point E-1) to the off position at the PDP main control panel.
3. Open the cell guard door.
4. Disconnect all air and electrical connections from the robot to the end of arm tooling (see callout **A** in *Figure 7-4*).
5. While supporting the end of arm tooling, remove the bolts securing the end of arm welded post (see callout **B** in *Figure 7-4*) to the robot attachment plate (see callout **C** in *Figure 7-4*).
6. Remove the end of arm tooling from the robot.
7. After making adjustments or replacing any necessary tooling, install the end of arm tooling to the robot by tightening the bolts the secure the welded post to the robot attachment plate.
8. Connect all air and electrical connections from the robot to the end of arm tooling.
9. Close the cell guard door.

7.5. EX190 COVER DELIVERY ROBOT END OF ARM TOOLING

To replace the end of arm tooling (see callout **A** in *Figure 7-5*) on the Cover Delivery Robot, complete the following steps:

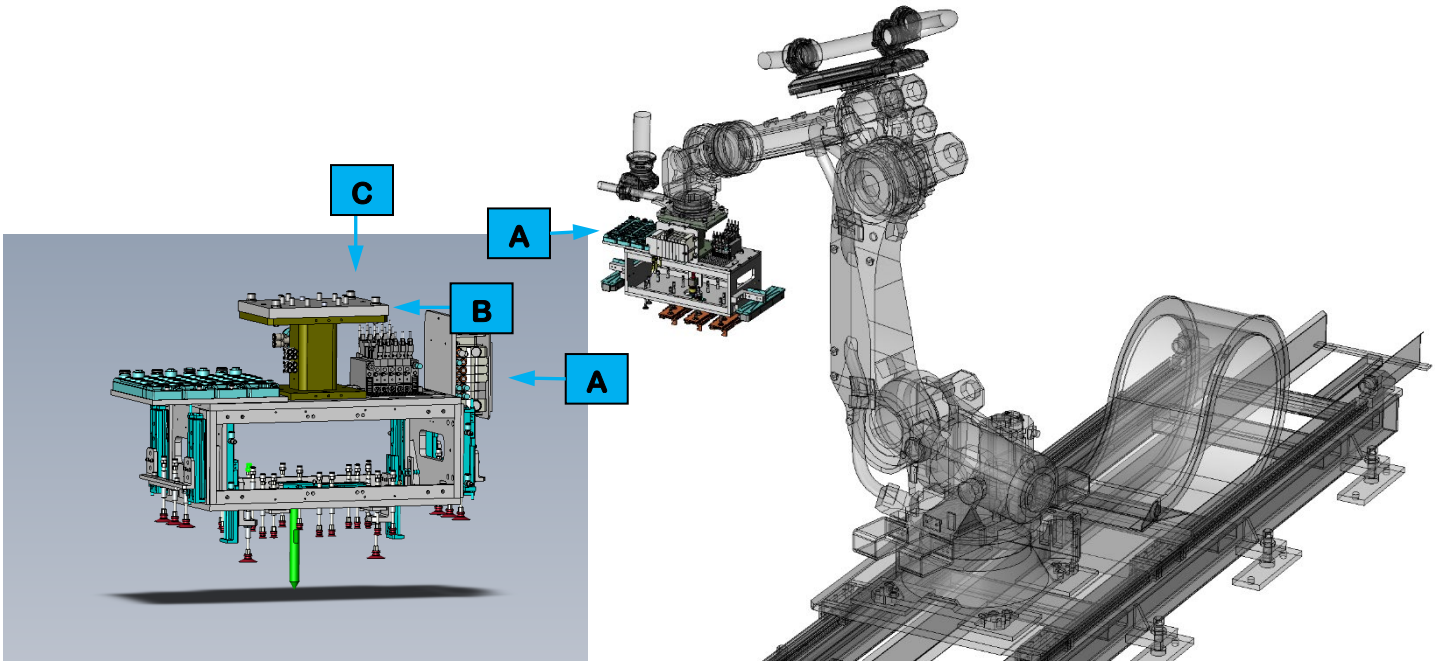

Figure 7-5. Illustrations of the Cover Delivery Robot end of arm tooling.

1. Safely stop the cell by navigating to the Service screen and touching the **PREPARE FOR STOP** button. The cell completes its current cycle and then comes to a stop.
2. Turn the MAIN DISCONNECT switch (Lockout Point E-1) to the off position at the PDP main control panel.
3. Open the cell guard door.
4. Disconnect all air and electrical connections from the robot to the end of arm tooling (see callout **A** in *Figure 7-5*).
5. While supporting the end of arm tooling, remove the bolts securing the end of arm welded post (see callout **B** in *Figure 7-5*) to the robot attachment plate (see callout **C** in *Figure 7-5*).
6. Remove the end of arm tooling from the robot.
7. After making adjustments or replacing any necessary tooling, install the end of arm tooling to the robot by tightening the bolts the secure the welded post to the robot attachment plate.
8. Connect all air and electrical connections from the robot to the end of arm tooling.
9. Close the cell guard door.

7.6. EX280 MODULE TRANSFER ROBOT END OF ARM TOOLING

To replace the end of arm tooling (see callout **A** in *Figure 7-6*) on the Module Transfer Robot, complete the following steps:

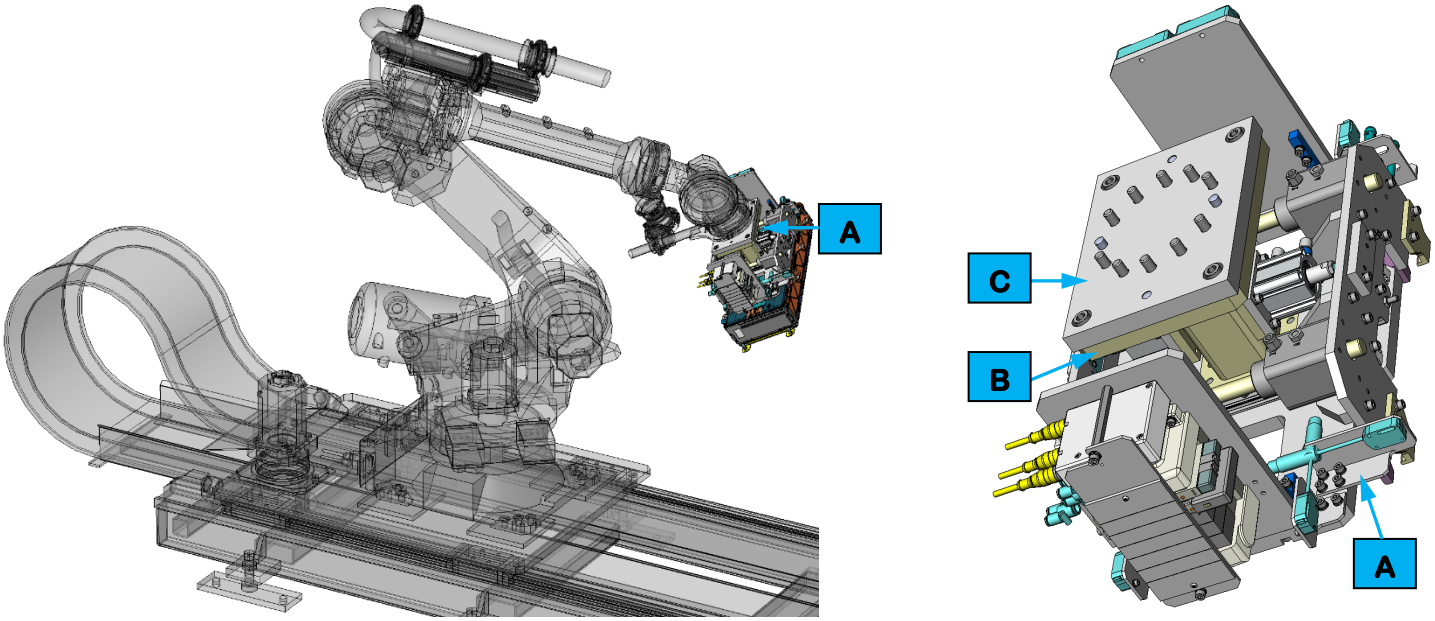

Figure 7-6. Illustrations of the Module Transfer Robot end of arm tooling.

1. Safely stop the cell by navigating to the Service screen and touching the **PREPARE FOR STOP** button. The cell completes its current cycle and then comes to a stop.
2. Turn the MAIN DISCONNECT switch (Lockout Point E-1) to the off position at the PDP main control panel.
3. Open the cell guard door.
4. Disconnect all air and electrical connections from the robot to the end of arm tooling (see callout **A** in *Figure 7-6*).
5. While supporting the end of arm tooling, remove the bolts securing the end of arm welded post (see callout **B** in *Figure 7-6*) to the robot attachment plate (see callout **C** in *Figure 7-6*).
6. Remove the end of arm tooling from the robot.
7. After making adjustments or replacing any necessary tooling, install the end of arm tooling to the robot by tightening the bolts the secure the welded post to the robot attachment plate.
8. Connect all air and electrical connections from the robot to the end of arm tooling.
9. Close the cell guard door.

8. INSTALLATION

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8.1. LONG TERM STORAGE

If the system is not installed immediately after delivery, it must be stored in a protected and dry location. It must be covered up appropriately to prevent moisture infiltration.

The system must not be stored out of doors. Shiny components are not protected with long-term preservation against climatic influences. Electrical cabinets and other electrical equipment are not rainproof.

If the shipping cover is removed the machine is not protected.

8.2. COMMISSIONING

This section outlines procedures for installing the Module Final Assembly Line. After the Factory Acceptance Test at the manufacturing facility, the system is broken up into major assemblies which are then vacuum sealed into an appropriate shipping material and secured inside custom-built wooden crating, then delivered to the GM facility. Care should be taken when unpacking system components.

In general, ATS personnel are ready to install, configure, and troubleshoot the installation of the Module Final Assembly Line. If this system is installed or moved without ATS assistance the following instructions are to be used as a guideline.

For a new install, it is recommended to install components as they are delivered from the manufacturer, as opposed to waiting for the full delivery. For example, as one cell tooling arrives, install before starting the remaining cells.

For the previously disassembled system, it is recommended to install according to the teardown map created in the removal section of this document. For example, ensure all of one cell components are present in the staging area before beginning the installation.

8.2.1. Required Personnel

All installations are to be conducted by trained and ATS-approved personnel. During installation, all personnel within the work area must be ATS-approved installation personnel, unless otherwise approved by the ATS project (or program) manager.

8.2.2. Installation Facility

The main requirement is a facility that meets the minimum space needs of the project, as shown in the engineering documents supplied by ATS. The facility must have a flat, reinforced concrete floor with a minimum thickness that complies with local building code. The facility must also be capable of delivering the required facility resources.

8.2.3. Installation Overview

Install the Module Final Assembly Line in the following general steps.

8.2.3.1. Draw Installation Locations on Facility Floor

On the facility floor, indicate with chalk markings or other marking system exactly where conveyors, electrical enclosures, and tooling are to be installed. Refer to engineering drawings supplied by ATS. Only authorized ATS personnel should perform this task.

8.2.3.2. Unpack Shipped Components

Carefully unpack all components shipped from the manufacturer, using heavy lifting equipment where necessary to remove components from the vacuum-sealed wooden crates. Check contents against the shipping documents. Place unpacked components for assembly in a suitable staging area as close as possible to the layout marked out on the facility floor.

8.2.3.3. Install Main Structure

Install the main structure for the cell.

8.2.3.4. Install Conveyor System

Where suitable, install the conveyor system to the cell.

8.2.3.5. Install Zone Tooling

Install all robots, lift assists, feed systems, jib cranes, and other tooling system to the cell.

8.2.3.6. Install Electrical Enclosure and Pneumatic Controls

Install the electrical enclosure and pneumatic controls unit for the cell.

8.2.3.7. Connect the Facility Electrical Supply

When safe to do so, connect the facility electrical supply to the cell.

8.2.3.8. Connect Facility Air Supply

When safe to do so, connect the facility air supply to the cell.

8.2.3.9. Install All Safety Guarding

Where suitable install safety guarding to the cell.

8.2.3.10. Repeat for All Cells

Continue to install all cells of the Module Final Assembly Line until the Line is fully assembled.

8.3. LIFTING POINTS

WARNING!

To prevent severe injury or equipment damage, use only appropriate lifting equipment and use caution when lifting and handling equipment. Always follow local laws and regulations and third-party equipment guidelines.

8.3.1. Fanuc R-2000 iC Robot Lifting

Lift the Fanuc R-2000 iC robots using the fork tubes on the robot base.

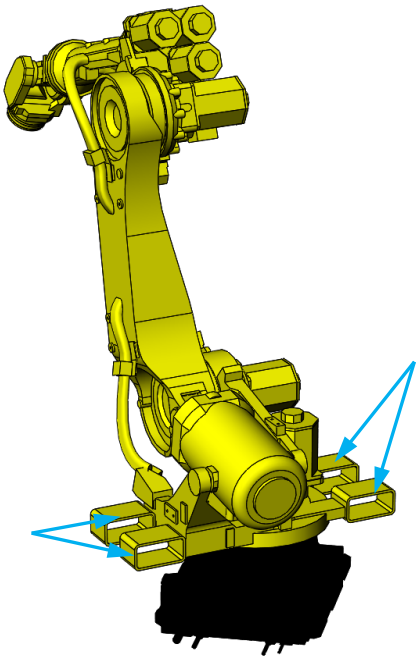


Figure 8-1. Fanuc R-2000 iC lifting points.

REFERENCE

For more information about lifting the robots, refer to the equipment supplier documentation (Fanuc Robot R-2000 iC Operator's Manual pg. 1-10).

8.3.2. PDP / Cabinet Lifting

Lift each PDP using the eyebolts on the top of the cabinet.

Figure 8-2. PDP lifting points.

8.3.3. Programming Terminal Lifting

Lift each programming terminal using the eyebolts on the top of the cabinet.

Figure 8-3. Programming terminal lifting points.

8.3.4. Fume Extractor Lifting

Lift each fume extractor using the four welded tie plates on the top of the device.

NOTE

There are two more lift points on the opposite side of the device.

REFERENCE

For more information about moving the fume extractor, refer to the equipment supplier documentation (Donaldson Torit Downflo Oval DFO 1-1 to 3-3 Installation and Operation Manual Pg. 5).

Figure 8-4. Fume extractor lifting points.

8.3.5. Chiller Cabinet Lifting

Lift each chiller using the eyebolts on the top of the cabinet.

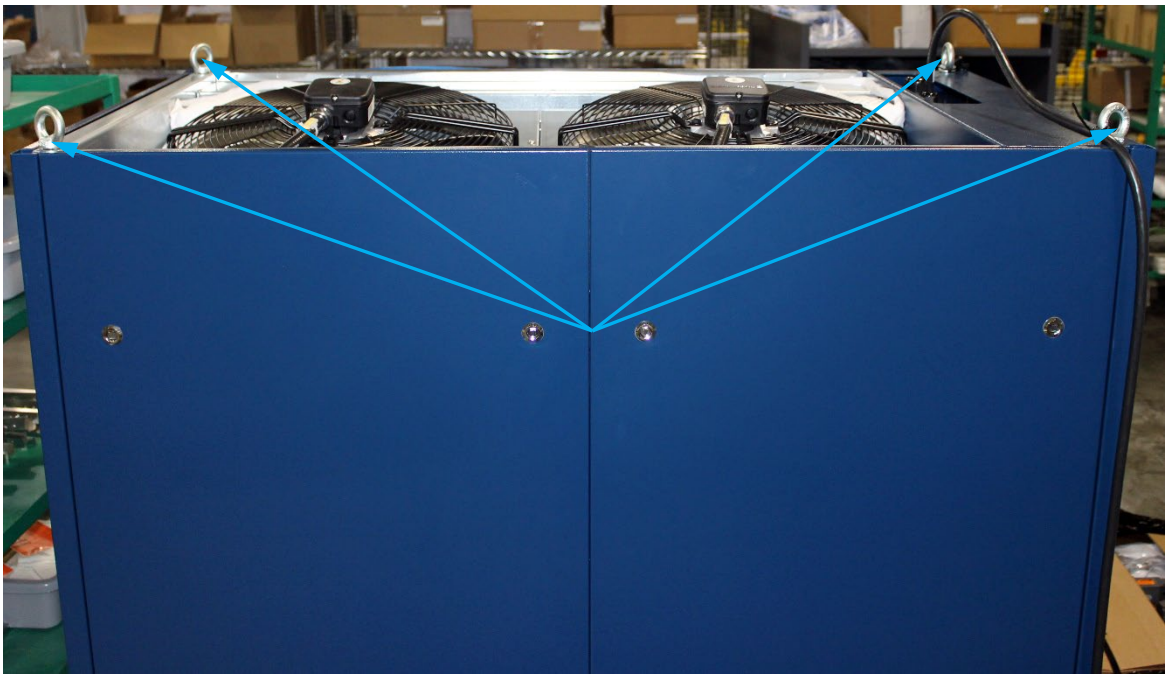


Figure 8-5. Chiller lifting points.

REFERENCE ***For more information about moving the chiller, refer to the equipment supplier documentation (Riedel Chiller Operating Instructions pg. 23-26).***

8.3.6. Base Table Lifting

Lift station base tables using the fork tubes on the bottom of the base table.

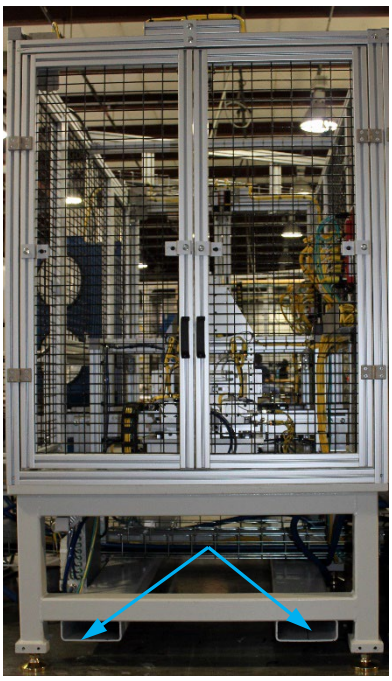
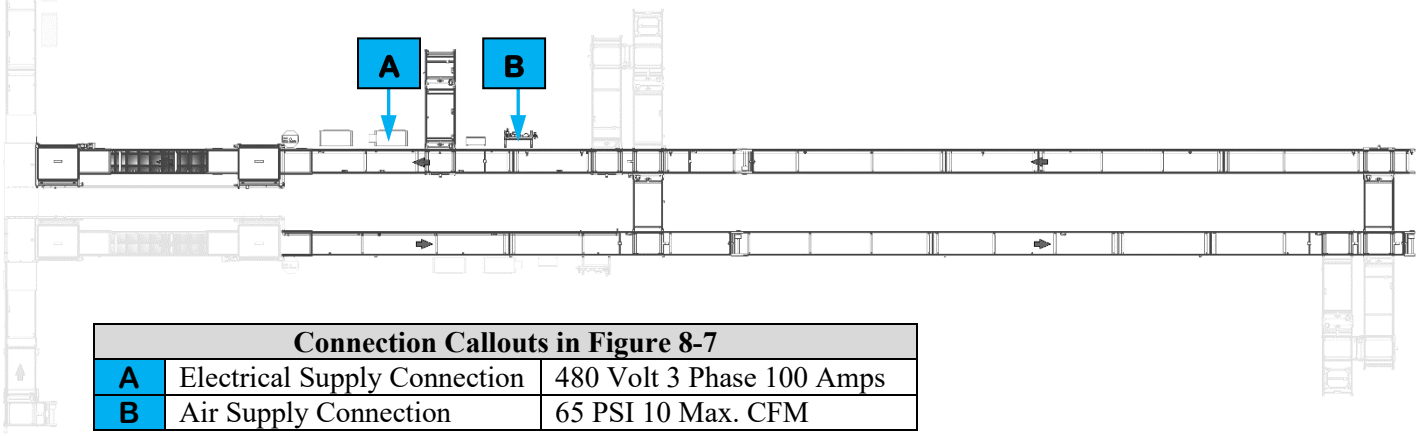


Figure 8-6. Base table lifting points.

8.4. CONNECTION POINTS

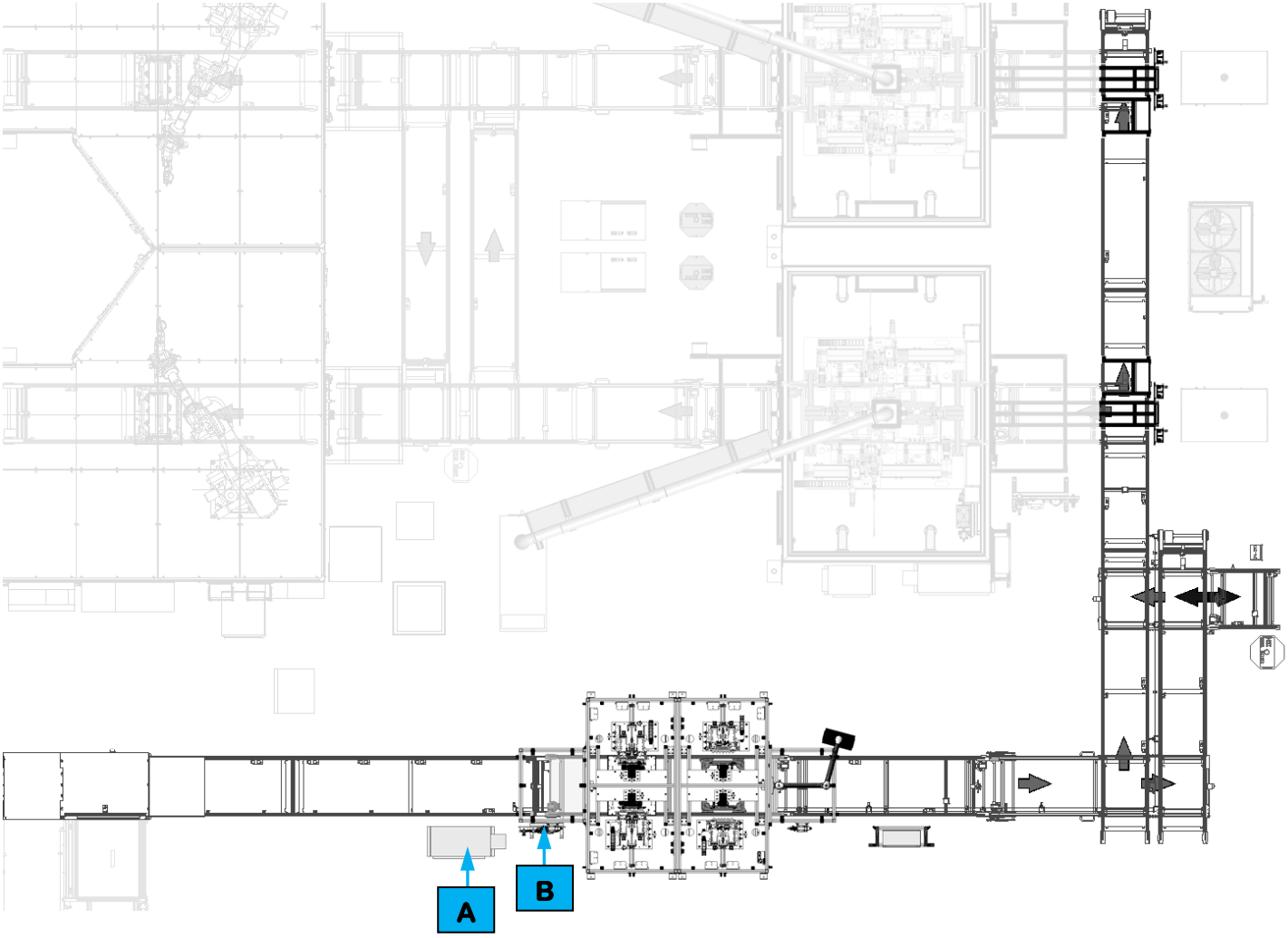
8.4.1. EX010 Module Input VTU Utility Connections



Connection Callouts in Figure 8-7		
A	Electrical Supply Connection	480 Volt 3 Phase 100 Amps
B	Air Supply Connection	65 PSI 10 Max. CFM

Figure 8-7. EX010 Module Input VTU utility connection points.

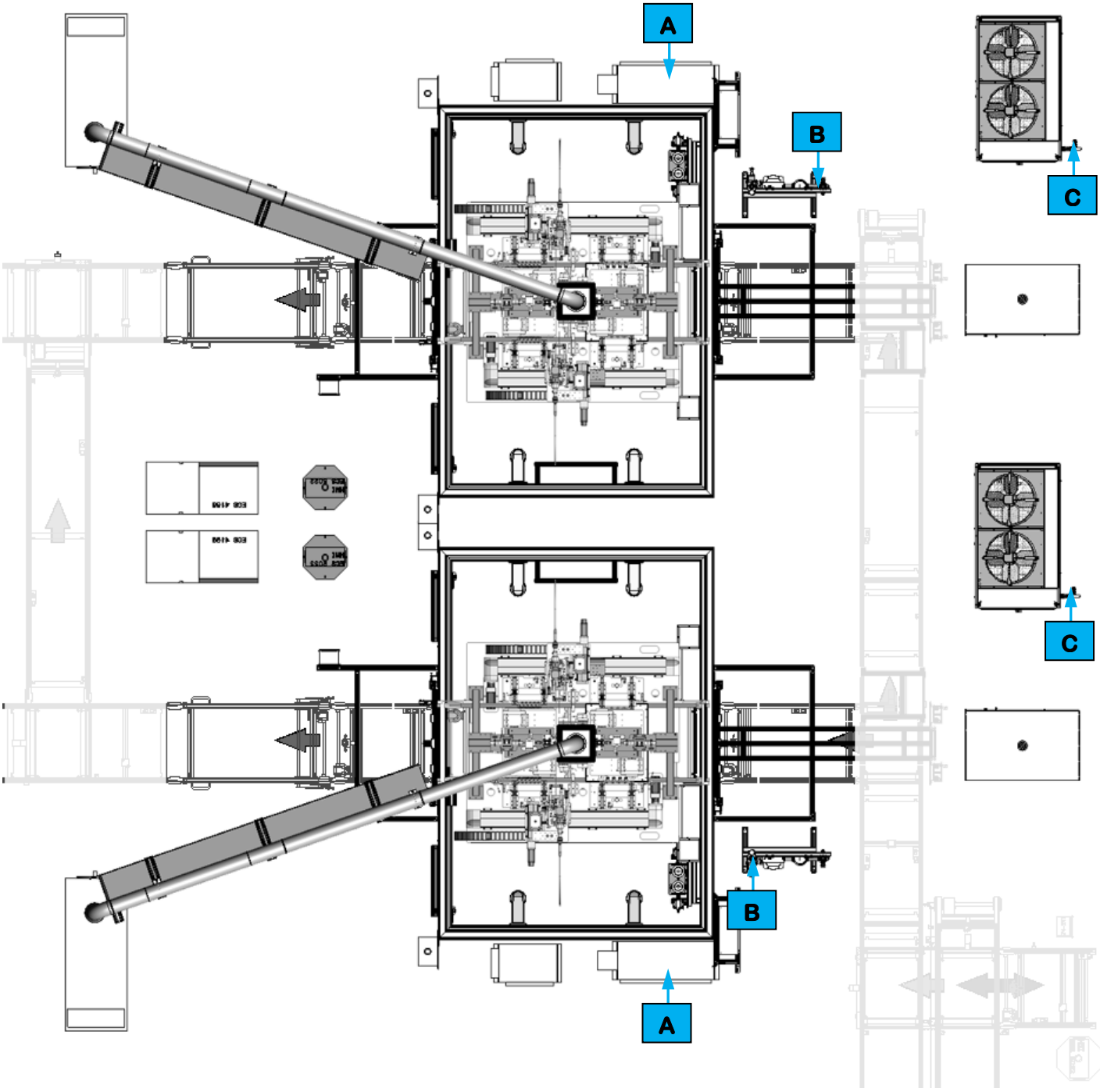
8.4.2. EX020 Post Tab Bend Utility Connections



Connection Callouts in Figure 8-8		
A	Electrical Supply Connection	480 Volt 3 Phase 100 Amps
B	Air Supply Connection	65 PSI 20 Max. CFM

Figure 8-8. EX020 Post Tab Bend utility connection points.

8.4.3. EX070 Tab Weld Utility Connections



Connection Callouts in Figure 8-9		
A	Electrical Supply Connection	480 Volt 3 Phase 200 Amps
B	Air Supply Connection	65 PSI 30 Max. CFM
C	Water Supply Connection	43 PSI 132 GPM

Figure 8-9. EX070 Tab Weld utility connection points.

8.4.4. EX110 Pulse Phase Thermography Utility Connections

REFERENCE

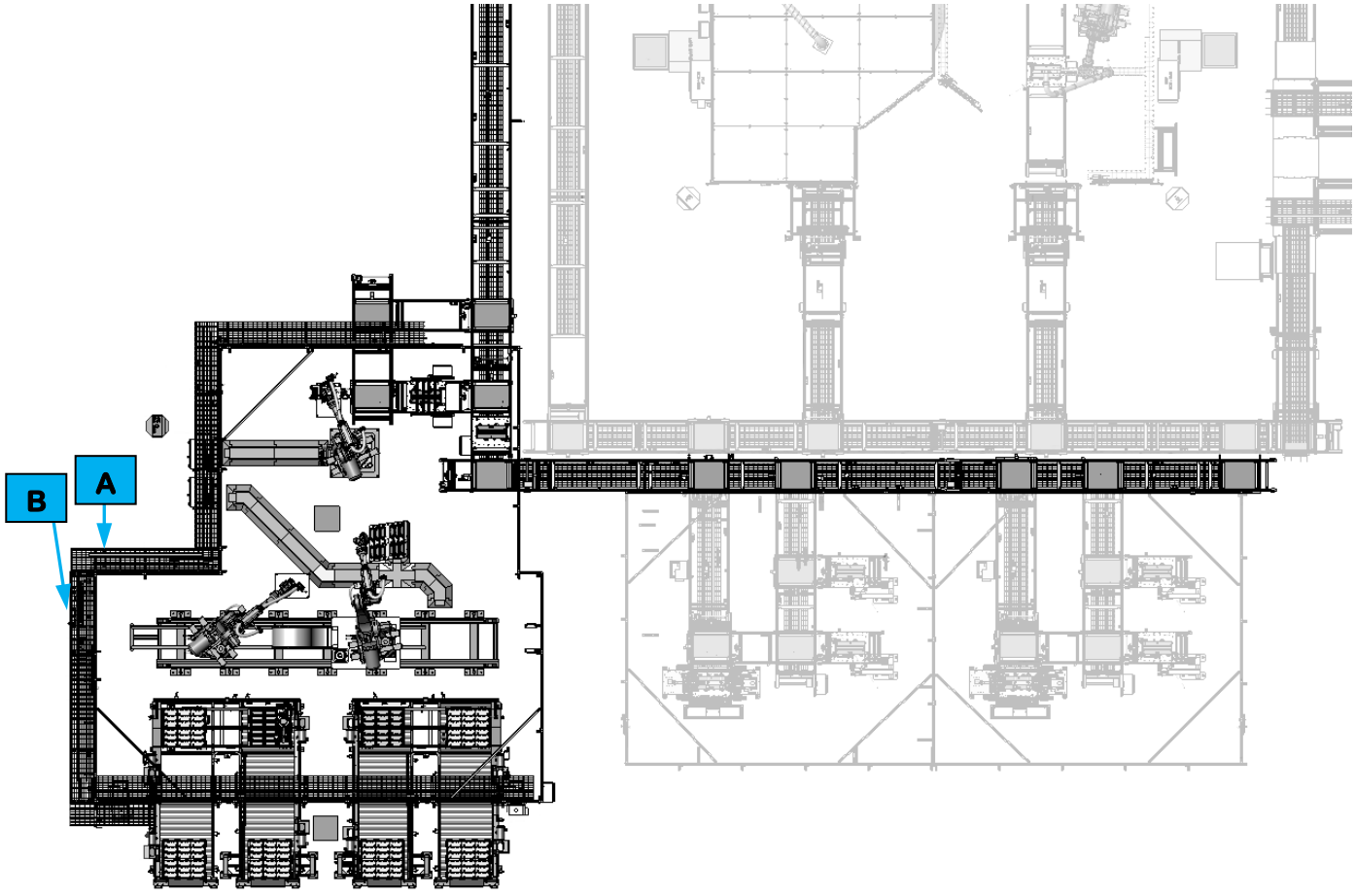
Refer to the ATS Pulse Phase Thermography and Module Electrical Test EX110 and EX140 Operation and Maintenance Manual for information about these connections.

8.4.5. EX140 Module Electrical Test Utility Connections

REFERENCE

Refer to the ATS Pulse Phase Thermography and Module Electrical Test EX110 and EX140 Operation and Maintenance Manual for information about these connections.

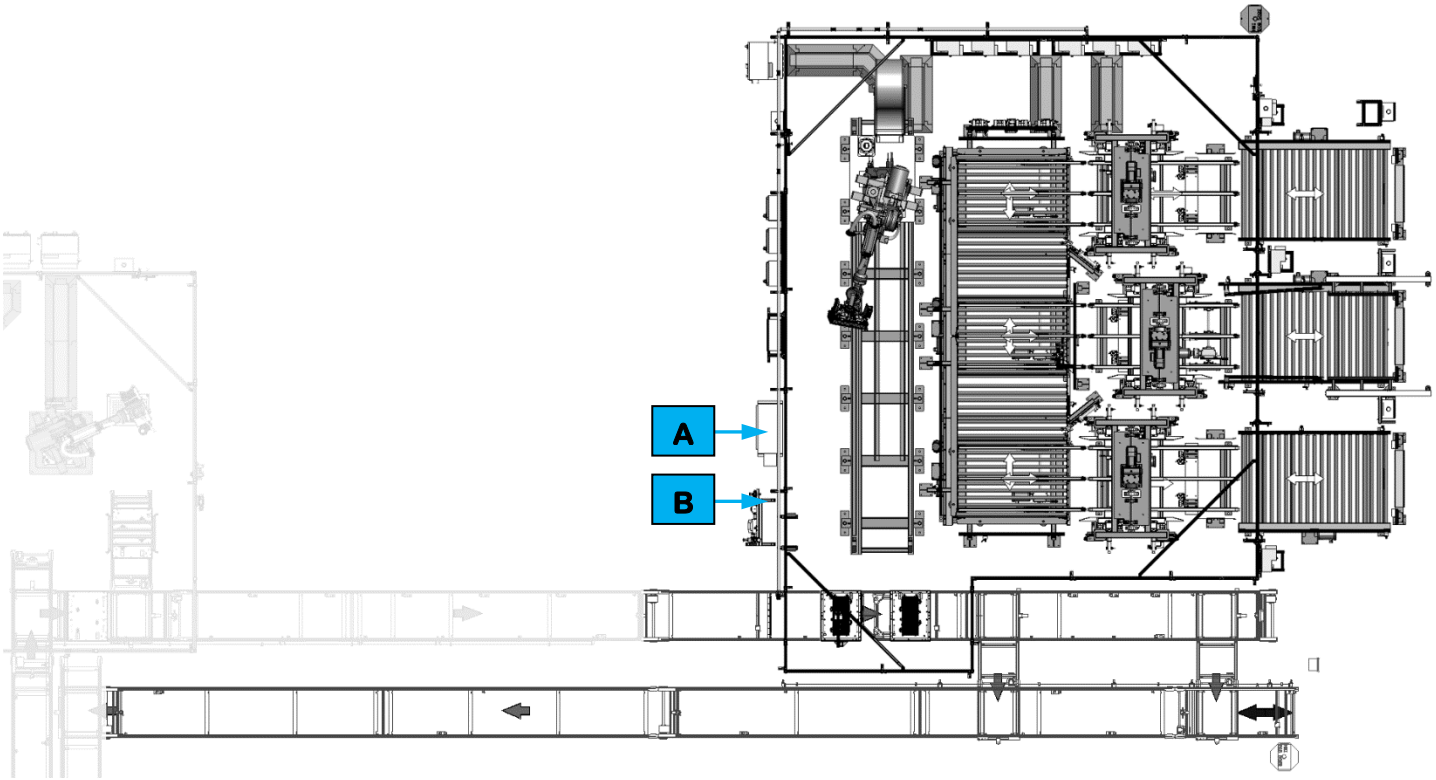
8.4.6. EX190 Module Cover Install Utility Connections



Connection Callouts in Figure 8-10		
A	Electrical Supply Connection	480 Volt 3 Phase 100 Amps
B	Air Supply Connection	65 PSI 30 Max. CFM

Figure 8-10. EX190 Module Cover Install utility connections.

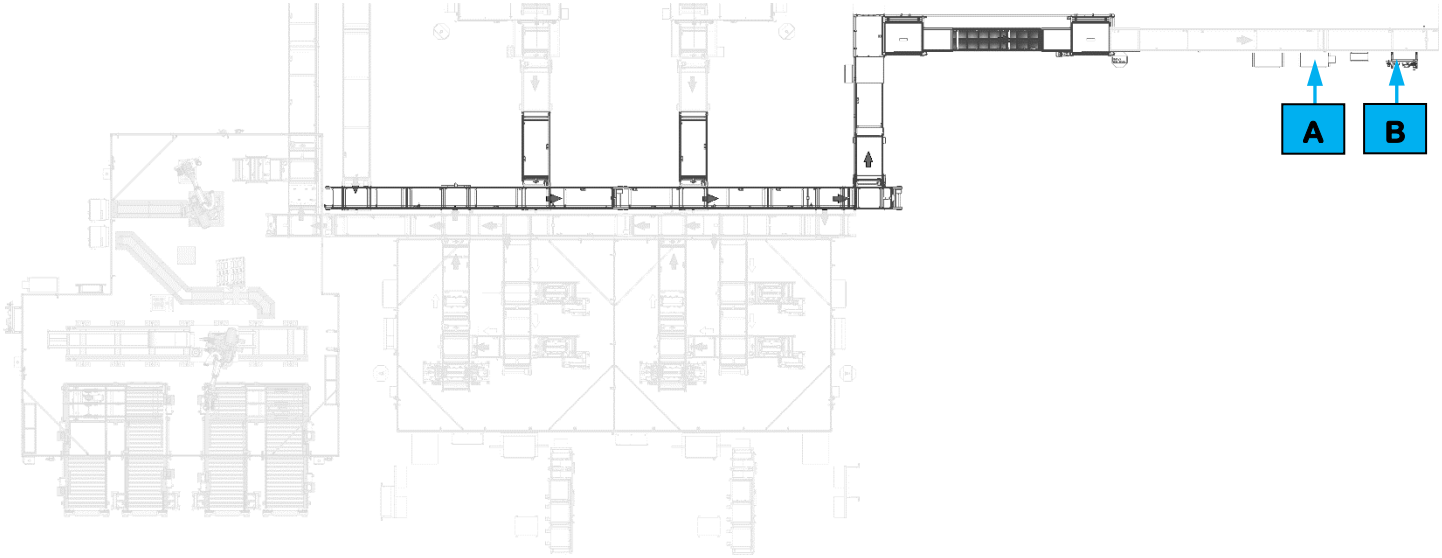
8.4.7. EX280 Module Transfer Utility Connections



Connection Callouts in Figure 8-11		
A	Electrical Supply Connection	480 Volt 3 Phase 100 Amps
B	Air Supply Connection	65 PSI 30 Max. CFM

Figure 8-11. EX280 Module Transfer utility connections.

8.4.8. EX500 Module Return VTU Utility Connections



Connection Callouts in Figure 8-12		
A	Electrical Supply Connection	480 Volt 3 Phase 100 Amps
B	Air Supply Connection	65 PSI 10 Max. CFM

Figure 8-12. EX500 Module Return VTU utility connections.

8.5. UTILITIES

The Module Final Assembly System has the following utility requirements:

		Module Input VTU (EX010)	Post Tab Bend (EX020)	Tab Weld 1 (EX070P1)	Tab Weld 2 (EX070P2)	PPT1 (EX110P1)	PPT2 (EX110P2)	Module Electrical Test 1 (EX140P1)		Module Electrical Test 2 (EX140P2)		Module Cover Install (EX190)	Module Transfer (EX280)	Module Return VTU (EX500)
Compressed Air Supply	Air Pressure (PSI)	65	65	65	65	65	65	65		65		65	65	65
	Max. CFM	10	20	30	30	10	10	20		20		30	30	10
	Supply Pipe Size	1.5″	1.5″	1.5″	1.5″	1.5″	1.5″	1.5″		1.5″		1.5″	1.5″	1.5″
Electrical Supply	Equipment Volts	480	480	480	480	480	480	480	480	480	480	480	480	480
	Equipment Phase	3	3	3	3	3	3	3	3	3	3	3	3	3
	Main Disconnect Amps	100	100	200	200	100	100	100	200	100	200	100	100	100
Water Supply	Water Pressure (PSI)	N/A	N/A	43	43	N/A	N/A	N/A		N/A		N/A	N/A	N/A
	Water Flow (GPM)	N/A	N/A	132	132	N/A	N/A	N/A		N/A		N/A	N/A	N/A

8.6. DECOMMISSIONING

This section outlines procedures for disassembling for moving or removal of the Module Final Assembly Line.

In General, ATS personnel are ready to disassemble, reconfigure, and assist in moving the Module Final Assembly Line. If this system is disassembled or moved without ATS assistance the following instructions are to be used as a guideline.

8.6.1. Disassembly Planning

Before the disassembly process, a disassembly plan should be created. This plan should outline:

1. The General Manager of the disassembly operation and their team.
2. Local staging area for disassembled components (the "Teardown Map").
3. Moving and Shipping strategy.
4. Destination staging area for disassembled components.
5. Final reassembly location for assembling disassembled components.
6. A disposal plan, if necessary.

8.6.2. Disassembly Overview

The following steps are a high-level overview of the disassembly process.

8.6.2.1. Observe Safety Precautions

All personnel involved with the disassembly should review safety and potential safety hazards as described in Chapter 2-Safety. All hazardous energy sources must be isolated from the machine prior to disassembly.

8.6.2.2. Review to the Teardown Map

All personnel involved with the disassembly should fully understand the Teardown Map prior to the disassembly.

8.6.2.3. Label Each Item Clearly

All components, tooling, guarding, and devices should be labeled before disassembly to ensure correct reassembly, including labelling all wiring, air lines, and cabling.

8.6.2.4. Ensure System is Clear

Ensure the system is clear of all workpieces, including inside enclosures. Ensure all air lines have been vented, feeder lines cleared, and all products have been removed from the cells and equipment.

8.6.2.5. Disassemble and Remove Electrical Enclosure and Pneumatic Controls

Disconnect and remove the electrical enclosure and pneumatic controls unit from the cell.

8.6.2.6. Disassemble and Remove All Safety Guarding

Disassemble and remove safety guarding from the cell.

8.6.2.7. Disassemble and Remove Tooling

Disconnect and remove all robots, lift assists, feed systems, and other tooling systems from the cell.

8.6.2.8. Disassemble and Remove Conveyor Systems

Disconnect and remove all conveyor equipment from the cell.

8.6.2.9. Disassemble and Remove Main Structure

Disassemble and remove the main structure for the cell.

8.7. PACKING AND MOVING

It is recommended that you retain the original packaging of the system if there is an expectation of moving the system to another facility in the future. Follow these general steps to safely move the system:

1. Before packing or moving the system, ensure the system is clear of all parts, the system is drained of all fluids, and all electrical and air connections are disconnected (see ***Section 8.4 CONNECTION POINTS***)
2. Follow the disassembly procedure (see ***Section 8.6 DECOMMISSIONING***)
3. Load and secure the disassembled parts of the system into crates, skids, and packaging appropriate for moving the parts of the system.
4. Once the system has been moved, follow the assembly procedure (see ***Section 8.2 COMMISSIONING***).

Refer to the OEM manuals for specific moving requirements for system equipment not covered by this manual. Contact ATS with any questions on disassembling, moving, or reassembling the system.

8.8. DISPOSAL

If the entire Module Final Assembly Line is to be disposed of (i.e., at the end of the product's lifecycle) the disassembly process will follow the Disassembly Plan for the disposal contingency, with the addition of the following general, disposal guidelines:

1. All third-party components on the machine should be disposed of in accordance with relevant OEM product documentation.
2. All hazardous materials should be disabled or isolated to prevent accidental re-use in the wrong hands. Disposal of such hazardous materials should be done either through the original manufacturer or in accordance with local hazardous waste disposal rules.
3. Where possible and practical, disassembled components should be salvaged for re-use.
4. Careless disposal of any product that may pollute the environment should be avoided.
5. All remaining miscellaneous materials should be disposed of in accordance with local laws and regulations and any applicable national regulations.

9. PROCESS PARAMETERS

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9.1. EX010 MODULE INPUT VTU PARAMETERS

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET/BEV	All	Main Air Prep	Air Pressure Regulator	65 PSI
		Air Shutoff	Air Pressure Switches	60 PSI

9.2. EX020 POST TAB BEND PARAMETERS

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET/BEV	All	Main Air Prep	Air Pressure Regulator	65 PSI
		Air Shutoff	Air Pressure Switches	60 PSI

9.3. EX070 TAB WELD PARAMETERS

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET/BEV	All	Air Drier	Air Pressure Regulator	45 PSI
		Riedel Chiller	Thermostat	18°C/64.4°F
		Main Air Prep	Air Pressure Regulator	65 PSI
		Air Shutoff	Air Pressure Switches	60 PSI
BET/BEV	Tab Weld	Contact Tooling	Air Pressure Regulator	35 PSI

NOTE

All taught laser positions will be automatically reverted to when the unit is homed after service. All laser or laser components will be serviced by a Trumpf technician and new positions will be taught as needed per GM positioning and geometry requirements.

9.4. EX110 PULSE PHASE THERMOGRAPHY PARAMETERS

For information regarding equipment located in Cell EX110, refer to the *Pulse Phase Thermography and Module Electrical Test EX110 and EX140 Operation and Maintenance Manual*.

9.5. EX140 MODULE ELECTRICAL TEST PARAMETERS

For information regarding equipment located in Cell EX140, refer to the *Pulse Phase Thermography and Module Electrical Test EX110 and EX140 Operation and Maintenance Manual*.

9.6. EX190 MODULE COVER INSTALL PARAMETERS

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET/BEV	All	End of Arm Tooling	Air Pressure Regulator	65 PSI
		Main Air Prep	Air Pressure Regulator	65 PSI
		Air Shutoff	Air Pressure Switches	60 PSI

9.7. EX280 MODULE TRANSFER PARAMETERS

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET/BEV	All	End of Arm Tooling	Air Pressure Regulator	65 PSI
		Main Air Prep	Air Pressure Regulator	65 PSI
		Air Shutoff	Air Pressure Switches	60 PSI

9.8. EX500 MODULE RETURN VTU PARAMETERS

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET/BEV	All	Main Air Prep	Air Pressure Regulator	65 PSI
		Air Shutoff	Air Pressure Switches	60 PSI