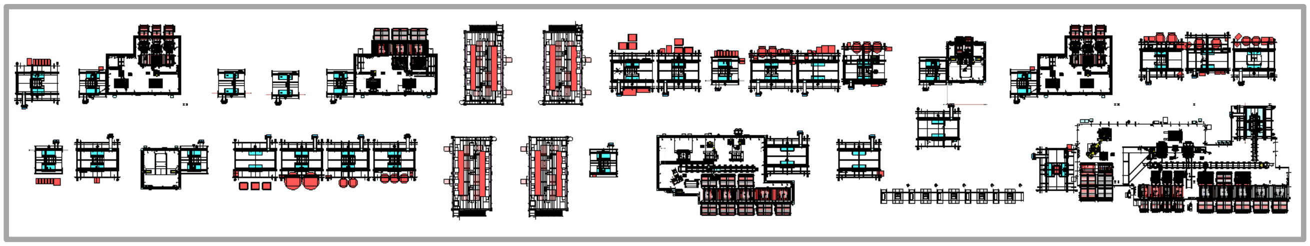

Pack Line Operation and Maintenance Manual

Designed and Built By

ATS Cambridge Job 14287
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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	03/2023	Draft Document release	All
A	04/2023	Revision A released	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 Pack Main Line 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.

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2. SAFETY

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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.***

Assembly line personnel must comply with the following safety rules:

- Always wear appropriate personal protective equipment.
- Remove or properly cover all personal metal objects (watches, rings, earrings, piercings, necklaces, badges, and belt buckles).
- Never touch anyone working on a battery.
- Never distract anyone working on a battery.

2.2. HEALTH AND SAFETY STATEMENT

Operate all assemblies, electrical components, and parts of this assembly line 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. Safety 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 assembly line operation before working on any part of the assembly line or individual cell.
- Adopt good work habits regarding safety when working on or around the assembly line.
- Avoid working on the assembly line 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 assembly line.
- 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 assembly line.
- 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 often 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 assembly line, individual 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 assembly line or individual cell to become thoroughly familiar with its operation before working with it. Knowledge of the assembly line or cell will help to avoid accidents. Read and understand all safety instructions before setting up, operating, maintaining, or servicing the assembly line or cell. Know the location and function of all safety devices provided with the assembly line or cell and check regularly to ensure 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 assembly line 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 warning signs 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 traffic areas 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. Automated Station Guarding

The guarding used in the BET/BEV3 Battery Pack Assembly Line forms a protective housing around automated stations 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. Automated Guided Cart (AGC) Safety

Operators and maintenance personnel must be aware of all safety hazards before operating around or maintaining an Automated Guided Cart (AGC) and associated equipment.

NOTE	***Consult your GM Automated Guided Cart (AGC) training and manuals for a proper understanding of the AGC system.***

2.5.7. Lift Assist Safety

While working with lift assists observe the following precautions:

- Ensure all Personnel are trained for working with lift assists.
- Do not use the lift assist as a slinging point.

- Do not use the lift assist to lift Personnel.
- Do not operator the lift assist if it is broken.
- Always inspect the lift assist before operation.
- Always position the lift assist directly above the item to be lifted.
- Always operate the lift assist by the handles, never "side pull" or "side push" the load.
- Ensure load is properly seated before lifting.
- Pay attention to the load at all times while operating the lift assist.
- Do not lift unbalanced loads.
- Ensure no Personnel or objects are in the path of the load or under the load.
- Avoid collisions or bumping into personnel or objects with the lift assist.
- Move slowly with the lift assist to avoid swinging or twisting.
- Perform as much work as possible at ground level before working at heights.

2.5.8. 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 assembly line or individual cell. Any machine vibration may cause tools to fall into moving automation and cause extensive damage.

- When repairing or adjusting any part of the assembly line or individual 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

WARNING!	***Before working on electrical or mechanical problems with a 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.***

Electrical safety precautions are outlined below:

- Assembly line and cell troubleshooting or maintenance should be performed only by qualified technicians familiar with the assembly line or cell, using an up-to-date set of 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.
- 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

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.***

Pneumatic safety precautions are outlined below:

- Assembly line and individual cell troubleshooting or maintenance should be performed only by qualified technicians familiar with the assembly line or cell, using an up-to-date set of 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.

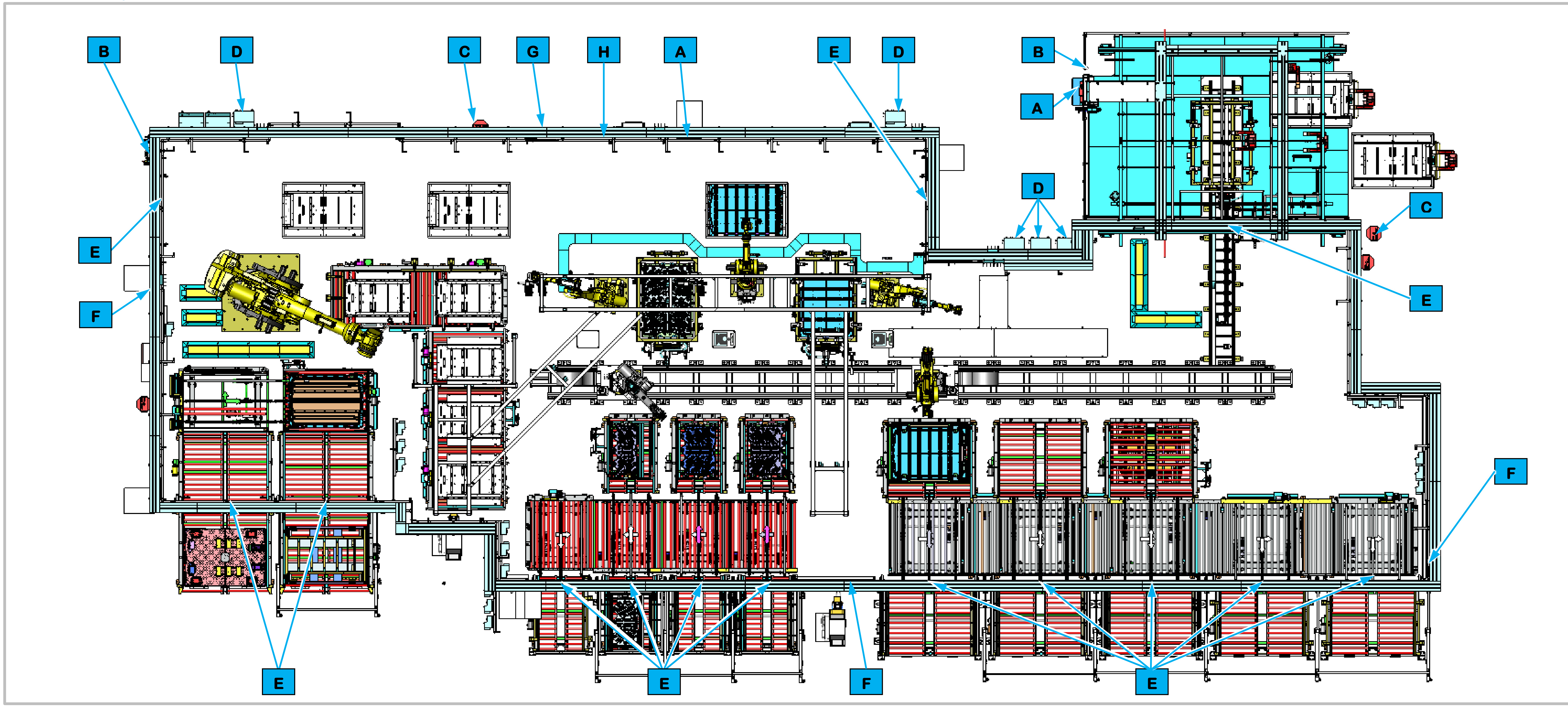
2.8.3. Mechanical Safety

Mechanical safety precautions are outlined below:

- Mechanical maintenance, adjustments or repairs should be performed only by qualified technicians familiar with the assembly line and individual cell.
- Before performing any maintenance or repairs, 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, excessive oil, and metal debris.
- Before operating any moving machinery, all protective guards must be in place and secured.
- When working with hot urethane sealant, care must be taken to avoid making contact as it can cause burns.

2.9. PACK MAIN LINE SAFETY DEVICE LOCATIONS

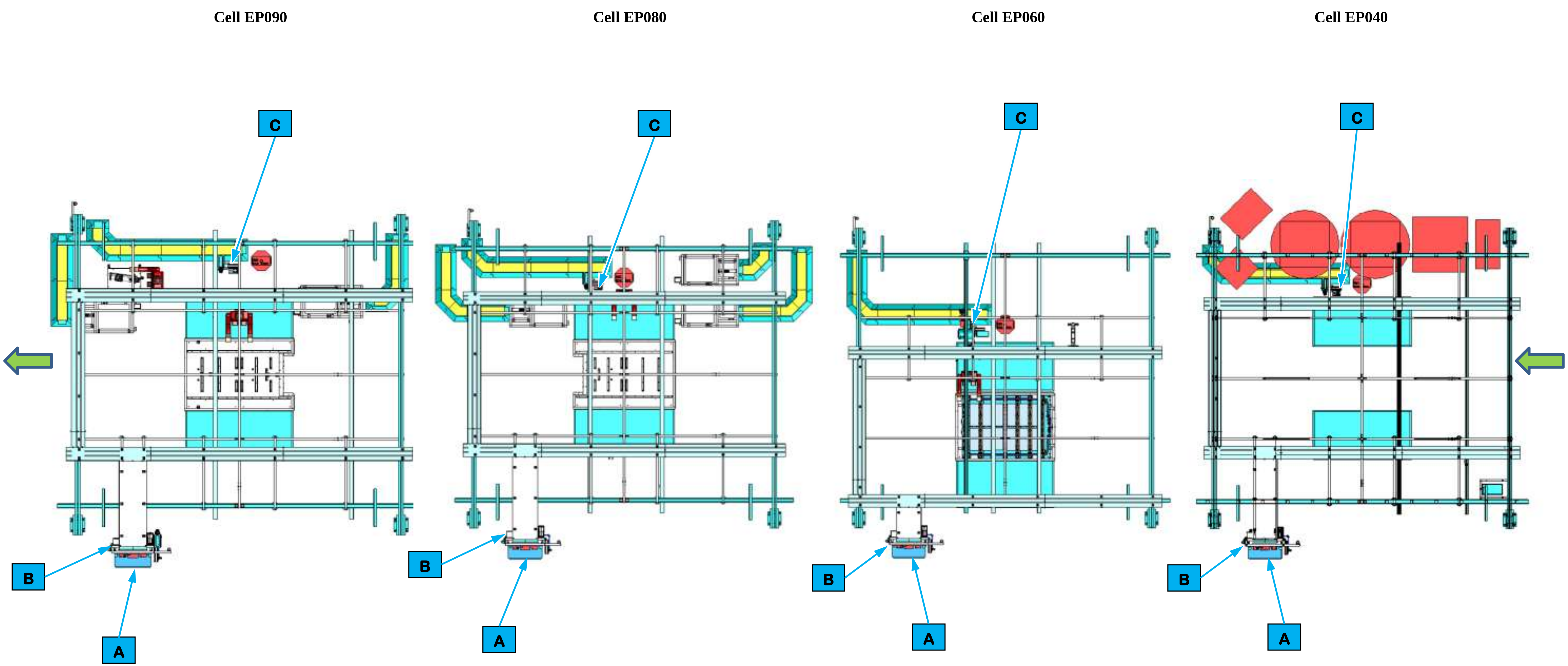
2.9.1. Safety Device Locations for Cells EP020 and EP720



Safety Device Callouts in Figure 2-1							
A	Cell Power Distribution Panel	C	E-Stop Button	E	Light Curtain	G	Entrance Gate Box
B	Cell Main Pneumatic Disconnect	D	Robot Electrical Disconnect	F	Conveyor Electrical Disconnect	H	Station Guarding

Figure 2-1. Cells EP020 and EP720 Safety Device Locations.

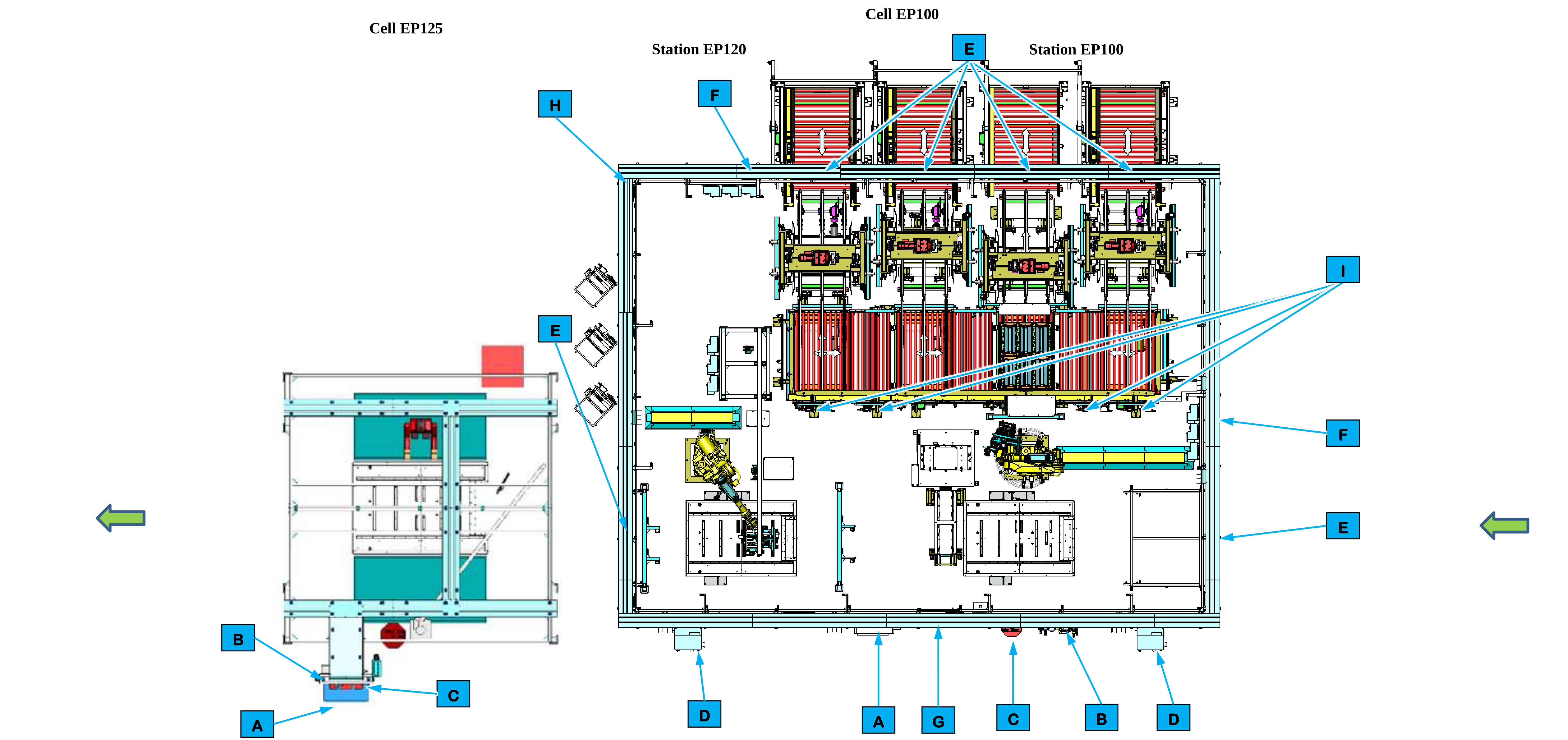
2.9.2. Safety Device Locations for Cells EP040, EP060, EP080, and EP090



Safety Device Callouts in Figure 2-2					
A	Cell Power Distribution Panel	B	Cell Pneumatic Disconnect	C	E-Stop Button

Figure 2-2. Cells EP040, EP060, EP080, and EP090 Safety Device Locations.

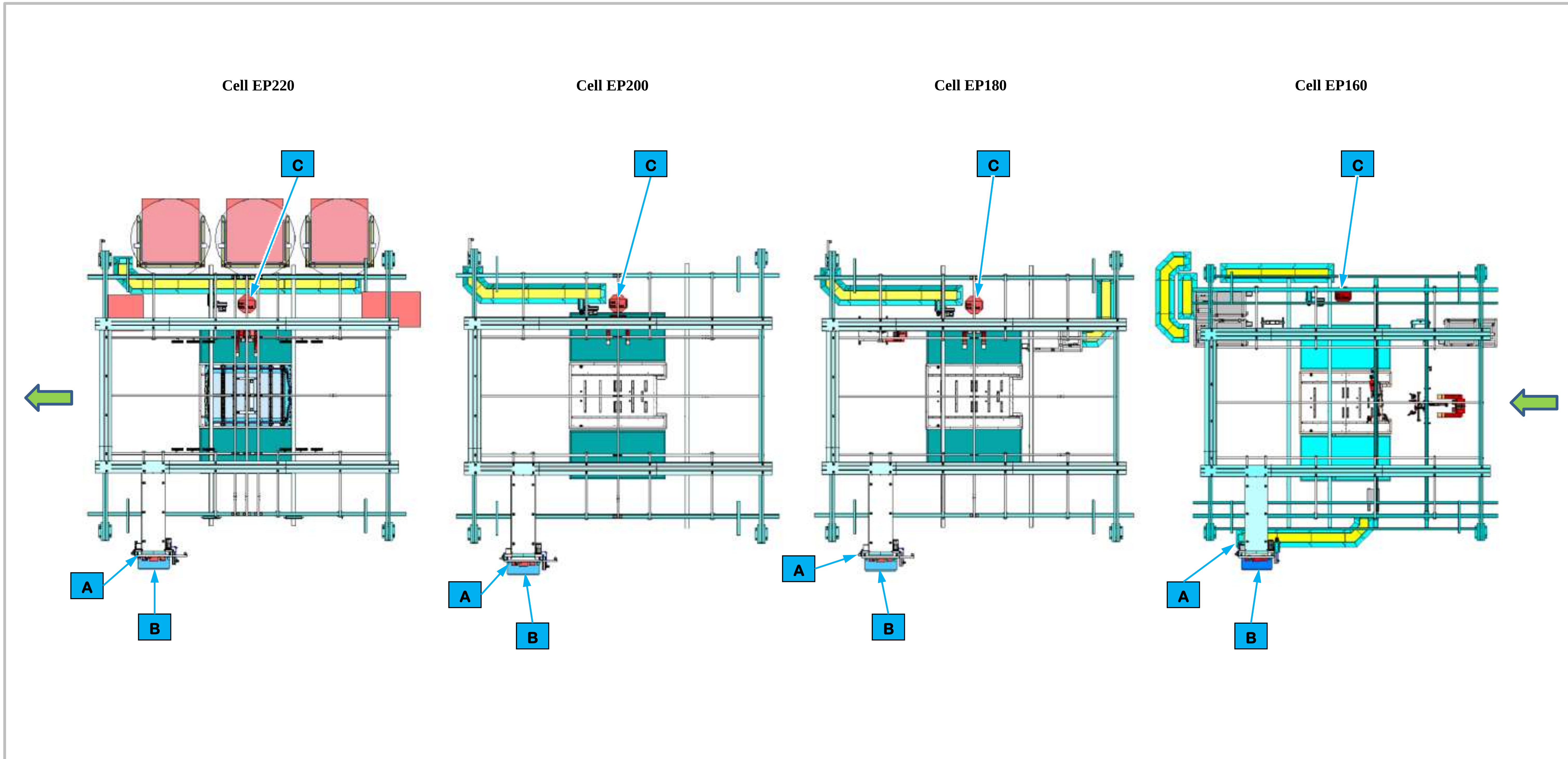
2.9.3. Safety Device Locations for Cells EP100, and EP125



Safety Device Callouts in Figure 2-3									
A	Cell Power Distribution Panel	C	E-Stop Button	E	Light Curtain	G	Entrance Gate Box	I	Air Preparation Unit
B	Cell Main Pneumatic Disconnect	D	Robot Electrical Disconnect	F	Conveyor Electrical Disconnect	H	Station Guarding		

Figure 2-3. Cells EP100, and EP125 Safety Device Locations.

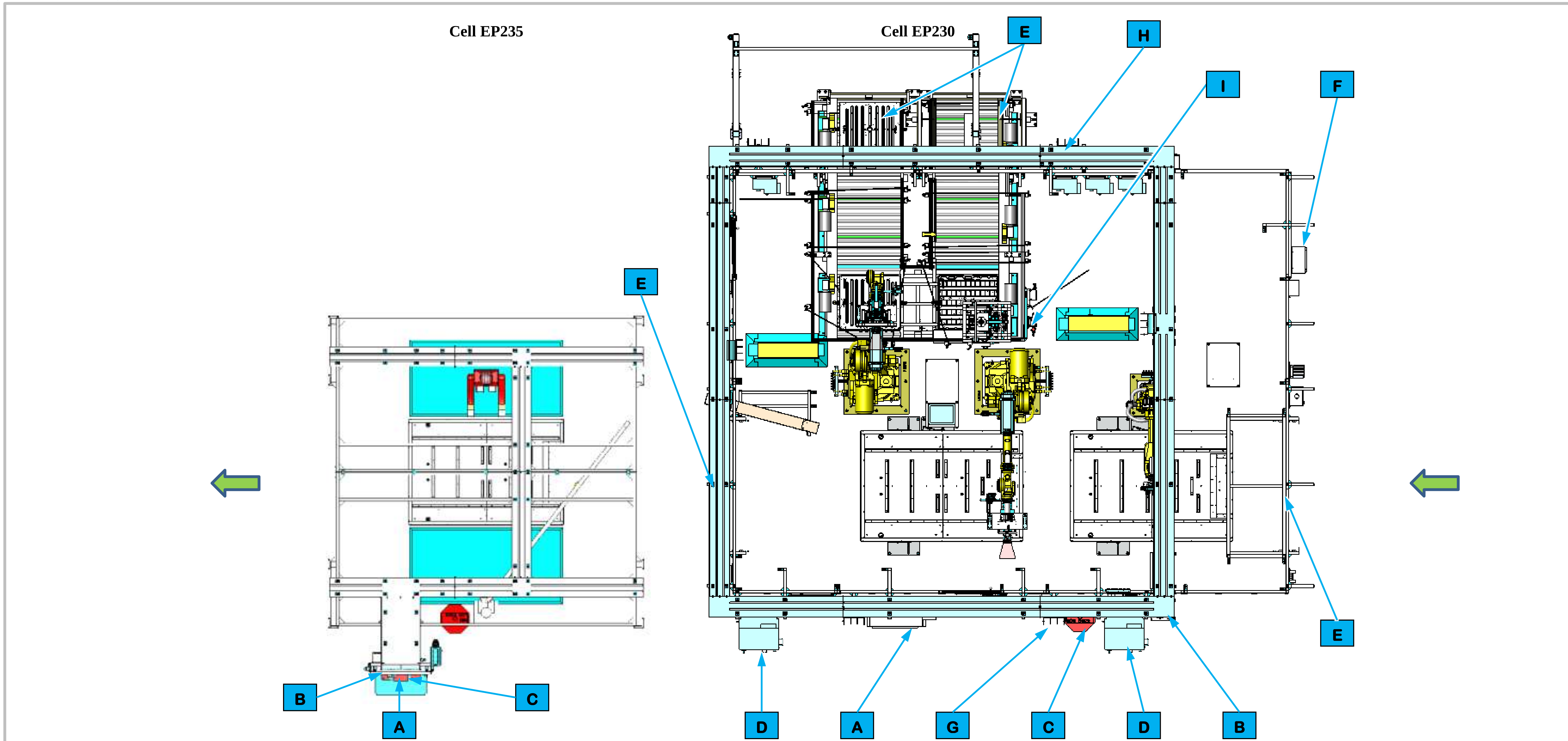
2.9.4. Safety Device Locations for Cells EP160, EP180, EP200, and EP220



Safety Device Callouts in Figure 2-4					
A	Cell Main Pneumatic Disconnect	B	Cell Power Distribution Panel	C	E-Stop Button

Figure 2-4. Cells EP160, EP180, EP200, and EP220 Safety Device Locations.

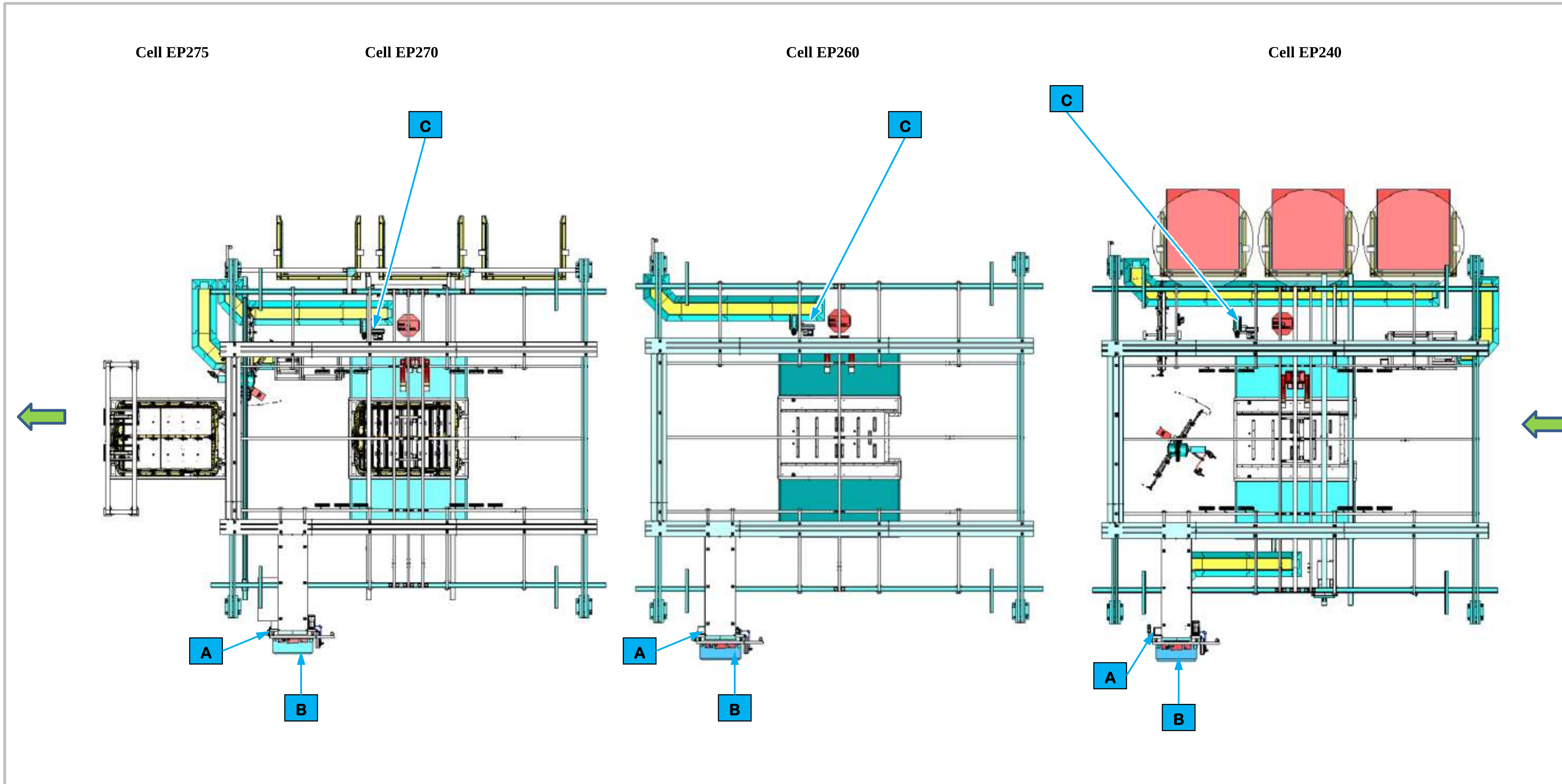
2.9.5. Safety Device Locations for Cells EP230 and EP235



Safety Device Callouts in Figure 2-5									
A	Cell Power Distribution Panel	C	E-Stop Button	E	Light Curtain	G	Entrance Gate Box	I	Air Preparation Unit
B	Cell Main Pneumatic Disconnect	D	Robot Electrical Disconnect	F	Conveyor Electrical Disconnect	H	Station Guarding		

Figure 2-5. Cells EP230 and EP235 Safety Device Locations.

2.9.6. Safety Device Locations for Cells EP240, EP260, and EP270

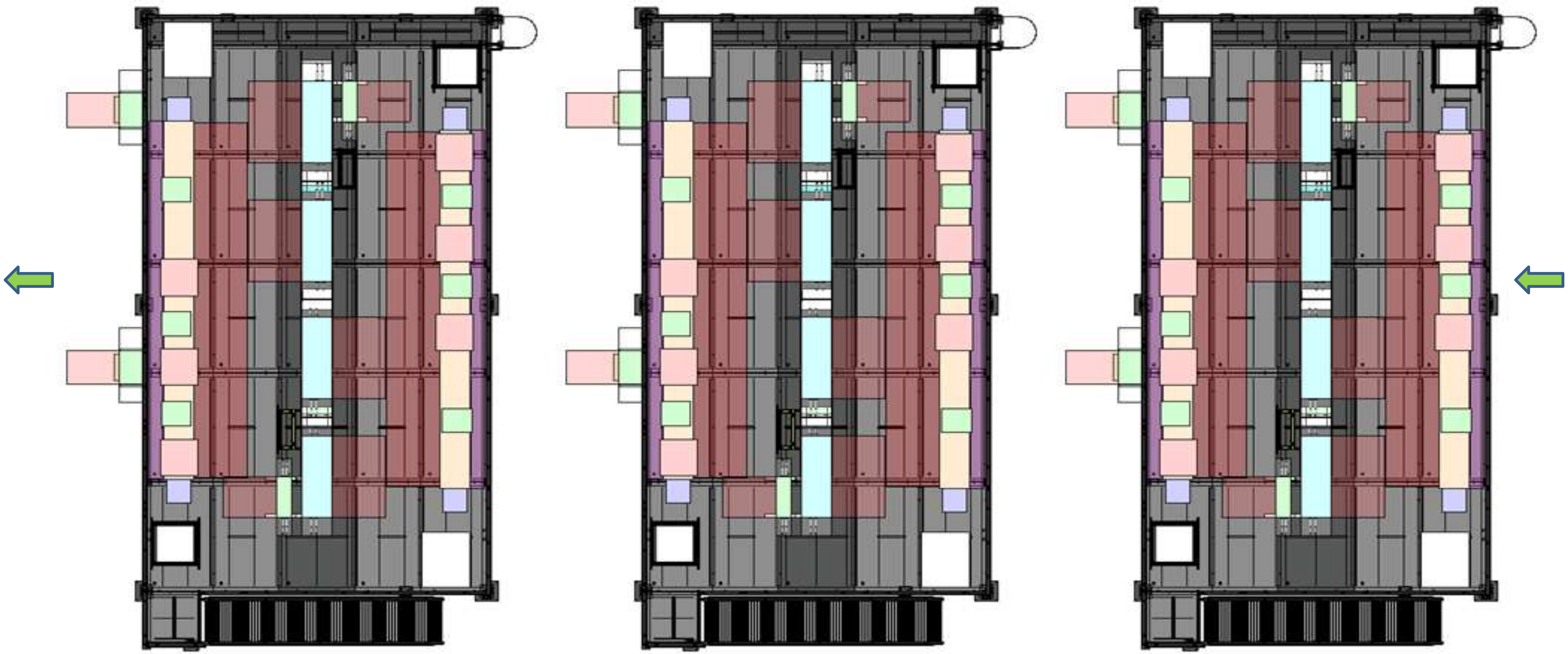


Safety Device Callouts in Figure 2-6					
A	Cell Main Pneumatic Disconnect	B	Cell Power Distribution Panel	C	E-Stop Button

Figure 2-6. Cells EP240, EP260, and EP270 Safety Device Locations.

2.9.7. Safety Device Locations for Cell EP280

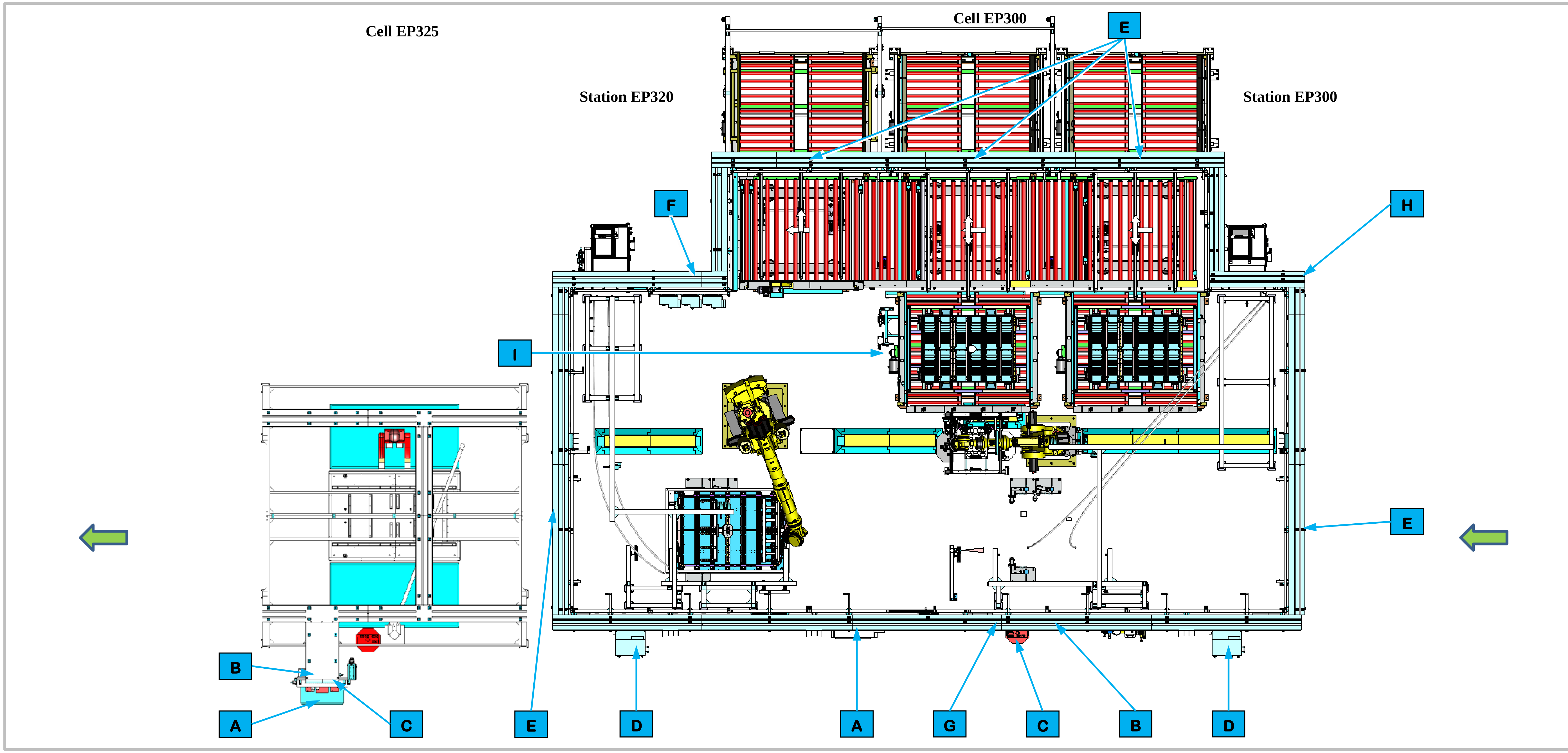
Cell EP280



For information regarding safety devices located in Cell EP280, refer to *Battery Pack Test and Cover Leak Test Operation and Maintenance Manual.*

Figure 2-7. Cell EP280 Safety Device Locations.

2.9.8. Safety Device Locations for Cells EP300, EP320, and EP325

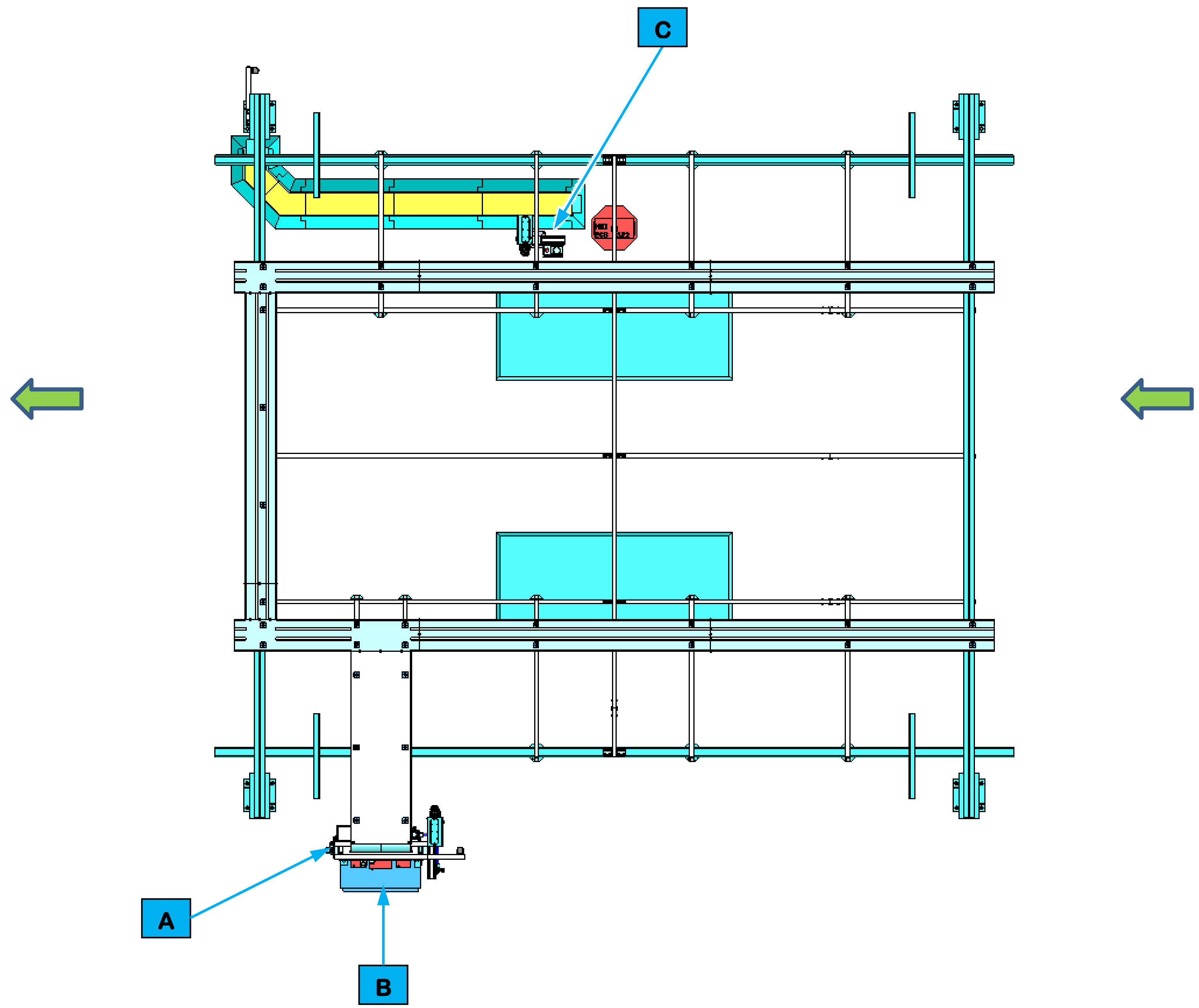


Safety Device Callouts in Figure 2-8									
A	Cell Power Distribution Panel	C	E-Stop Button	E	Light Curtain	G	Entrance Gate Box	I	Air Preparation Unit
B	Cell Main Pneumatic Disconnect	D	Robot Electrical Disconnect	F	Conveyor Electrical Disconnect	H	Station Guarding		

Figure 2-8. Cells EP300, EP320, and EP325 Safety Device Locations.

2.9.9. Safety Device Locations for Cell EP340

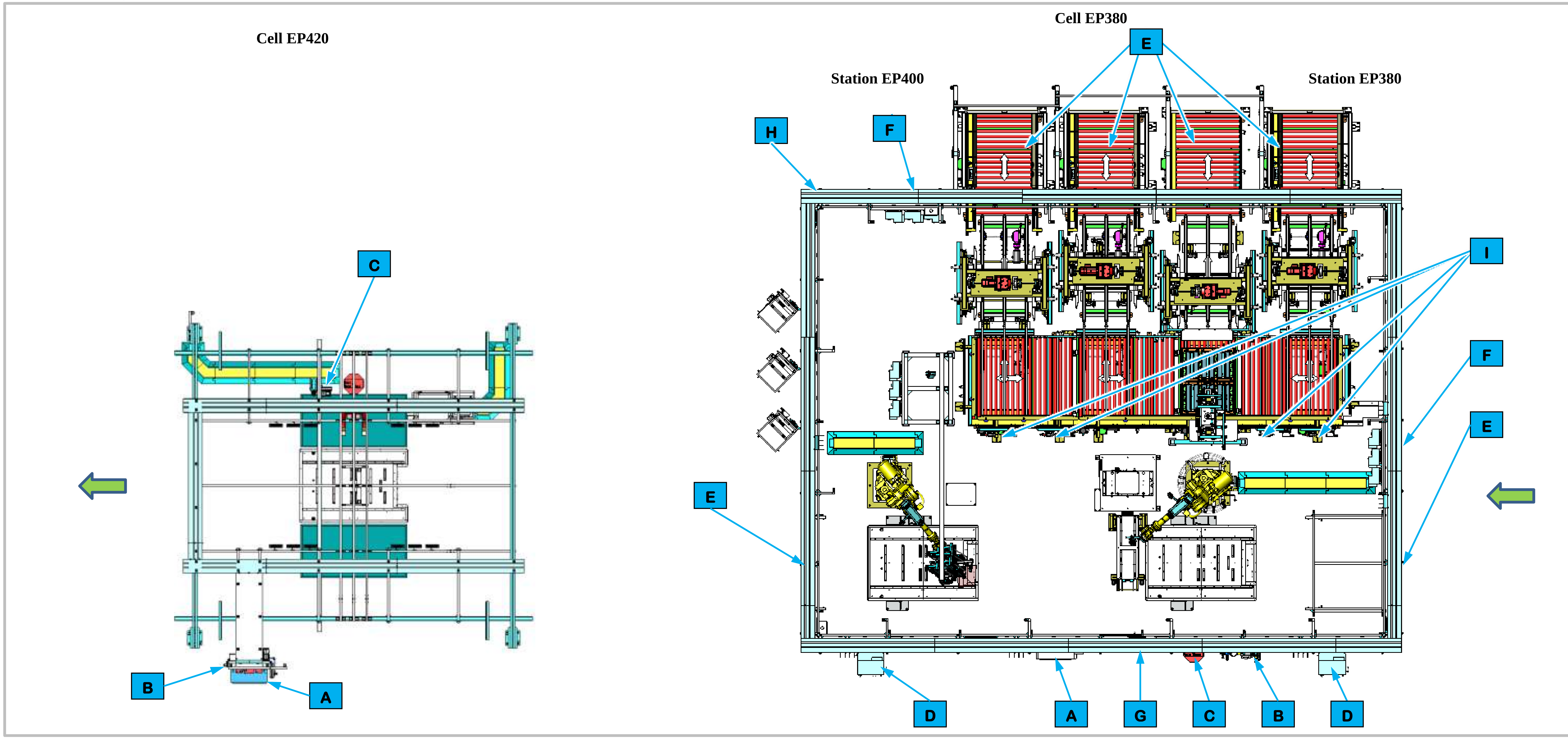
Cell EP340



Safety Device Callouts in Figure 2-9					
A	Cell Main Pneumatic Disconnect	B	Cell Power Distribution Panel	C	E-Stop Button

Figure 2-9. Cell EP340 Safety Device Locations.

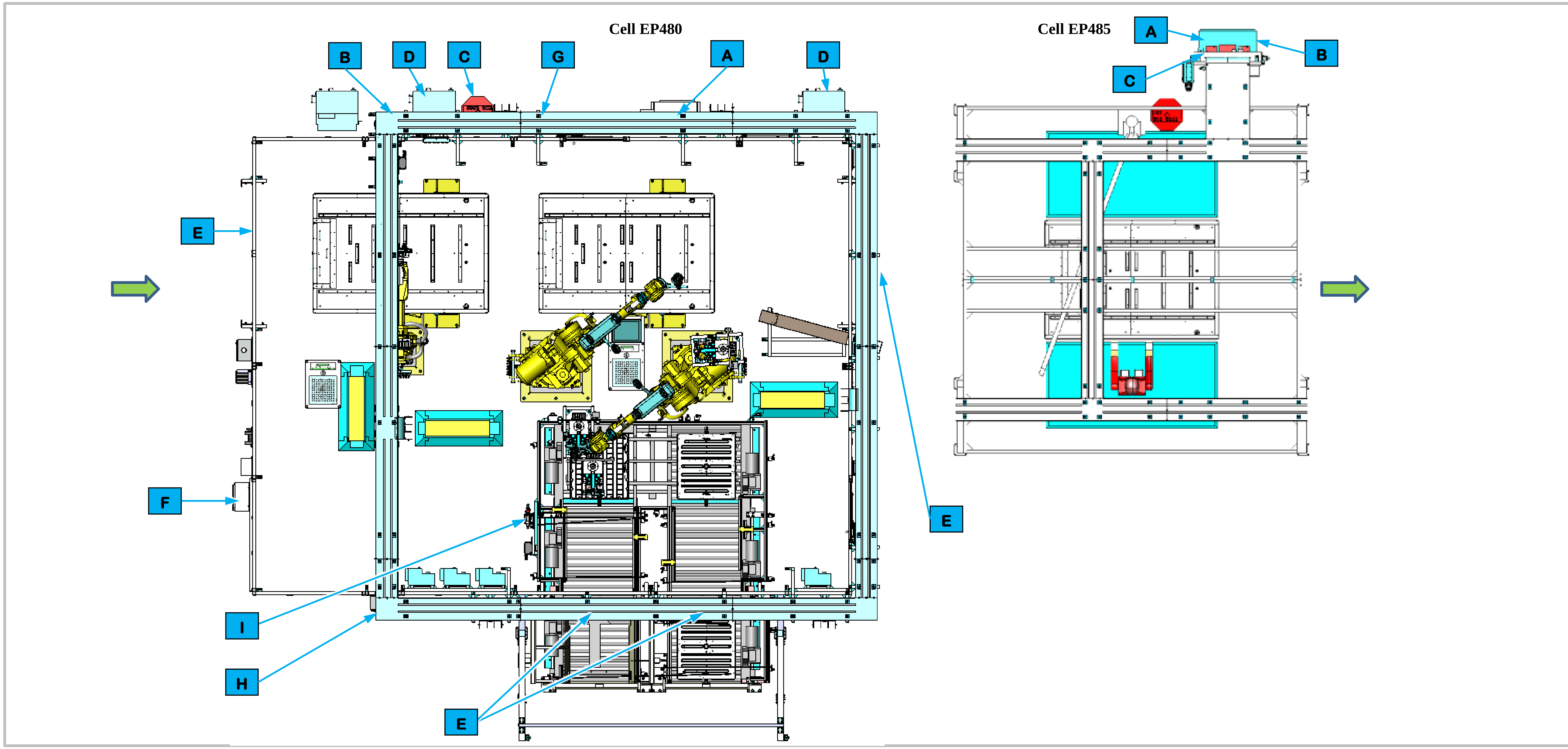
2.9.10. Safety Device Locations for Cells EP380, EP400, and EP420



Safety Device Callouts in Figure 2-10									
A	Cell Power Distribution Panel	C	E-Stop Button	E	Light Curtain	G	Entrance Gate Box	I	Air Preparation Unit
B	Cell Main Pneumatic Disconnect	D	Robot Electrical Disconnect	F	Conveyor Electrical Disconnect	H	Station Guarding		

Figure 2-10. Cells EP380, EP400, and EP420 Safety Device Locations.

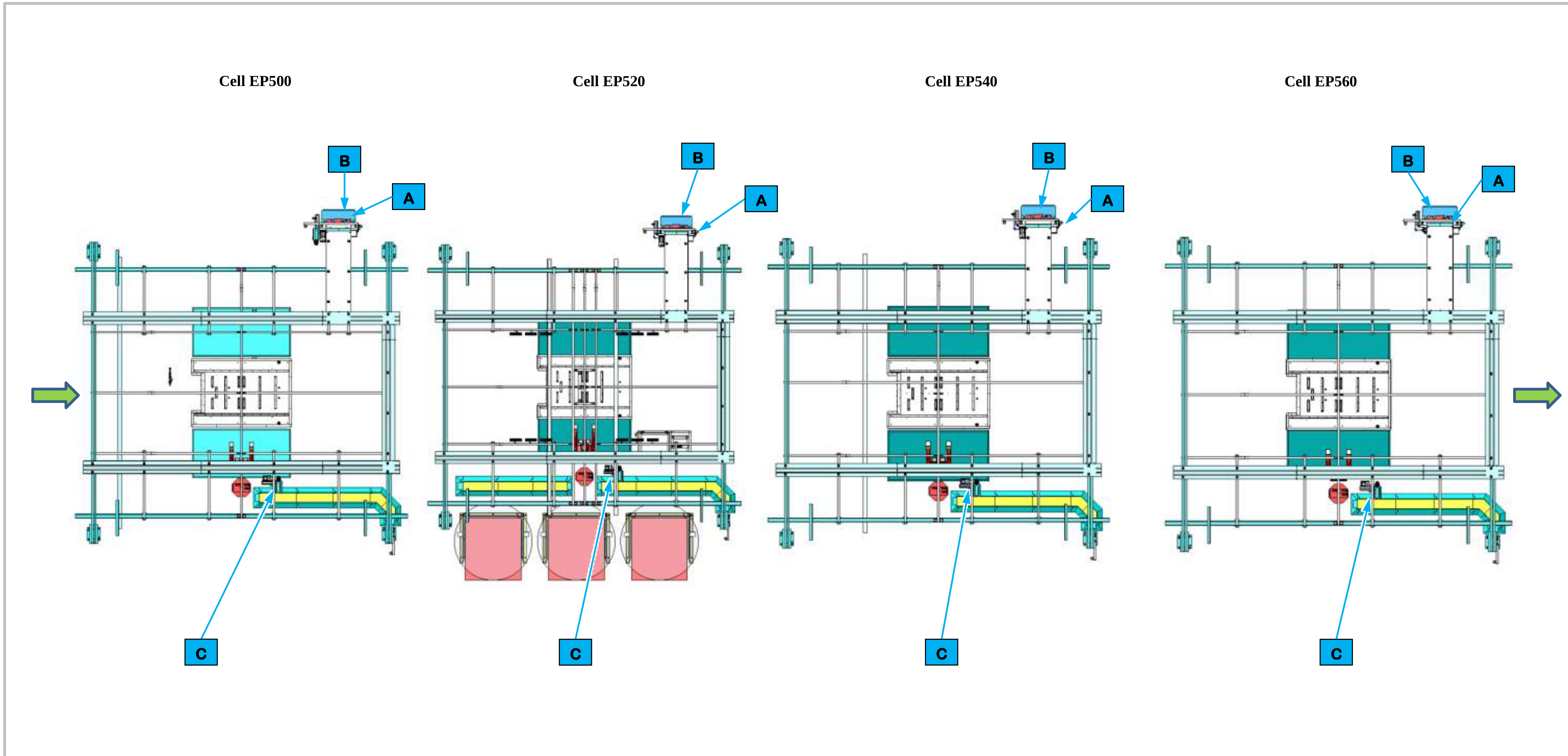
2.9.11. Safety Device Locations for Cells EP480 and EP485



Safety Device Callouts in Figure 2-11									
A	Cell Power Distribution Panel	C	E-Stop Button	E	Light Curtain	G	Entrance Gate Box	I	Air Preparation Unit
B	Cell Main Pneumatic Disconnect	D	Robot Electrical Disconnect	F	Conveyor Electrical Disconnect	H	Station Guarding		

Figure 2-11. Cells EP480 and EP485 Safety Device Locations.

2.9.12. Safety Device Locations for Cells EP500, EP520, EP540, and EP560

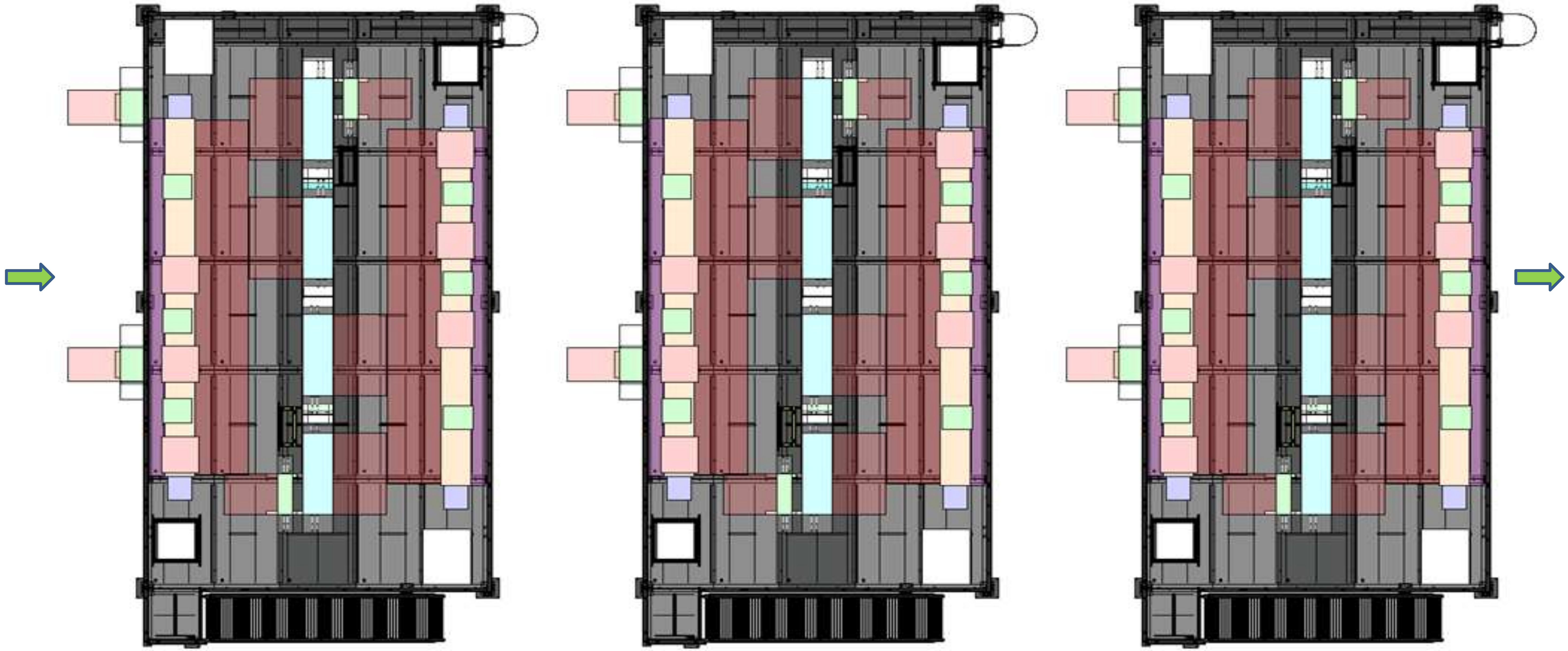


Safety Device Callouts in Figure 2-12					
A	Cell Main Pneumatic Disconnect	B	Cell Power Distribution Panel	C	E-Stop Button

Figure 2-12. Cells EP500, EP520, EP540, and EP560 Safety Device Locations.

2.9.13. Safety Device Locations for Cell EP580

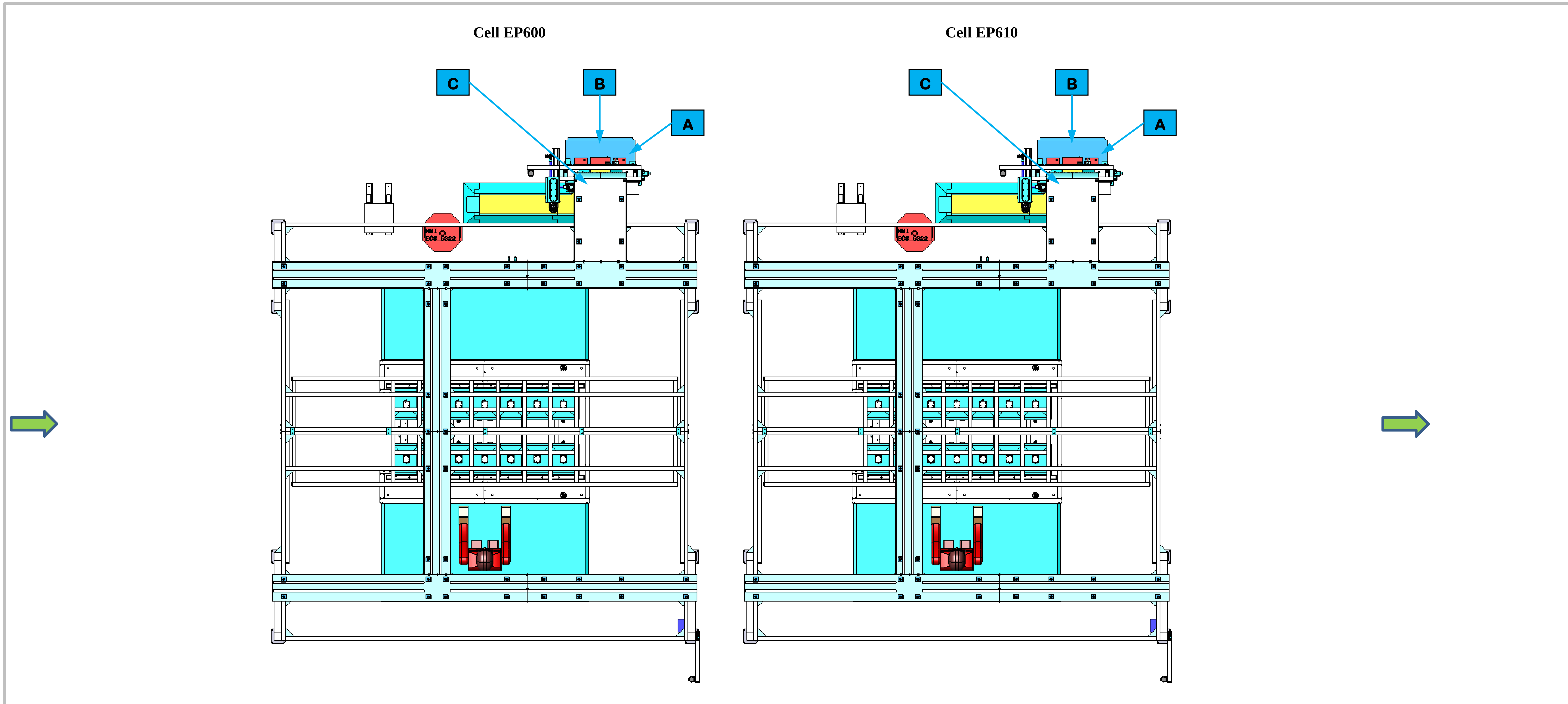
Cell EP580



For information regarding safety devices located in Cell EP580, refer to *Battery Pack Test and Cover Leak Test Operation and Maintenance Manual.*

Figure 2-13. Cell EP580 Safety Device Locations.

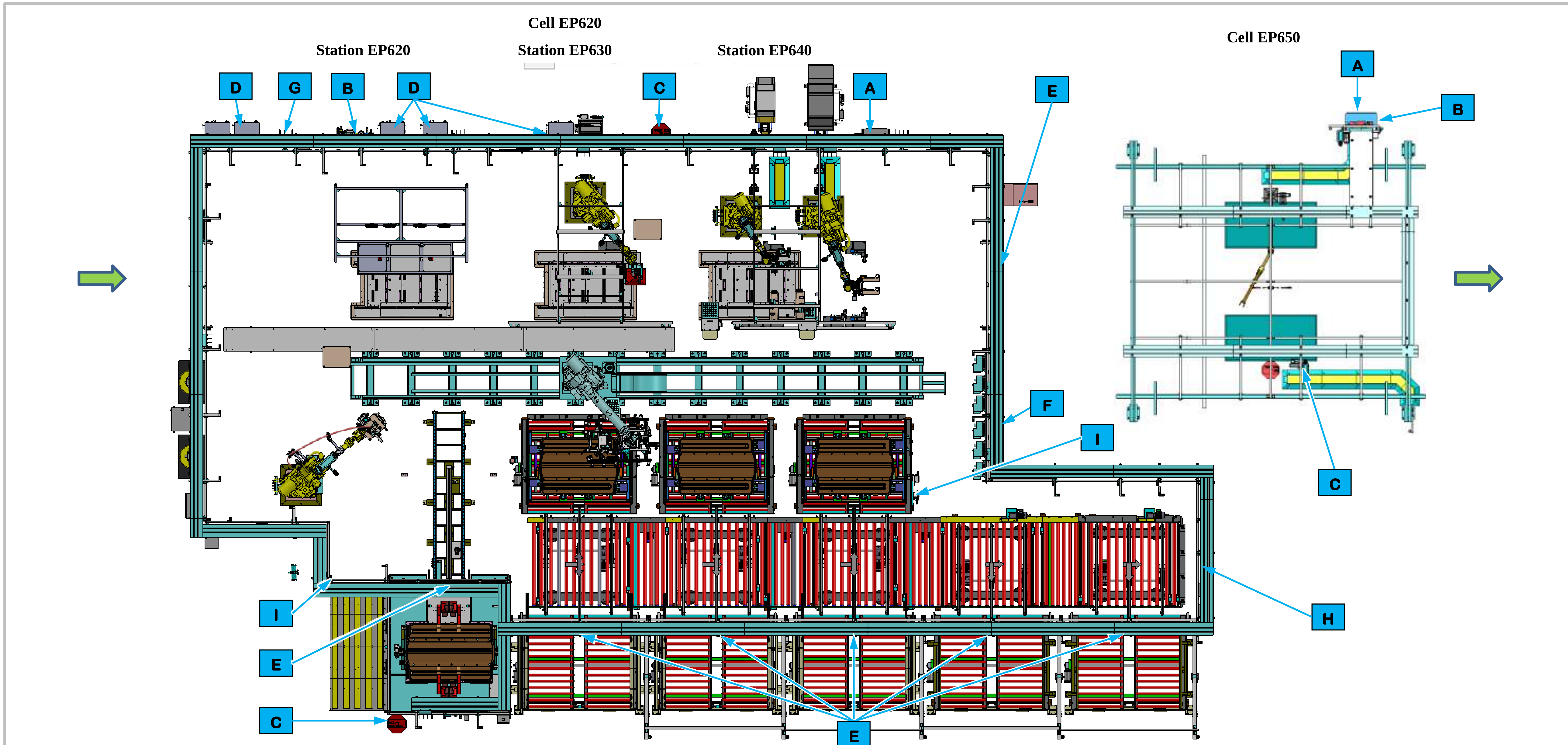
2.9.14. Safety Device Locations for Cells EP600, and EP610



Safety Device Callouts in Figure 2-14					
A	Cell Main Pneumatic Disconnect	B	Cell Power Distribution Panel	C	E-Stop Button

Figure 2-14. Cells EP600, and EP610 Safety Device Locations.

2.9.15. Safety Device Locations for Cells EP620, EP630, EP640, and EP650

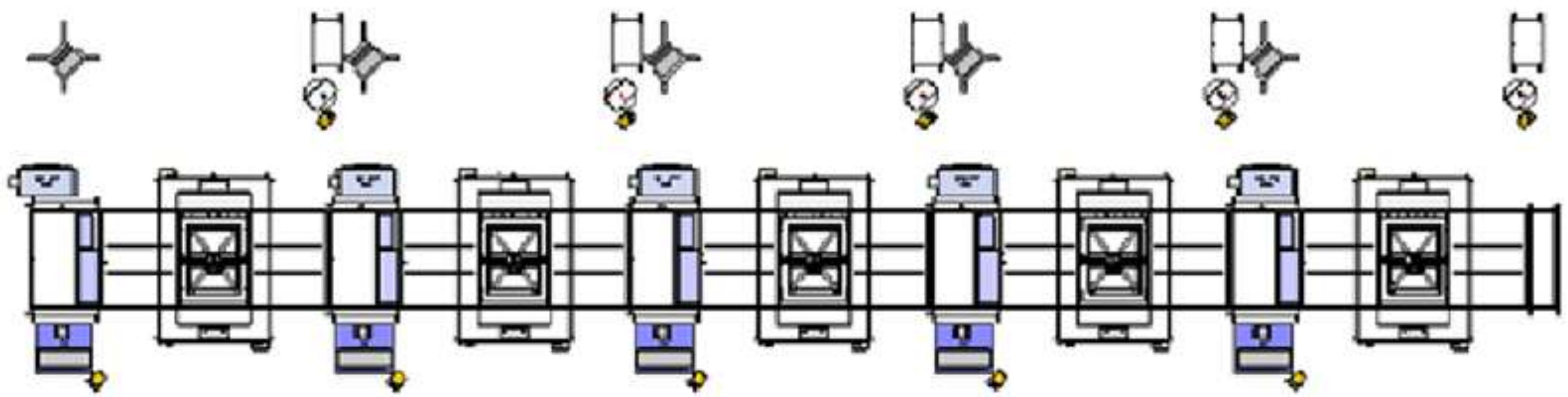


Safety Device Callouts in Figure 2-15									
A	Cell Power Distribution Panel	C	E-Stop Button	E	Light Curtain	G	Entrance Gate Box	I	Air Preparation Unit
B	Cell Main Pneumatic Disconnect	D	Robot Electrical Disconnect	F	Conveyor Electrical Disconnect	H	Station Guarding		

Figure 2-15. Cells EP620, EP630, EP640, and EP650 Safety Device Locations.

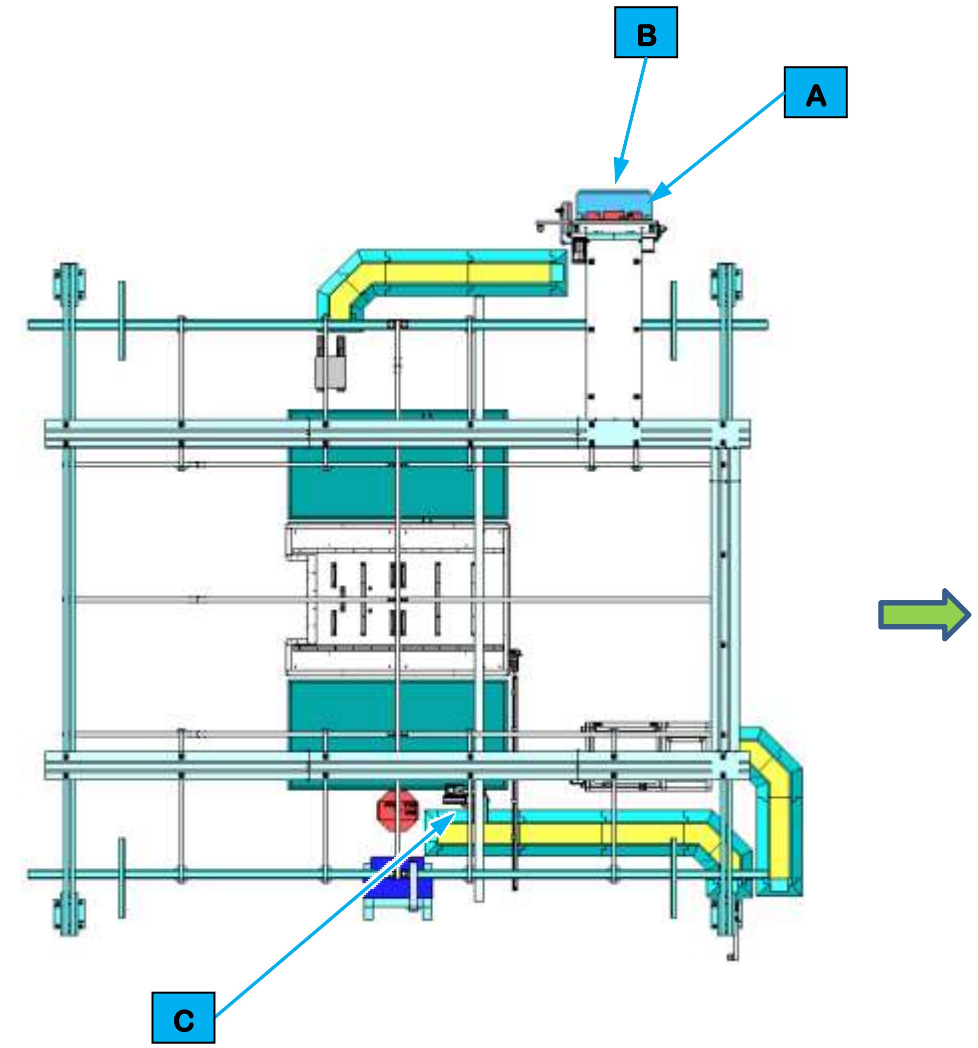
2.9.16. Safety Device Locations for Cells EP680 and EP700

Cell EP680



For information regarding safety devices located in Cell EP680, refer to *Battery Pack Test and Cover Leak Test Operation and Maintenance Manual.*

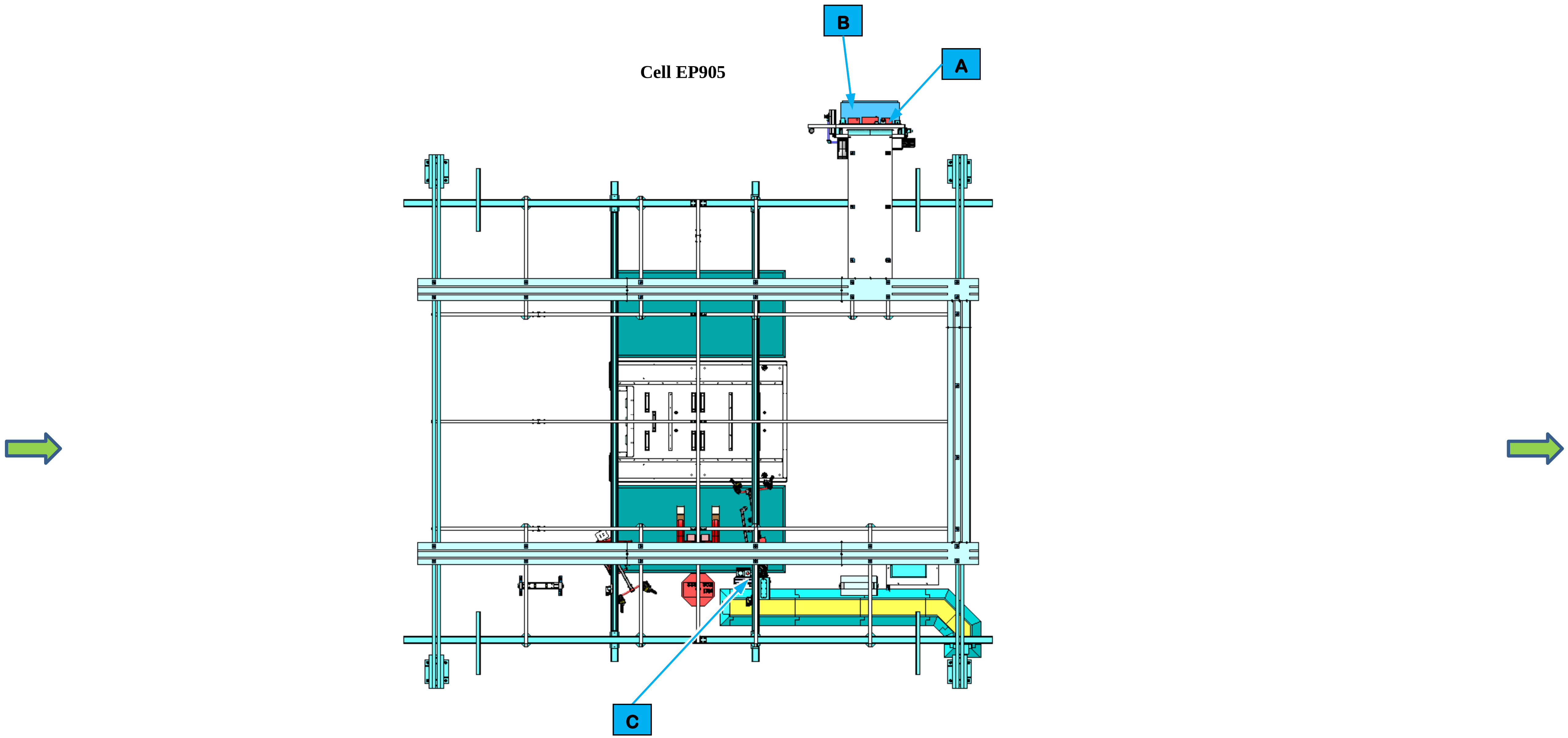
Cell EP700



Safety Device Callouts in Figure 2-16					
A	Cell Main Pneumatic Disconnect	B	Cell Power Distribution Panel	C	E-Stop Button

Figure 2-16. Cells EP680 and EP700 Safety Device Locations.

2.9.17. Safety Device Locations for Cell EP905



Safety Device Callouts in Figure 2-16					
A	Cell Main Pneumatic Disconnect	B	Cell Power Distribution Panel	C	E-Stop Button

Figure 2-17. Cell EP905 Safety Device Locations.

2.10. ENERGY CONTROL DEVICE DESCRIPTIONS

There are many different types of energy control devices used throughout the assembly line. 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 (refer to Section ***2.9. BET/BEV3 Battery Pack Assembly Line Safety Device Locations***), 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 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 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. Emergency Stop (E-Stop) Button

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.***

Each cell has one or more Emergency Stop (E-Stop) Button that when used will removed all power from a cell and bring all robots, tooling, conveyors to a full stop. Emergency stop buttons are located on Maintenance HMI panels in every cell and on the operator run stands of manual cells. 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.

2.10.4. Conveyor Electrical Disconnect

Each conveyor in each automated 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 conveyor equipment, refer to the equipment supplier documentation (Allen-Bradley ArmorStart Distributed Motor Controller User Manual).***

2.10.5. Robot Electrical / Pneumatic Disconnect

Each robot within in each automated cell has its own proprietary controller. Each controller features an electrical disconnect and a pneumatic disconnect (for robot end of arm tooling that utilizes pneumatic and/or vacuum equipment). Power is distributed from the cell Power Distribution Panel 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, 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 M-900 iB Operator's Manual, FANUC Robot M-2000 iA Operator's Manual, and FANUC Robot R-2000 iC Operator's Manual).***

2.10.6. Station Guarding

Each automated station is enclosed by guarding to form a protective housing that allows Operators to safety operate a station. The guarding consists of a metal framework with wire mesh cover, safety-interlocked guarding gates, and light curtains.

Station Guarding should only be removed by qualified Personnel for maintenance purposes and the station should never be normally operated without the guarding in place.

2.10.7. Light Curtain

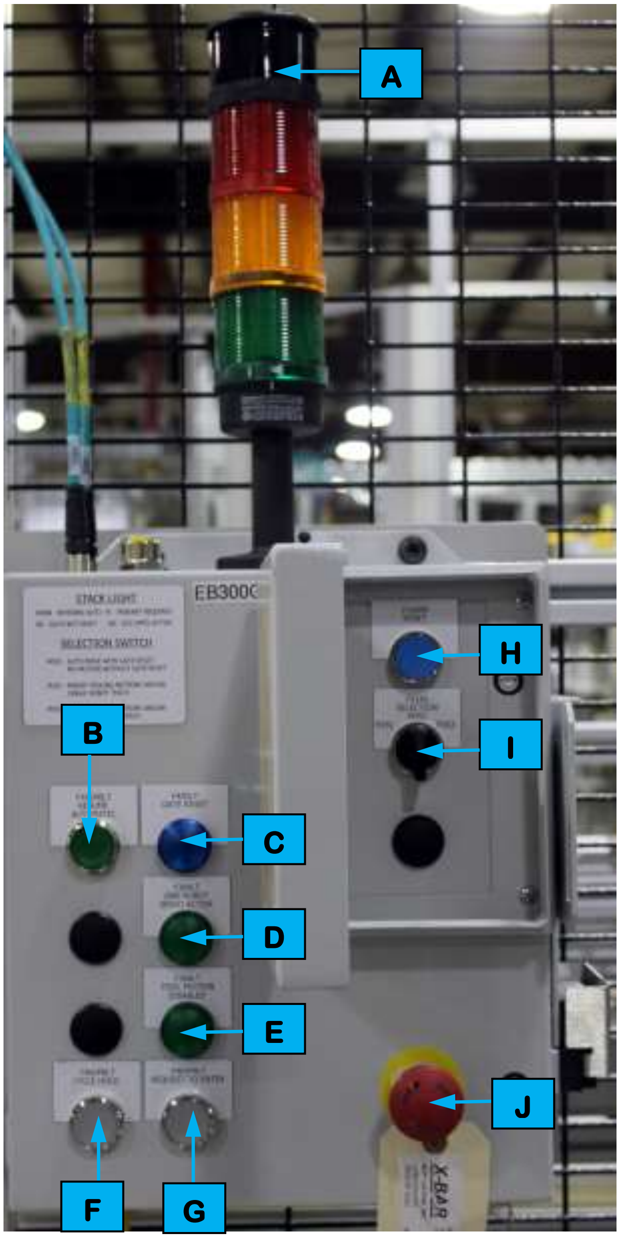
Part of every automated cells protective housing are light curtains located between guarded and unguarded areas (AGC entrances and exits and both input and output sides of conveyors). Light curtains are sensing devices are in series to aid in the detection and distinction of the object traversing the 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, an AGC, or a container is traversing the field. When a AGC or 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 AGC or 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 Light Curtain equipment, refer to the equipment supplier documentation (FGS 300 to FGS 1800 Safety Light Curtain Operating Instructions).***

2.10.8. Entrance Gate Box

Each automated cell has an entrance gate box (refer to ***Figure 2-18***) 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 2-18	
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 2-18. An illustration of an entrance gate box.

Stack Light Indicators

On top of the entrance gate box is a stack light (refer to **A** in ***Figure 2-18***) 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 (refer to **B** in ***Figure 2-18***) 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 (refer to **C** in ***Figure 2-18***) illuminates to indicate the gate is closed and reset.

One Robot Servo Active Indicator

The One Robot Servo Active indicator (refer to **D** in ***Figure 2-18***) 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 (refer to **E** in ***Figure 2-18***) 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 (refer to **F** in ***Figure 2-18***) 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 (refer to **G** in ***Figure 2-18***) 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 (refer to **H** in ***Figure 2-18***) 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 (refer to **I** in ***Figure 2-18***) 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 teaching.

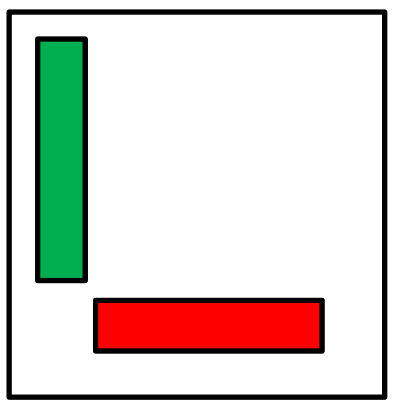
The selector switch does not affect non-motion output power, such as indicators, vacuum, and horns.

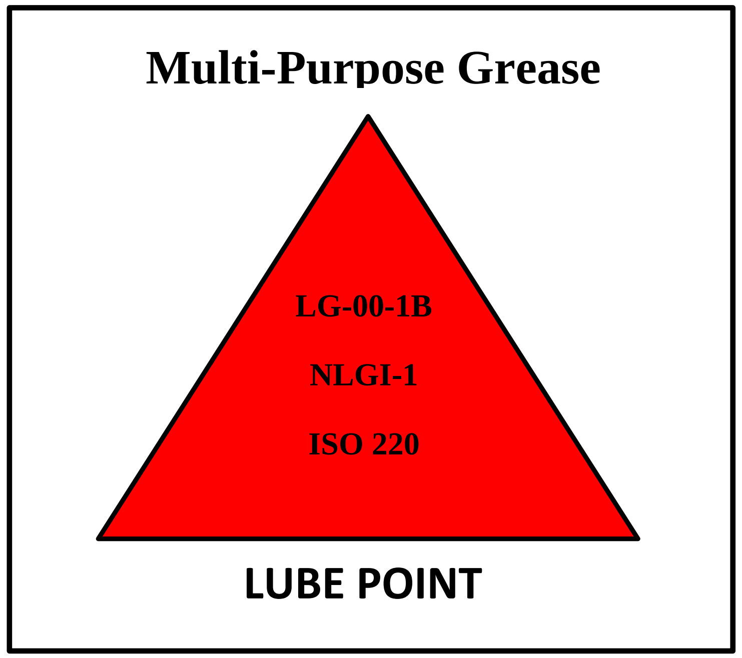
E-STOP Button

The EMERGENCY STOP button (refer to **J** in ***Figure 2-18***) 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.

2.11. VISUAL AIDS

There are visual aids added to pieces of equipment in addition to safety and maintenance labels already attached by third party manufactures. Refer to the following table regarding visual aids.

Visual Aid	Visual Aid Description	Locations Used
SET TO 65 PSI	Displays various pressures that equipment is normally set for	Can be found at all pressure regulators
NORMALLY OPEN	Displays a valves normal position (Open or Closed)	Can be found at all manually controlled air valves
	Displays an air valve handle 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 for air lines	Can be found on all air lines

Visual Aid	Visual Aid Description	Locations Used
	Displays a grease/lubrication point on a piece of equipment. Includes the type of lubricate suggested for the lube point.	Can be found at lubrication points of equipment.
	Displays a warning about possible pinch points for mechanical equipment	Can be found at possible pinch points of equipment

2.12. SDS REFERENCES

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

Device	Product	Manufacturer	File Name
Roller Conveyors	UH1-6-460	Klübersynth	Klubersynth_UH1.pdf
Rotate Table Gearbox	792D Lubricating Grease	NyoGel	NYOGEL_792D.pdf
THK Rails	AFB-LF Grease	THK Co.,LTD	THK_AFB-LF+70.pdf
Urethane Dispense System	BETASEAL Urethane Adhesive	DDP Specialty Electronic Materials US Inc.	DDP_BETASEAL.pdf
Lift Assist Balancers	Demag Chain Lube	Fuchs Europe Schmierstoffe GmbH Export Division	Fuchs_DeMag Chain Lube.pdf
Repair Shuttle Cylinder	Dynalub 510 Oil	Bosch	Bosch_Dynalub 510.pdf
FANUC Robots	Gadus S2 V100 2	Shell Oil Products US	Shell_Gadus S2 V100.pdf
Stacker Gearbox	GearOil Base 220	SEW-Eurodrive GmbH $ Co KG	SEW_GearOil Base 220.pdf
Anchors	HIT-HY 200A Anchors	Hilti (Canada) Corp.	Hilti_HIT-HY 200.pdf
Lift Assist Grease Points	AFA Grease	THK Co.,LTD	THK_AFA.pdf
FANUC Robots	RV Oil SB150	Kyodo Yushi Co., Ltd	Kyodo Yushi_RV OIL SB150.pdf
Roller Conveyors	SHC 636 Gear Oil	Mobil	MOBIL_SHC 636.pdf
Roller Conveyors	Unirex EP 2 Bearing Grease	Mobil	MOBIL_Unirex EP 2.pdf

3. SYSTEM DESCRIPTION

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3.1. BET/BEV3 PACK MAIN LINE SUMMARY

The BET/BEV3 Pack Main Line is part of a larger BET/BEV3 Battery Pack Assembly System. The Pack Main Line consists of manual and automated cells that each perform different operations in loading, testing, and securing battery modules to battery assemblies for cars (BEV3) and trucks (BET). Battery assemblies are processed throughout the system on automated guided carts (AGCs). One (1) BEV3 and eighteen (18) BET different model configurations are processed together throughout the system, with tool adaptations at each cell for the different models. For the assembly of BET models, all cells in the system play a part in the assembly. For assembly of BEV3 models, some cells are bypassed. At the end of the Pack Main Line, assembled units are unloaded to shipping crates, allowing empty AGCs to move on and restart the assembly process.

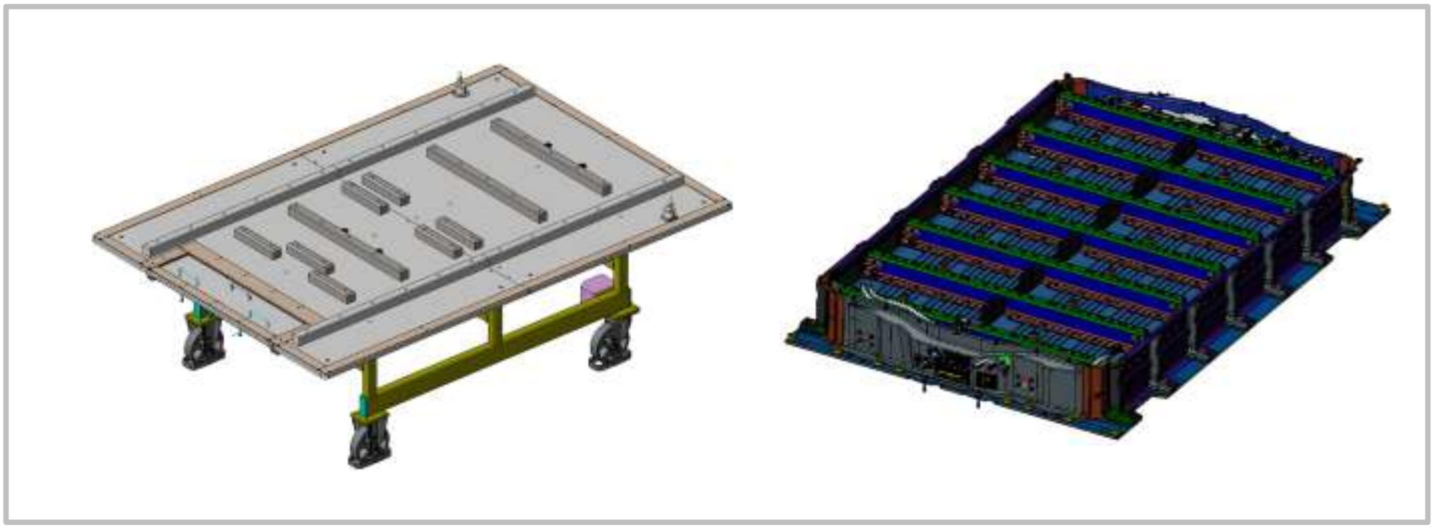


Figure 3-1. Automated Ground Cart and a 24 Module Long Wheelbase Battery Assembly Example

The following lists the 19 battery assembly types handled by the pack line:

Pack Type	Tray Type	Module Qty	Layers	Module Design
BET	Long Wheelbase Off-Road	24	2	Current 8S3P
BET	Long Wheelbase	24	2	Current 8S3P
BET	Long Wheelbase Off-Road	22	2	MCP1 “Thin” 8S3P
BET	Long Wheelbase	22	2	MCP1 “Thin” 8S3P
BET	Long Wheelbase Off-Road	20	2	Current 8S3P
BET	Long Wheelbase	20	2	Current 8S3P
BET	Short Wheelbase Off-Road	20	2	Current 8S3P
BET	Short Wheelbase	20	2	Current 8S3P
BET	Short Wheelbase Off-Road	20	2	MCP1 “Thick” 10S2P
BET	Short Wheelbase	20	2	MCP1 “Thick” 10S2P
BET	Long Wheel Base Off-Road	18	2	MCP1 “Thick” 10S2P
BET	Long Wheelbase	18	2	MCP1 “Thick” 10S2P
BET	Short Wheelbase	18	2	MCP1 “Thick” 10S2P
BET	Short Wheelbase	16	2	MCP1 “Thin” 12S2P
BET	Long Wheelbase	14	2	MCP1 “Thin” 12S2P
BET	Short Wheelbase	14	2	MCP1 “Thin” 12S2P
BET	Long Wheelbase	10	1	MCP1 “Thick” 10S2P
BET	Short Wheelbase	10	1	MCP1 “Thick” 10S2P
BEV3	BEV3	12	1	Current 8S3P

3.2. BET/BEV3 BATTERY PACK ASSEMBLY SYSTEM LAYOUT

The BET/BEV3 Battery Pack Assembly System includes a Pack Main Line, four (4) Module Final Assembly Lines, and eight (8) Stacker Lines. ***Figure 3-2*** illustrates a simplified version of the Battery Pack Assembly System. Refer to ***Figure 3-3*** for an isometric view of the Pack Main Line. For information about the Stacker Line, refer to the ATS *Stacker Line Operation and Maintenance Manual*. For information about the Module Final Assembly Line, refer to the ATS *Module Final Assembly Line Operation and Maintenance Manual*.

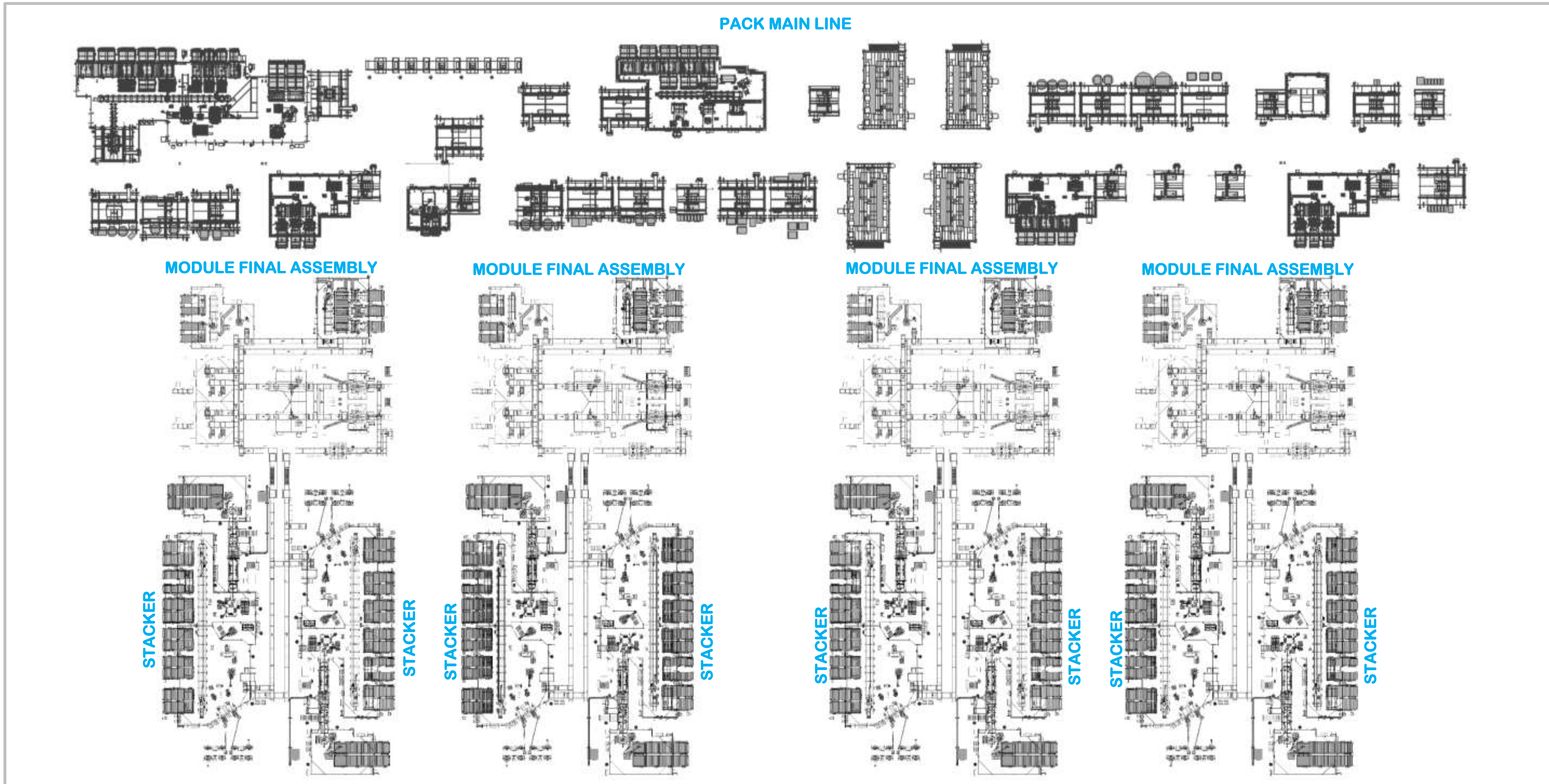


Figure 3-2. BET/BEV3 System layout

3.2.1. BET/BEV3 Battery Pack Assembly System

Figure 3-3 illustrates the BET/BEV3 Battery Pack Assembly System.

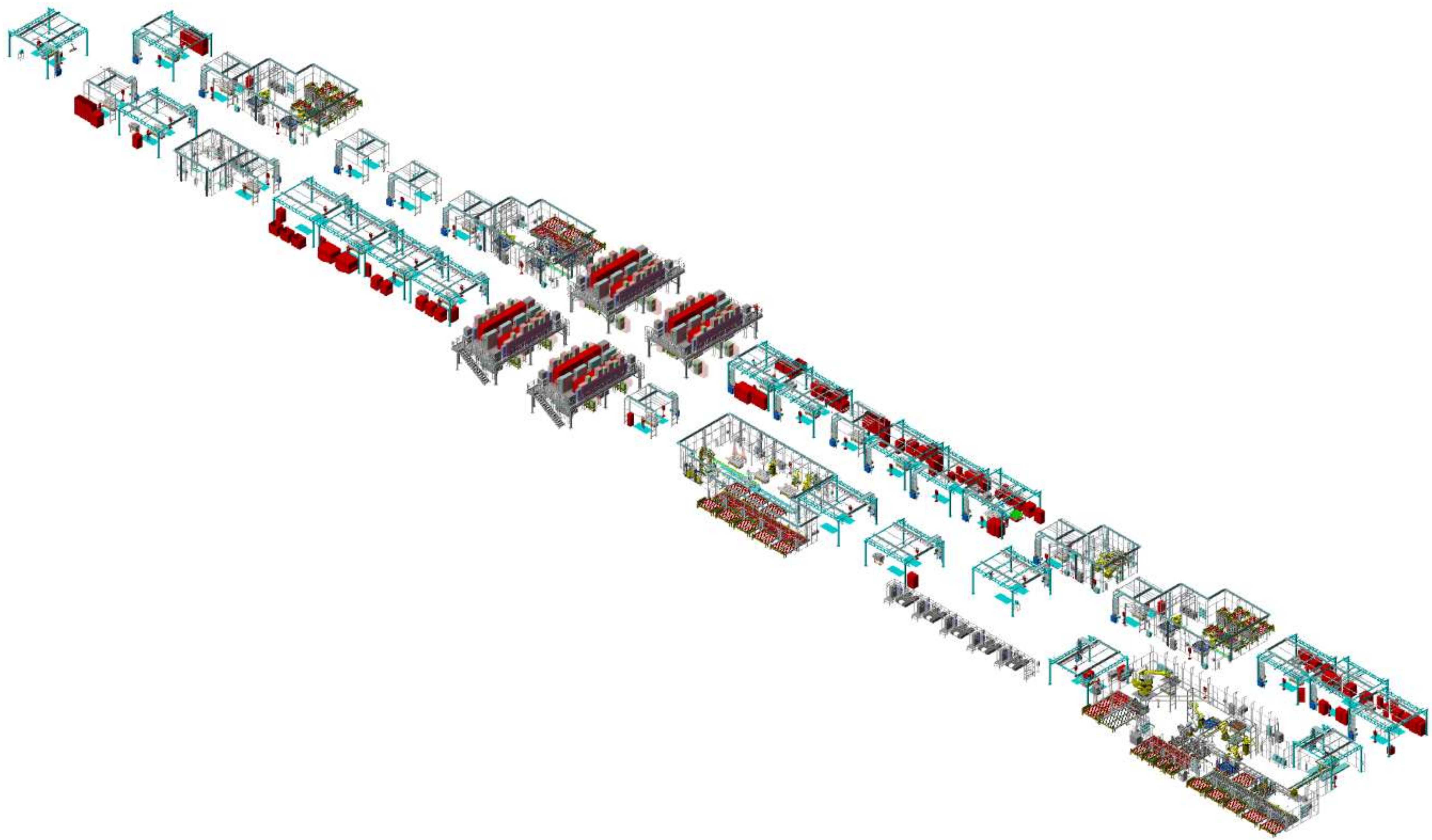


Figure 3-3. The BET/BEV3 Pack Main Line in Isometric View

3.3. BET/BEV3 PACK MAIN LINE LAYOUT

The Pack Main Line consists of seven (7) automated cells with adjoining repair stations, four (4) electrical testing cells, nineteen (19) manual cells and two (2) general repair cells. *Figure 3-4* illustrates the layout of cells.

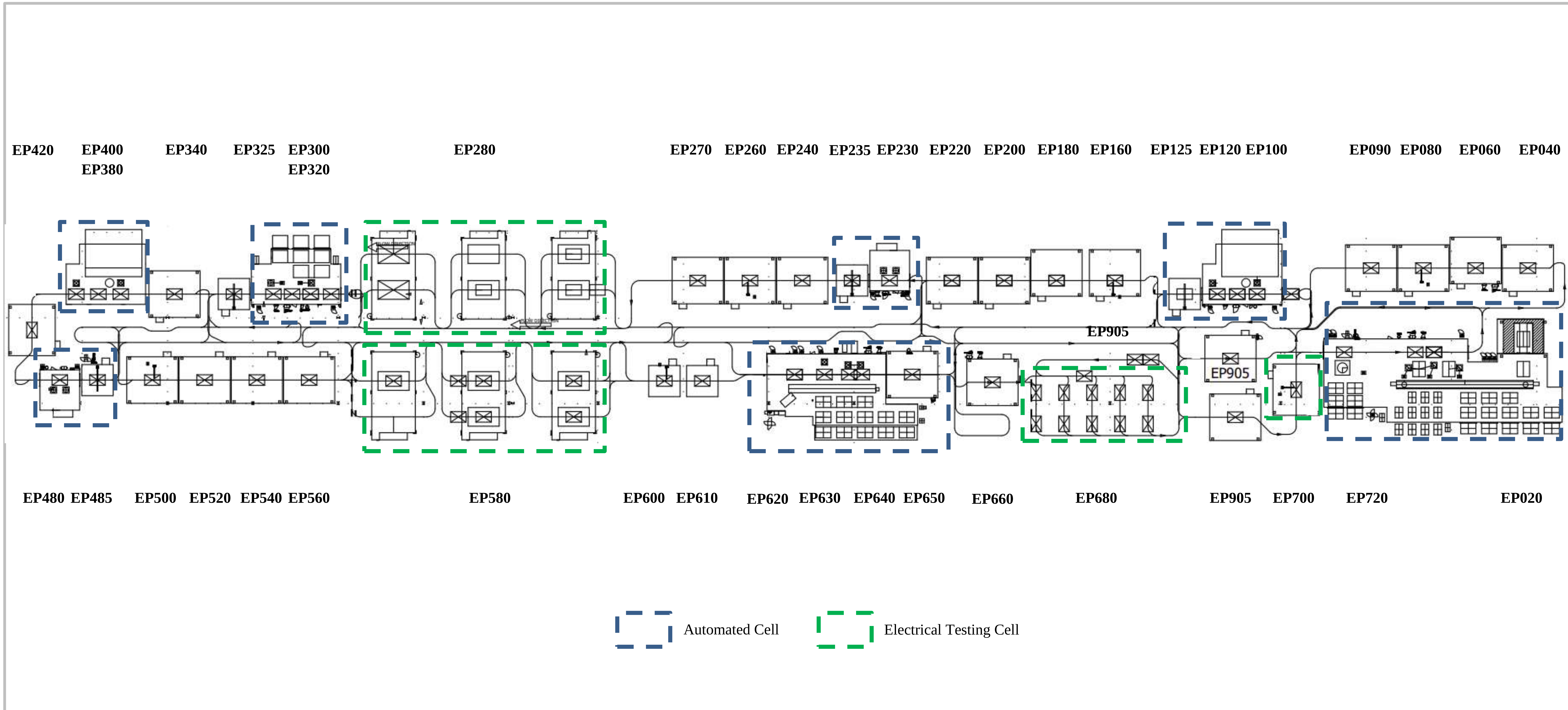


Figure 3-4. Pack Main Line Layout

3.4. BET/BEV3 PACK MAIN LINE UTILITIES

3.4.1. Pack Main Line Utilities – Automated Stations

		020	100	120	230	300	320	380	400	480	620	630	640	720
Compressed Air Supply	Air Pressure (PSI)	60	60	60	60	60	60	60	60	60	60	60	60	60
	Max CFM	105	105	105	105	105	105	105	105	105	105	105	105	105
	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"	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	See cell 100	100	100	See cell 300	100	See cell 380	100	200	See Cell 620	See Cell 620	See Cell 620

3.4.2. Pack Main Line Utilities – Manual Stations

		040	060	080	090	125	160	180	200	220	235	240	260	270	280	325	340	420	485	500	520	540	560	580	600	610	650	660	680	700	905
Compressed Air Supply	Air Pressure (PSI)	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	Max CFM	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105	105
	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"	1.5"	1.5"	1.5"	1.5"	1.5"	1.5"	1.5"	1.5"	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	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	480
	Equipment Phase	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	2	2	3	3	2	3
	Main Disconnect Amps	100	See Cell 040			See Cell 100	See Cell 520				See Cell 230	See Cell 520				See Cell 320	See Cell 660		See Cell 480	See Cell 660	100	See Cell 660			N/A	See Cell 520	See Cell 620	100	100	See Cell 040	60

3.5. BET/BEV3 PACK LINE EQUIPMENT

Tables *3.5.1* and *3.5.2* are equipment matrixes for the BET/BEV3 Pack Line. Section *3.5.3* contains descriptions of common equipment found throughout both manual and automated stations of the Pack Line.

3.5.1. Equipment Matrix – Automated Stations

Item	EP020	EP100	EP120	EP230	EP300	EP320	EP380	EP400	EP480	EP620	EP630	EP640	EP720
ArmorStart Controller Set	2	1		1	2		1		2	2			1
Air Preparation Unit	1	1		1	1		1		1	1			
Barcode Scanner	1			1	1		1						
Conveyor System	2	4		1	1		4		1	1			2
FANUC Robot M-2000IA/1700L													1
FANUC Robot M900IB-280L	1				1								
FANUC Robot M900IB-360	1												
FANUC Robot R-2000IC/210F	2	1	1	2		1	1	1	2	1	1	2	
FANUC Robot R-2000IC/210L	1									1			
FANUC Robot R-20IA/12L				1					1				
Fastener Feed System	2		1		1	2		1			1	2	
Operator Console HMI	2	1			1		1		1	2			
Robot and Vision Calibration Stand	3	1	1	2	1	1	1	1	2	1	1	1	1
Status Beacon	1	1		1	1		1		1	1			

3.5.2. Equipment Matrix – Manual Stations

Item	040	060	080	090	125	160	180	200	220	235	240	260	270	280	325	340	420	485	500	520	540	560	580	600	610	650	660	680	700	905
Air Preparation Unit	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Barcode Reader	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Manual Lift Assist							1					1																		2
Operator Push Button Box	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Operator Release/E-Stop	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Jib Crane					1					1					1			1												
Atlas Copco Nutrunner	4	3	2	4	1	3	3	3	2	1	2	3	3		1		3	1	2	1	1	1				2	1		2	
Nutrunner Controller	4	3	2	4	1	3	3	3	2	1	2	3	3		1		3	1	2	1	1	1				2	1		2	
Operator Console HMI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Tool Balancer	4	3	2	4	1	3	3	3	2	1	2	3	3		1		3	1	2	1	1	1				2	1		2	
Status Beacon	2	2	2	2	1	2	2	2	2	1	2	2	2	1	1	2	2	1	2	2	2	2	1	2	2	2	2	1	2	1

3.5.3. Common Equipment Descriptions

3.5.3.1. Air Preparation Unit

Air preparation unit are a combination of filter, lubricator, and regulator assembled into a single unit that ensures that air pressure service to a cell is in a condition that is appropriate for use by tooling in the cell.

3.5.3.2. ArmorStart Controller

The Allen-Bradley ArmorStart Controller is a motor controller that allows for disabling conveyor system motors for maintenance and service. The controller is mounted on station guarding with other ArmorStart Controllers.

3.5.3.3. Atlas COPCO Nutrunner

The Atlas COPCO Angle Nutrunner PF-6000 tool is a hand-held electrically powered torque tools used on manual stations. This tool provides a consistent and precise torque required for various industrial applications. The tool is pre-configured to a specific torque to suit the fastener, materials, and other applications. The correct torque output is adjusted by controlling the voltage. This wired tool is connected to a power source and are also typically wired with a network feedback cable.

3.5.3.4. Atlas COPCO Nutrunner Controller

The Atlas COPCO Nutrunner Controller PF-6000 control system is suitable for various Atlas Copco Nutrunner models and can handle all torque levels, requiring fewer back-up units.

Advanced control functions built into the Controller prevent the Operator deviating from the required process. When the Controller receives assembly information, the programmed Job function automatically selects the correct tightening sequence and parameters. When combined with barcode scanning for component identification, the Job function offers traceable, zero-fault process control.

The controller is equipped with a USB connector for laptop access and is located on the front of the unit for maximum accessibility and communication with the MES over Ethernet TCP/IP. The PF 4000 Graph has an easy-to-read LCD color display. Statistical data is collected, analyzed, and presented on the screen. Alpha-numeric keys allow on unit setup and easy checking of traces and statistics.

3.5.3.5. Automated Guided Cart (AGC)

The Automated Guided Cart (AGC) is a wheel-based automated load carrier that travels along a floor based magnetic path throughout the facility. The movements of the AGC are controlled by an onboard computer with precise and predictable acceleration, deceleration, and stopping locations.

3.5.3.6. Barcode Scanner

Each manual station is equipped with a handheld Honeywell Granit 1911i Industrial Scanner barcode reader. Automated stations are equipped with Fixed or End of Arm Tool barcode scanners. Barcode scanners are used to scan Battery Identification Numbers (BIN) part labels during operations and all scans are tracked by the HMI system.

3.5.3.7. Conveyor System

system makes use of conveyors systems made up of motorized rollers and chains to move dunnage frames and trays carrying product into and out of automated stations.

Sensing devices are located on both the input and output sides of the conveyors at the point of passage between the guarded and unguarded areas of the 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 personnel 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.

3.5.3.8. Fastener Feed System

The Fastener Feeder System will automatically count and dispense the necessary number of fasteners for the battery assembly type being worked on by the Operator in the cell.

3.5.3.9. FANUC Robots

The following FANUC Robots are used in the Main Pack Line:

The FANUC M-2000IA/1700L, a 6-axis robot with a load capacity of 3747 lbs. and a reach of 15.4 feet.

The FANUC M900IB-280L, a 6-axis robot with a load capacity of 617 lbs. and a reach of 10.1 feet.

The FANUC R-2000IC/210L, a 6-axis robot with a load capacity of 462 lbs. and a reach of 10.2 feet.

The FANUC R-2000IC/210F, a 6-axis robot with a load capacity of 642 lbs. and a reach of 8.7 feet.

The FANUC M900IB-360 is a 6-axis robot with a load capacity of 793 lbs. and a reach of 8.7 feet.

The FANUC M-20IA/12L is a 6-axis robot with a load capacity of 26 lbs. and a reach of 6.6 feet.

3.5.3.10. Guarding

A protective barrier situated around automated cell components to prevent Operator access to the components during operation.

3.5.3.11. Jib Crane

Mounted in Manual Repair Stations are Gorbel Free Standing Jib Cranes used to facilitate the Operator in moving and adjusting the battery assemblies while performing repair operations.

3.5.3.12. Manual Lift Assist

Manual Lift Assist provides a power frame suspended from the Cell that is used to facilitate the Operator in picking and placing parts into the battery assemblies.

3.5.3.13. Operator Console Human Machine Interface (HMI)

The Human Machine Interface (HMI) is a free-standing device which permits the Operator to interact with the machine, robot, device, or system. Common uses are for displaying data, tracking production time, overseeing Key Performance Indicators (KPI), and monitoring machine inputs and outputs.

3.5.3.14. Operator E-Stop

Each cell has one or more Emergency Stop (E-Stop) Button that when used will removed all power from a cell and bring all robots, tooling, conveyors to a full stop. Emergency stop buttons are located on HMI panels in every cell and on the power cabinet of manual cells. 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.

3.5.3.15. Operator Push Button Box

Operators can use buttons of the Operator Push Button Box to call for maintenance personnel, team leads, and other functions.

3.5.3.16. Robot and Vision Calibration Stand

The Robot and Vision Calibration Stand provides a calibration grid that is used as a reference when calibrating the robot and robot vision equipment. Calibration of the robot and robot vision equipment is documented in the associated FANUC documentation.

3.5.3.17. Status Beacon

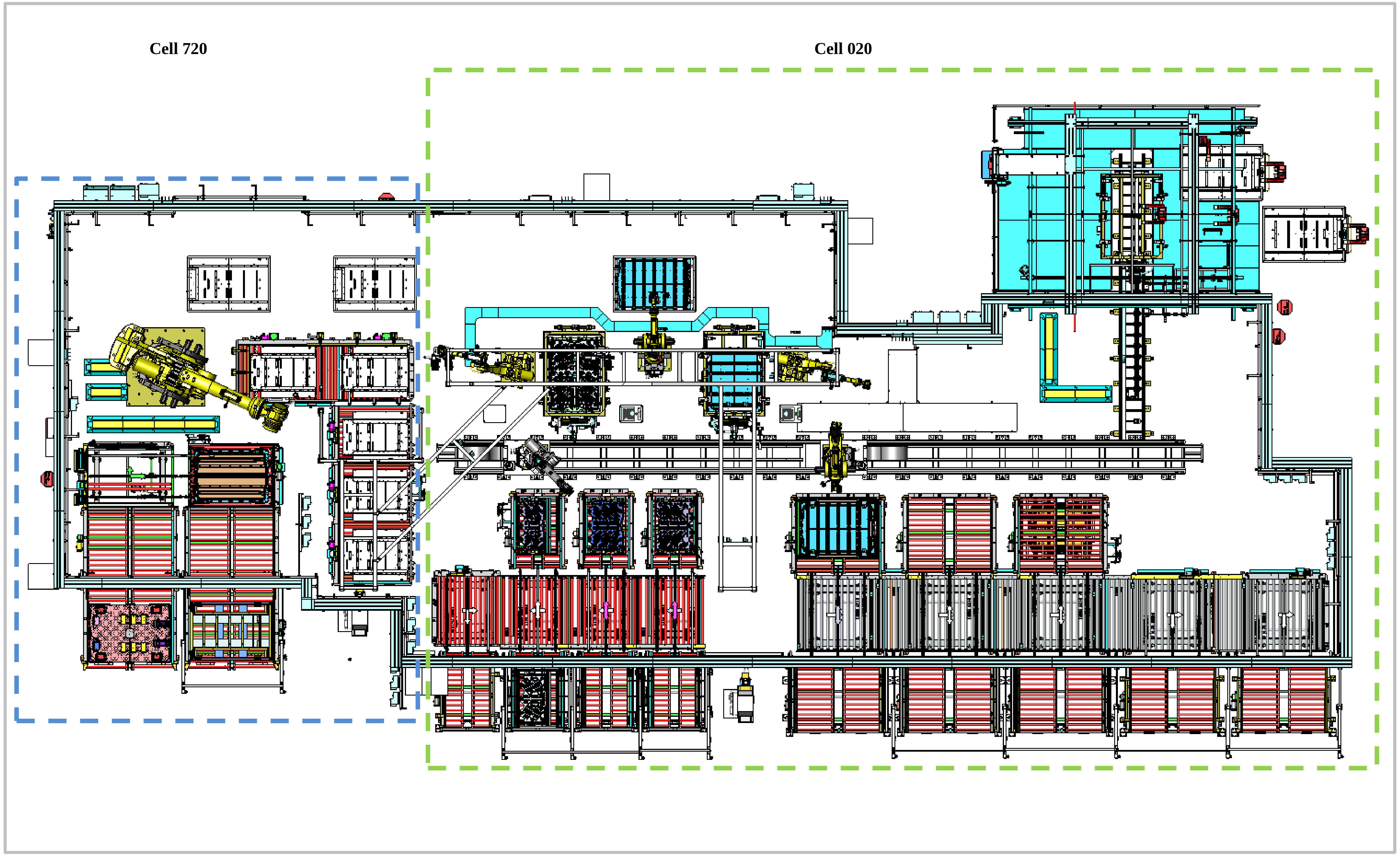
Automated stations of the BET/BEV3 Pack Line are equipped with status beacons, each mounted atop the safety enclosure for the associated station. The beacons alert Operators to the current system operational status. Operators should check status beacons regularly during system operation and respond as needed.

3.5.3.18. Tool Balancer

Tool Balancers are adjustable cable systems suspended from the cell frame that allow tools to hang within reach of the Operator.

3.6. BET/BEV3 PACK LINE – STATIONS DESCRIPTIONS

3.6.1. EP020/EP720 Battery Assembly Unload and Tray Station Load Description



3.6.1.1. Station Description

Cell EP020/EP720 is a fully automated station with an incorporated Repair Cell. In Station EP720 completed battery assemblies are first picked from the AGC and placed in a conveyor, if needed a BEV Spacer is then placed on the ACG before it moves to Station EP020. In Station EP020 battery assembly trays are picked based on the type of battery to be assembled and placed into a Fixture Rotate Table where they are inverted, and skid plates are pick and installed onto the trays. The trays are then inverted again and picked and placed onto the waiting AGC for both BET and BEV3 battery assemblies.

Figure 3-5. EP020/EP720 - Battery Assembly Unload and Tray Load Station Top View.

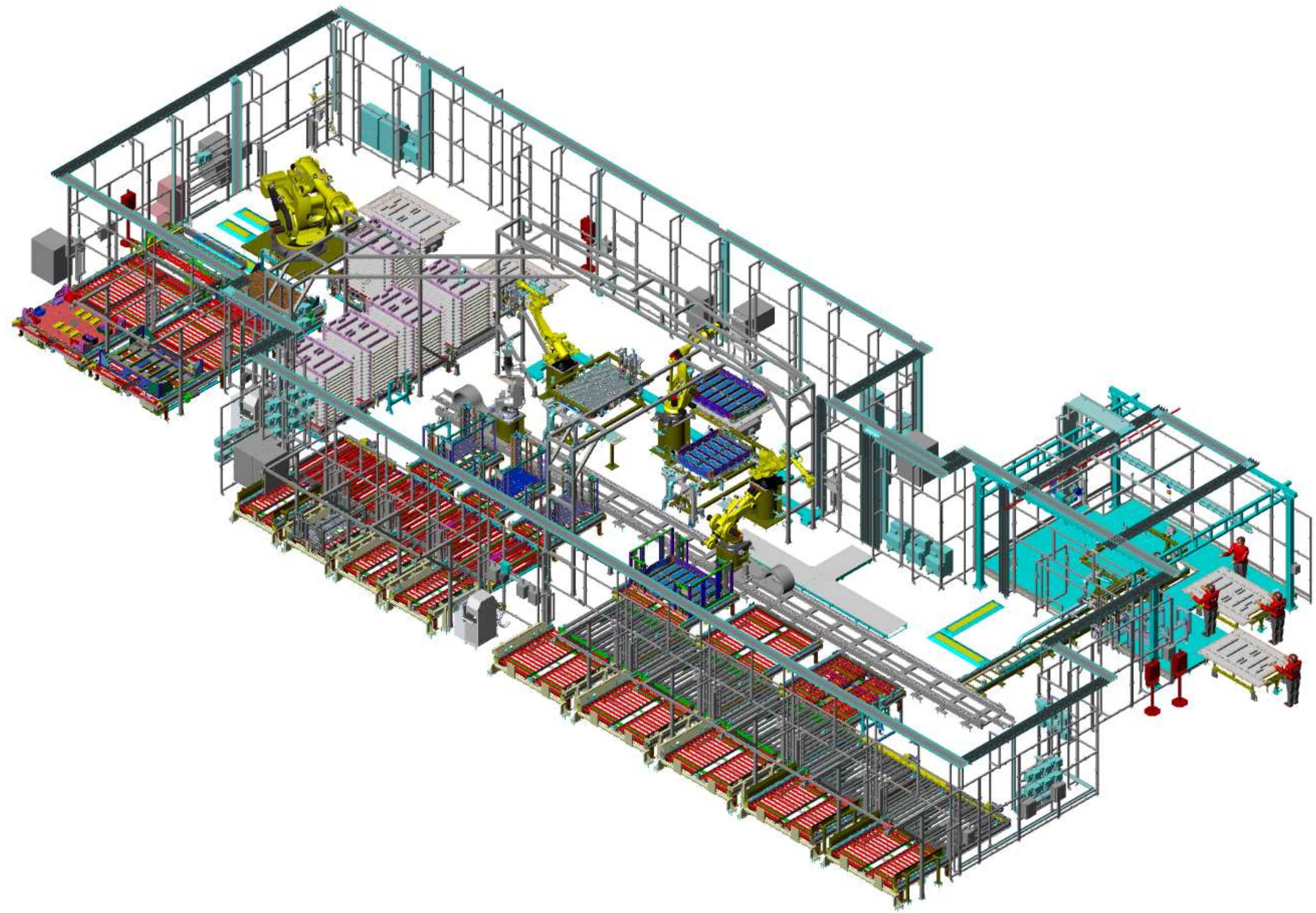
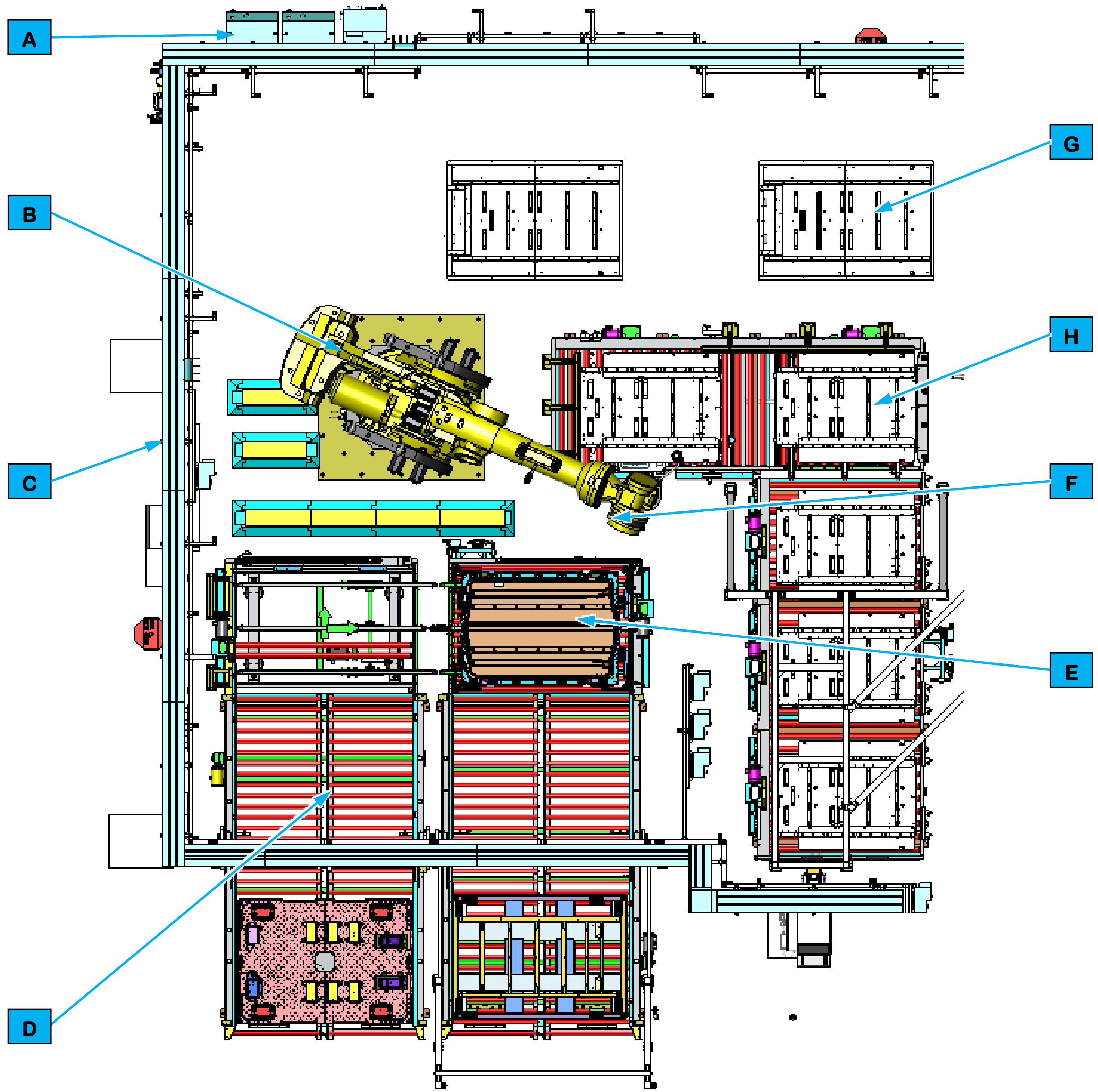


Figure 3-6. EP020/EP720 - Battery Assembly Unload and Tray Load Station Isometric View.



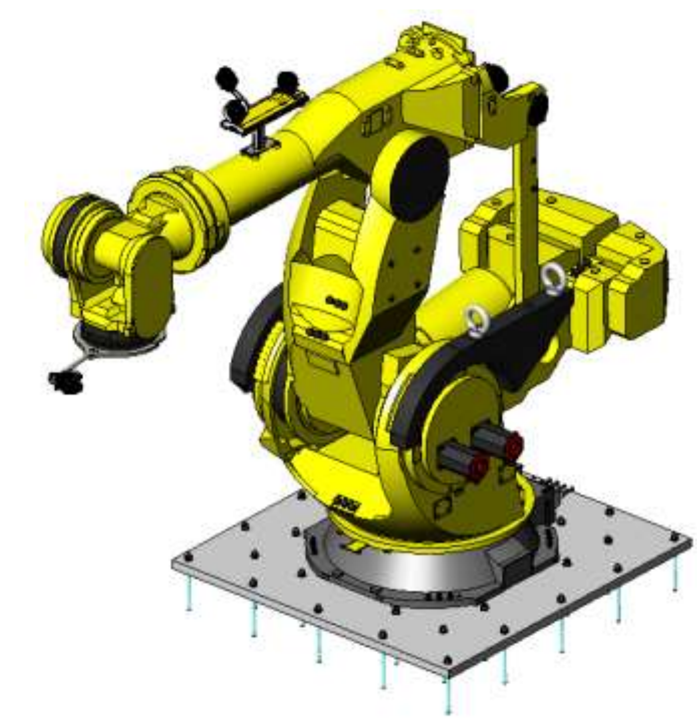
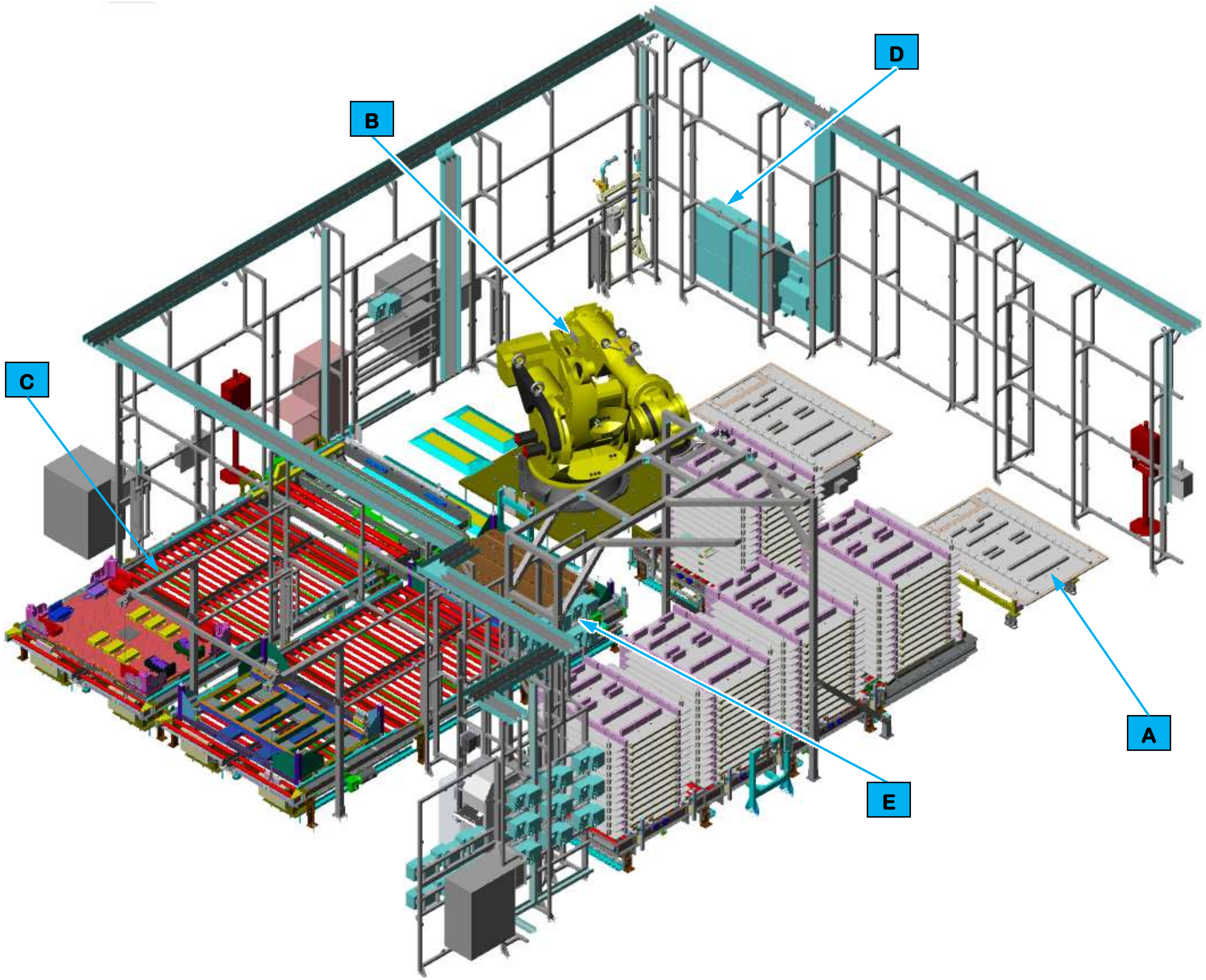


Figure 3-7. Pack Unload Robot

Equipment Callouts in Station EP720 Top View		
A	N/A	Robot Controller
B	EP720R01	Pack Unload Robot
C	IDC1 - 6	ArmorStart
D	EP720T01	Conveyors
E	N/A	Battery Assembly Dunnage
F	N/A	Robot and Vision Calibration Stand
G	N/A	Automated Guided Cart
H	EP720T01B01	Spacer Storage Conveyors

Figure 3-8. EP720 - Battery Assembly Unload Station Top View.



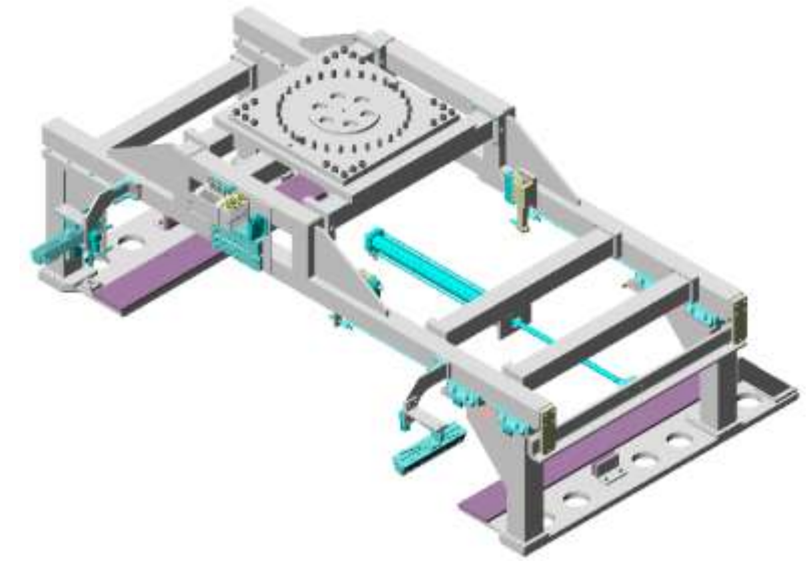


Figure 3-9. Pack Unload EOAT

Equipment Callouts in Station EP720 Isometric View		
A	N/A	Automated Guided Cart
B	EP720R01	Pack Unload Robot
C	EP720T01	Conveyors
D	N/A	Robot Controller
E	IDC1 - 6	ArmorStart

Figure 3-10. EP720 - Battery Assembly Unload Station Isometric View.

3.6.1.2. Station EP720 Sequence of Operation

The Battery Assembly Unload Station equipment completes the following operations during a normal cycle:

1. The AGC enters Station EP720 with a completed battery assembly.
2. The Pack Unload Robot (refer to callout **B** in ***Figure 3-10***) lowers to the battery assembly.
3. The Pack Unload Robot manipulates End of Arm Tooling (EOAT) to pick the battery assembly from the AGC.
4. The Pack Unload Robot raises clear of the AGC and rotates to the Conveyor equipment.
5. The Pack Unload Robot lowers and places the battery assembly onto a dunnage frame on the Conveyor equipment and the outfeed conveyor moves the dunnage frame out of the cell.
6. The Pack Unload Robot removes the BEV Spacer into the L-Shape conveyor if present and no longer needed. It will add the BEV Spacer if needed and not present.
7. The now empty AGC moves forward into Station EP020.
8. The Pack Unload Robot picks an empty dunnage frame from the infeed conveyor and places it on the outfeed conveyor.
9. The Pack Unload Robot rotates back to position awaiting another AGC to enter the cell.

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

3.6.1.3. The Pack Unload Robot and EOAT

Station EP720 contains one Pack Unload Robot (EP720R01). The FANUC M-2000IA/1700L (refer to ***Figure 3-7***) is a 6-axis robot with a load capacity of 3747 lbs. Attached to the Pack Unload Robot is End of Arm Tooling (EOAT) used to pick a completed battery assembly from a waiting AGC, rotate to the Conveyor equipment, and then lowers the battery assembly to a dunnage frame on the Conveyor equipment. Having completed this operation, the Battery Unload Robot raises clear of the frame dunnage and the dunnage frame moves out of the cell. The Battery Unload Robot picks an empty dunnage frame from the infeed conveyor and places it on the outfeed conveyor and then rotates back to position and waits for another AGC to enter the cell. Additionally, the Pack unload robot will pick and place the BEV spacers to and from the AGC carts onto an L-shaped conveyor as needed.

The Pack Unload EOAT (refer to ***Figure 3-9***) consists of a frame with linear lights, cameras, a pneumatic cylinder, holding pins, and grippers. Two (2) opposing light bars and two (2) opposing FANUC iRVision cameras are located on one side of the frame and are used to align the EOAT with the completed battery assembly. When the EOAT is lowered to the battery assembly, a center mounted pneumatic cylinder actuates to pull one (1) of two (2) opposing grippers to pick the battery assembly from the AGC and two (2) pneumatic holding pins are actuated to extend to hold the battery assembly in place. The cylinder, holding pins, and grippers remain in position while the Pack Unload Robot rotates to a waiting dunnage frame. Once the robot lowers the battery assembly to the dunnage frame the cylinder actuates to push the gripper away from the opposing gripper and the holding pins actuate to retract and releases the battery assembly.

REFERENCE	***For more information about the robot equipment, refer to the equipment supplier documentation (FANUC Robot M-2000 iA Operator's Manual).***

3.6.1.4. Robot and Vision Calibration Stand

The Robot and Vision Calibration Stand (refer to callout **F** in ***Figure 3-8***) provides a calibration grid that is used as a reference when calibrating the robot and robot vision equipment. Calibration of the robot and robot vision equipment is documented in the associated FANUC documentation.

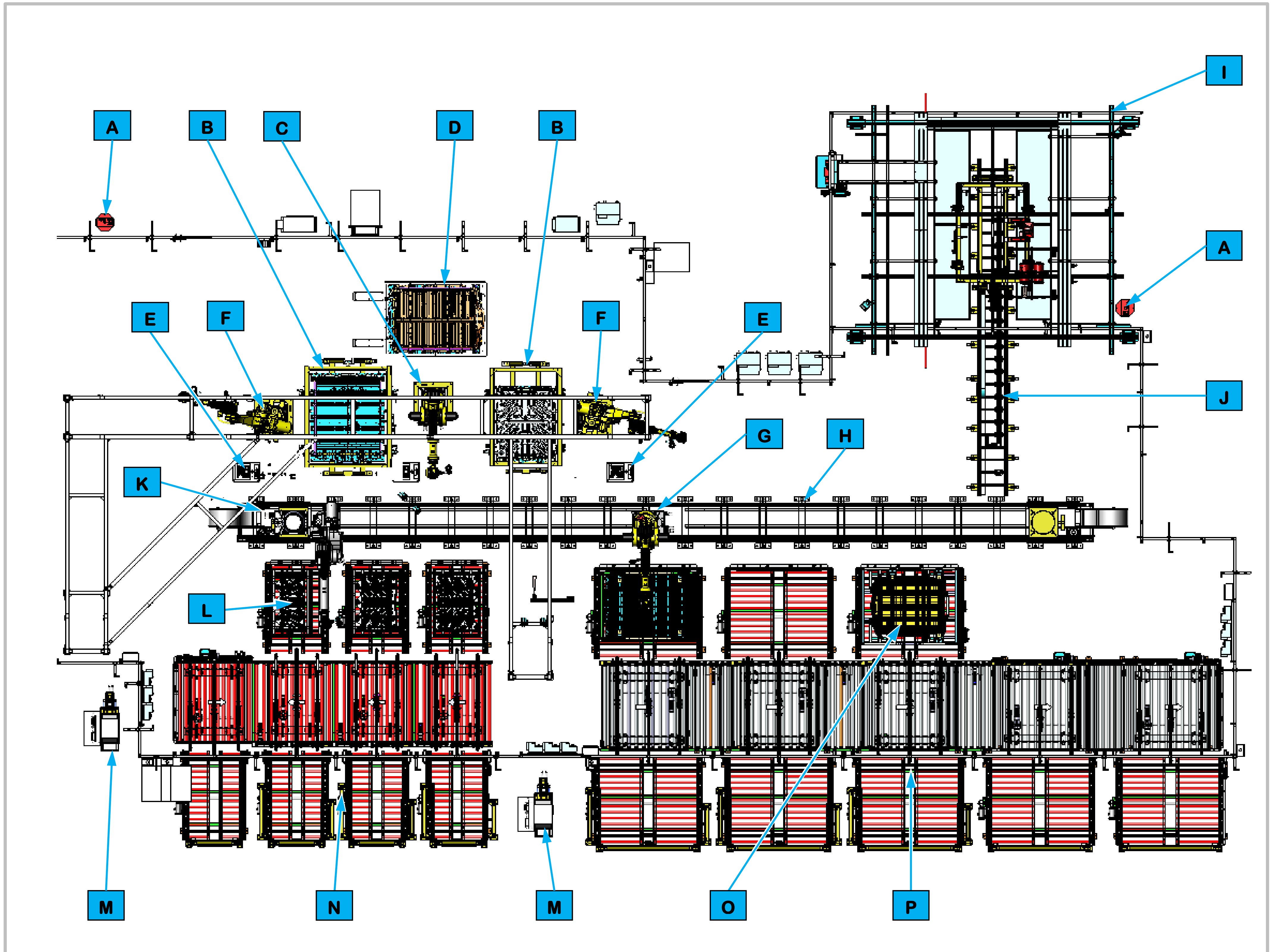
3.6.1.5. Conveyor Equipment

The Conveyor Equipment (EP720T01, refer to callout **C** in ***Figure 3-10***) transfers empty dunnage frames into the cell and dunnage frames carrying completed battery assemblies out of the cell.

The Conveyor Equipment utilizes third-party OTP conveyance devices. Powered roller conveyor sections are used to pull empty dunnage frames into the cell and to push full dunnage frames out of the cell. Each powered roller conveyor section has its own motor and motor starter. At the Pack Unload Robot inside the cell the robot uses attached EOAT to transfer an empty dunnage frame from the infeed conveyor and places on the outfeed conveyor.

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 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 personnel 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 conveyor equipment, refer to the equipment supplier documentation (Omni Metalcraft Technical Handbook).***



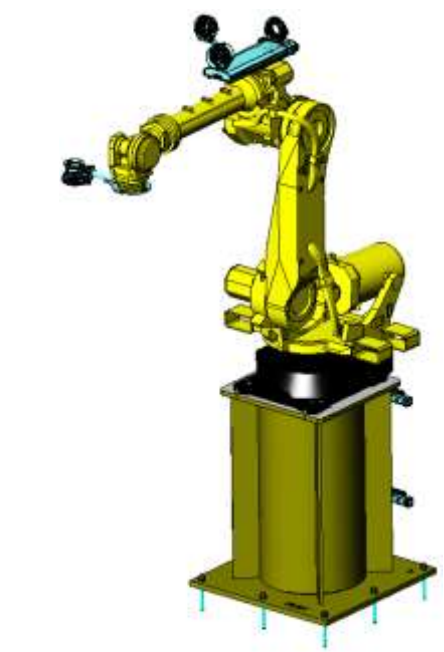
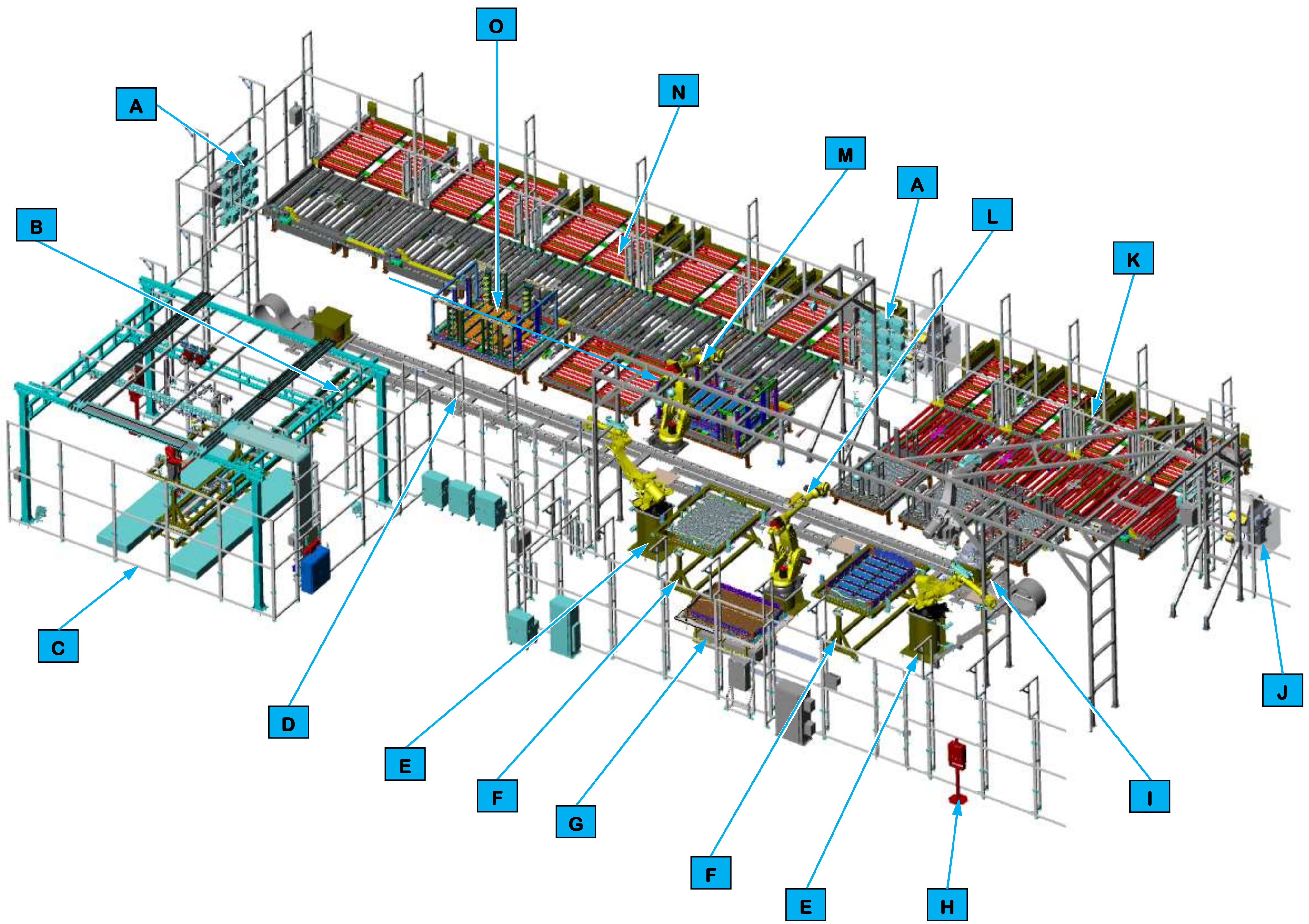


Figure 3-11. Tray/Skid Plate Assembly Robot

Equipment Callouts in Station EP020 Top View		
A	EP020D01-03	Operator Console HMI (3)
B	EP010P1B01-2	Fixture Rotate Table (2)
C	EP020R01	AGC Load Robot
D	N/A	Automated Guided Cart
E	N/A	Robot and Vision Calibration Stand
F	EP010P1R01-2	Tray/Skid Plate Assembly Robot (2)
G	EP010R01	Tray Robot
H	N/A	FANUC Robot Track Unit
I	N/A	Repair Cell
J	N/A	Repair Shuttle
K	EP010R02B01	Skid Plate Robot
L	N/A	Skid Plate Dunnage
M	EP010P1TC1	Fastener Feed System
N	EP010T02B01	Skid Plate Conveyors
O	EP010T01B01	Tray Conveyors
P	N/A	Tray Dunnage

Figure 3-12. EP020 - Tray Load Station Top View.



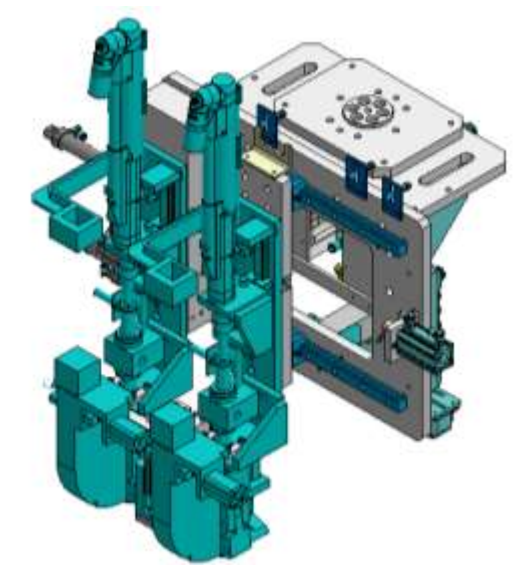
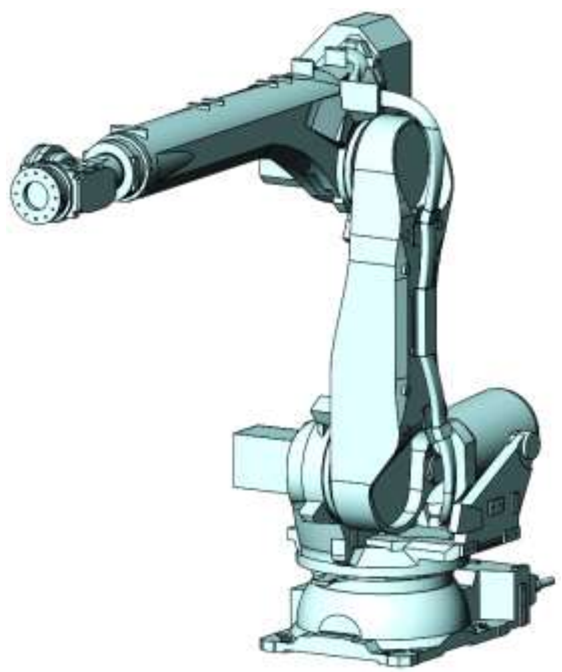


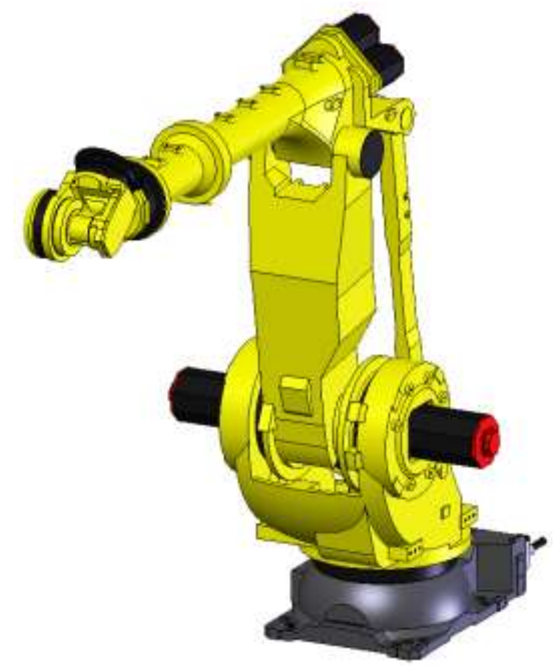
Figure 3-13. Tray/Skid Plate Assembly EOAT

Equipment Callouts in Station EP020 Isometric View		
A	IDC1 - 18	ArmorStart
B	N/A	Repair Shuttle
C	N/A	Repair Cell
D	N/A	FANUC Robot Track Unit
E	EP010P1R01-2	Tray/Skid Plate Assembly Robot (2)
F	N/A	Fixture Rotate Table (2)
G	N/A	Automated Guided Cart
H	EP020D01-03	Operator Console HMI
I	EP010R02B01	Skid Plate Robot
J	EP010P1TC1	Fastener Feed System
K	EP010T02B01	Skid Plate Conveyors
L	EP020R01	AGC Load Robot
M	EP010R01	Tray Robot
N	EP010T01B01	Tray Conveyors
O	N/A	Tray Dunnage

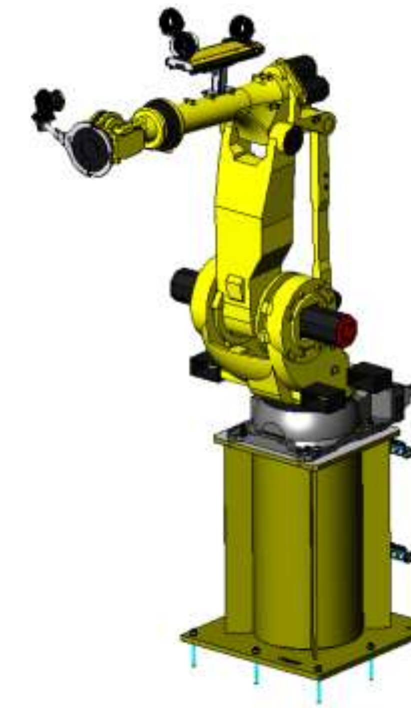
Figure 3-14. EP020 - Tray Load Station Isometric View.



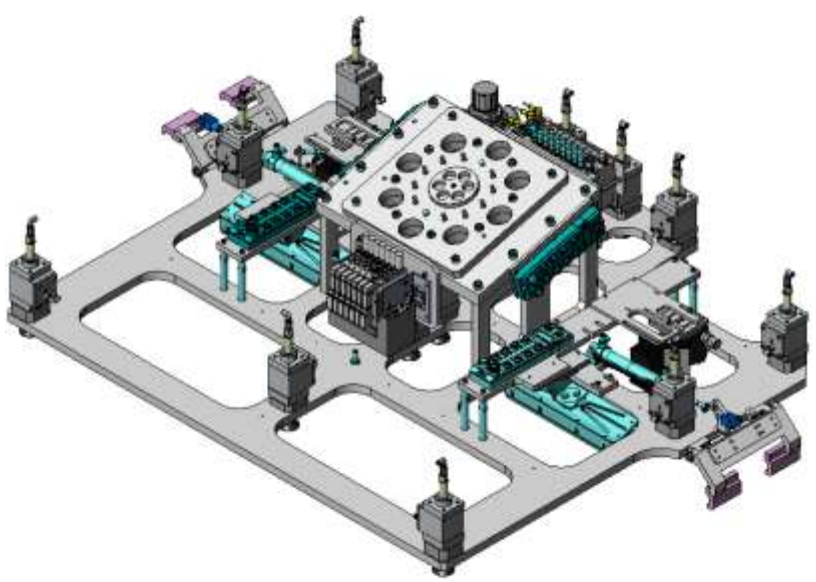
Skid Plate Robot



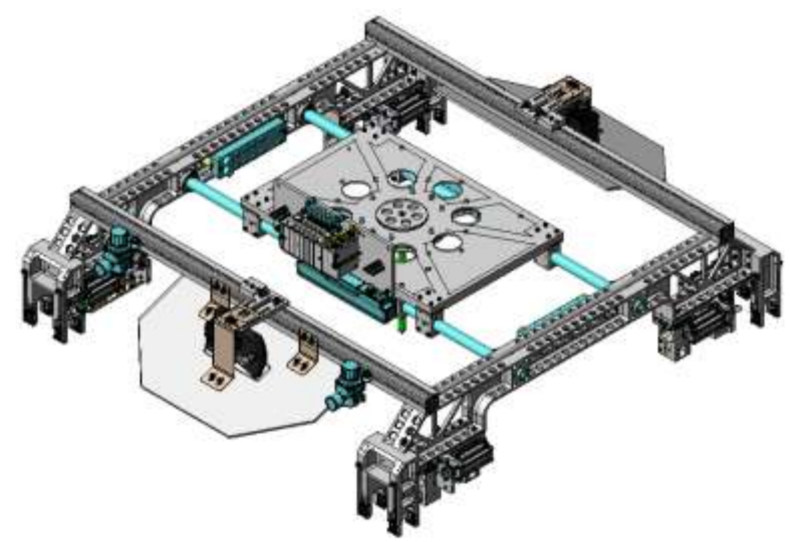
Tray Robot



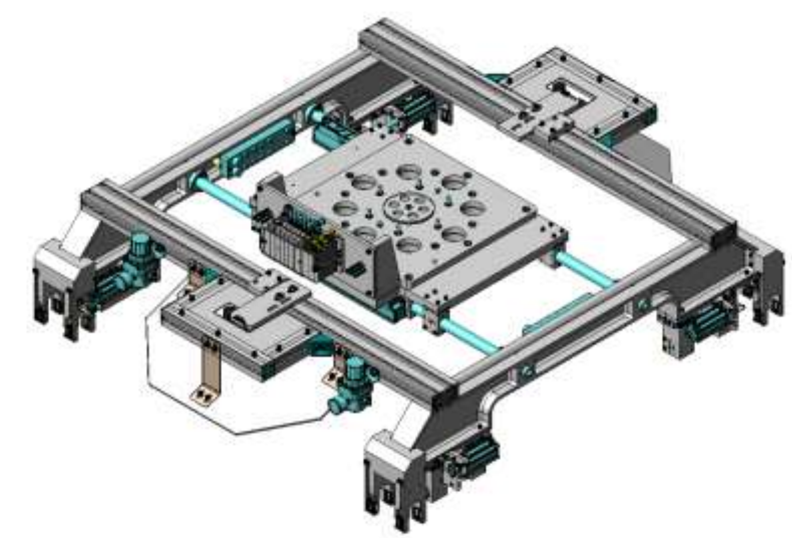
AGC Load Robot



Skid Plate EOAT



Tray EOAT



Load AGC EOAT

Figure 3-15. EP020 - Tray Load Station Robot and End of Arm Tooling.

3.6.1.6. Cell EP020 Sequence of Operation

The Tray Load Station equipment completes the following operations for a tray receiving a skid plate during a normal cycle:

1. An empty AGC enters Cell EP020 from Station EP720.
2. The Tray Robot (refer to callout **M** in ***Figure 3-14***) lowers and manipulates End of Arm Tooling (EOAT) to pick a battery assembly tray from dunnage on the Tray Conveyor Equipment and raises the tray clear of the conveyor.
3. The Tray Robot moves along its rail system to the Fixture Rotate Table (refer to callout **F** in ***Figure 3-14***) and rotates to align the tray onto the Fixture Rotate Table.
4. The Tray Robot lowers and places the tray onto the Fixture Rotate Table and then raises clear.
5. The Fixture Rotate Table clamps the tray in place and rotates to invert the tray presenting the bottom of the tray.
6. The Skid Plate Robot (refer to callout **I** in ***Figure 3-14***) lowers and manipulates EOAT to pick a skid plate from dunnage Skid Plate Conveyor Equipment and then raises the skid plate clear of the conveyor.
7. The Skid Plate Robot moves along its rail system to the Fixture Rotate Table and rotates to align the skid plate onto the Fixture Rotate Table.
8. The Skid Plate Robot lowers and places the skid plate onto the tray positioned on the Fixture Rotate Table and then raises clear.
9. The Tray/Skid Plate Assembly Robot (refer to callout **E** in ***Figure 3-14***) lowers and uses attached drivers to fasten the skid plate to the tray with blow-fed screws and then raises clear of the tray.
10. The Skid Plate and Tray/Skid Plate Assembly Robot repeat Steps 6 through 9 a second time on the same tray so that each tray has two (2) skid plates.
11. Once the tray has two (2) skid plates the Fixture Rotate Table rotates to invert the tray with the skid plates facing downwards and unclamps the tray.
12. The Load AGC Robot (refer to callout **L** in ***Figure 3-14***) rotates to the Fixture Rotate Table and lowers to the tray.
13. The Load AGC Robot manipulates EOAT to pick the tray from the Fixture Rotate Table and raises the tray clear.
14. The Load AGC rotates to the empty AGC in the Cell and lowers the tray to the AGC.
15. The Load AGC manipulates EOAT to place the tray onto the AGC where the tray is held in place with alignment pins. Sensors above the AGC check for pin alignment.
16. The Load AGC raises to clear the tray and the AGC moves forward and exits Cell EP020.

Not all trays receive skid plates, a tray without skid plates complete the following operations during a normal cycle:

1. An empty AGC enters Cell EP020 from Station EP720.
2. The Tray Robot (refer to callout **M** in ***Figure 3-14***) lowers and manipulates End of Arm Tooling (EOAT) to pick a battery assembly tray from dunnage on the Tray Conveyor Equipment and raises the tray clear of the conveyor.
3. The Tray Robot moves along its rail system to the Fixture Rotate Table (refer to callout **F** in ***Figure 3-14***) and rotates to align the tray onto the Fixture Rotate Table.
4. The Tray Robot lowers and places the tray onto the Fixture Rotate Table and then raises clear.
5. The Load AGC Robot (refer to callout **L** in ***Figure 3-14***) rotates to the Fixture Rotate Table and lowers to the tray.
6. The Load AGC Robot manipulates EOAT to pick the tray from the Fixture Rotate Table and raises the tray clear.
7. The Load AGC rotates to the empty AGC in the Cell and lowers the tray to the AGC.
8. The Load AGC manipulates EOAT to place the tray onto the AGC where the tray is held in place with alignment pins. Sensors above the AGC check for pin alignment.

9. The Load AGC raises to clear the tray and the AGC moves forward and exits Cell EP020.

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

3.6.1.7. The Tray Robot and EOAT

Cell EP020 contains one Tray Robot (EP010R01). The FANUC M-900IB-280L (refer to ***Figure 3-15***) is a 6-axis robot with a load capacity of 617 lbs. Attached to the Tray Robot is End of Arm Tooling (EOAT) used to pick trays from the Conveyor equipment, raises clear of the conveyor, and moves along its rail system to Fixture Rotate Table. Once the Tray Robot is aligned with the Fixture Rotate Table it rotates to the table and lowers to place the tray onto the Fixture Rotate Table. The Tray Robot then raises clear of the Table and returns to the conveyor.

The Tray EOAT (refer to ***Figure 3-15***) consists of a frame with linear lights, cameras, pneumatic cylinders, and holding pins. Two (2) opposing light bars and two (2) opposing FANUC iRVision cameras are located on the frame and used to align the EOAT with the tray. When the EOAT is lowered to the tray in dunnage, four (4) pneumatic cylinders actuate forward pushing attached holding pins to pick the tray from dunnage. The cylinders and holding pins remain in position holding the tray while the Tray Robot moves to the Fixture Rotate Table. Once the robot lowers the tray to the Fixture Rotate Table the cylinders retract pulling the holding pins back, releasing the tray.

3.6.1.8. The Skid Plate Robot and EOAT

Cell EP020 contains one Skid Plate Robot (EP010R02B01). The FANUC R-2000IC/210L (refer to ***Figure 3-15***) is a 6-axis robot with a load capacity of 462 lbs. Attached to the Skid Plate Robot is End of Arm Tooling (EOAT) used to pick skid plates from the Conveyor equipment, raises clear of the conveyor, and moves along its rail system to Fixture Rotate Table. Once the Skid Plate Robot is aligned with the Fixture Rotate Table it rotates to the table and lowers to place the skid plate onto tray on the Fixture Rotate Table. The Skid Plate Robot then raises clear of the Table and returns to the conveyor.

The Skid Plate EOAT (refer to ***Figure 3-15***) consists of a frame with linear lights, cameras, pneumatic cylinders, grippers, vacuum generators, and vacuum pads. Two (2) opposing light bars and two (2) opposing FANUC iRVision cameras are located on the frame and used to align the EOAT with the skid plate. The 11 vacuum pads are configured into 2 rows of 3 on the sides and 5 in a row on the center of the frame connected to the vacuum generator. When the EOAT is lowered to the skid plate in dunnage, the vacuum pads are activated to apply suction against the skid plate and two opposing cylinders located on the sides of the frame activate two grippers to hold the skid plate. The vacuum generator remains on and the grippers in place while the Skid Plate Robot moves to the Fixture Rotate Table. Once the robot lowers the skid plate to the tray on the Fixture Rotate Table the cylinders retract pulling the grippers back and the vacuum generator stops, releasing the skid plate.

3.6.1.9. The Tray/Skid Plate Assembly Robot and EOAT

Cell EP020 contains two Tray/Skid Plate Assembly Robots (EP010P1R01 and 2), each beside a Fixture Rotate Table. The FANUC R-2000IC/210F (refer to ***Figure 3-11***) is a 6-axis robot with a load capacity of 642 lbs. with attached End of Arm Tooling (EOAT) used to fasten the skid plate to the tray on the Fixture Rotate Table. The robot rotates and lowers the vision aligned EOAT to the skid plate, receives blow-fed screws to the EOAT and then fastens the screws two (2) at a time using drivers. Having completed this operation, the Tray/Skid Plate Assembly Robot raises to clear the skid plate.

The Tray/Skid Plate Assembly EOAT (refer to ***Figure 3-13***) consists of a frame with a linear light, a camera, pneumatic drivers with attached blow fed supply lines. A light and a FANUC iRVision Camera are located at the back of the frame and are used to align the EOAT with the skid plate. Two (2) pneumatic drivers are located on the front of the frame with attached blow-fed supply lines and one of the drivers mounted on a track allowing it to actuate sideways to facilitate screw spacing. When the EOAT is lowered to the skid plate the two (2) drivers receive blow-fed screws and then drive the screws into the skid plate.

3.6.1.10. The Load AGC Robot and EOAT

Cell EP020 contains one Load AGC Robot (EP020R01). The FANUC M900IB-360 (refer to ***Figure 3-15***) is a 6-axis robot with a load capacity of 793 lbs. Attached to the Load AGC Robot is End of Arm Tooling (EOAT) used to pick trays from the Fixture Rotate Table, raises the tray clear of the Table, and then rotates to a waiting empty AGC. The Load AGC then lowers to the AGC and vision aligns with the AGC to place the tray. Once the tray has been placed on the AGC the Load AGC raises clear of the tray and rotates back to a Fixture Rotate Table.

The Load AGC EOAT (refer to ***Figure 3-15***) consists of a frame with linear lights, cameras, pneumatic cylinders, and holding pins. Two (2) opposing light bars and two (2) opposing FANUC iRVision cameras are located on the frame and used to align the EOAT with the tray. When the EOAT is lowered to the tray on the Fixture Rotate Table, four (4) pneumatic cylinders actuate forward pushing attached holding pins to pick the tray from the Table. The cylinders and holding pins remain in position holding the tray while the Tray Robot raises and rotates to the AGC. Once the robot lowers the tray to the AGC, the cylinders retract pulling the holding pins back, releasing the tray.

REFERENCE	***For more information about the robot equipment, refer to the equipment supplier documentation (FANUC Robot M-900 iB Operator's Manual and FANUC Robot R-2000 iC Operator's Manual).***

3.6.1.11. Robot and Vision Calibration Stand

The Robot and Vision Calibration Stand (refer to callout **E** in ***Figure 3-12***) provides a calibration grid that is used as a reference when calibrating the robot and robot vision equipment. Calibration of the robot and robot vision equipment is documented in the associated FANUC documentation.

3.6.1.12. Fixture Rotate Table

There are two Fixture Rotate Tables in Cell EP020 (EP010P1B01, refer to callout **F** in ***Figure 3-14***) used to hold trays that will be receiving skid plates to the underside of the tray. The table consists of a trunnion stand holding a rotating frame with a center aligned servo motor that can rotate the rotate table to invert trays. The rotate frame holds four (4) pneumatic actuators with attached clamps that hold the tray in place while the rotate table is inverted and during skid plate installation.

Once the Tray Robot has placed the tray onto Table, the 4 pneumatic actuators are activated to lower clamps that hold the tray in place. Once the clamps are lowered the center aligned servo motor activates to rotate the table 180°, inverting the tray. The Skid Plate Robot than places 2 skid plates onto the tray and the Tray/Skid Plate Assembly Robot fastens the skid plate to the tray. Once the skid plate has been secured to the tray the center aligned servo motor activates to rotate the table 180°, inverting the tray with the skid plates downwards. The four pneumatic actuators are activated to raise the clamps, releasing the tray and the AGC Load Robot then picks the tray from the Fixture Rotate Table

3.6.1.13. Repair Shuttle and Repair Cell

The Repair Shuttle (refer to callout **J** in ***Figure 3-12)*** is a track system that moves the Cover Reject Table from Cell EP020 into the Repair Cell (refer to callout **I** in ***Figure 3-12***) so that an Operator can perform repairs on the tray and skid plate before the tray is returned to Cell EP020.

3.6.1.14. Fastener Feed System

The Airway Model 3 Fastener Feed System (refer to callout refer to callout **M** in ***Figure 3-12***) is an electrically motorized fastener assembly that sorts and aligns bolts into an inline track that are then blow fed into an air hose to the Tray/Skid Plate Assembly EOAT.

REFERENCE	*For more information about fastener feed system equipment, refer to the equipment supplier documentation (Airway Automation Equipment Manual).*

3.6.1.15. Conveyor Equipment

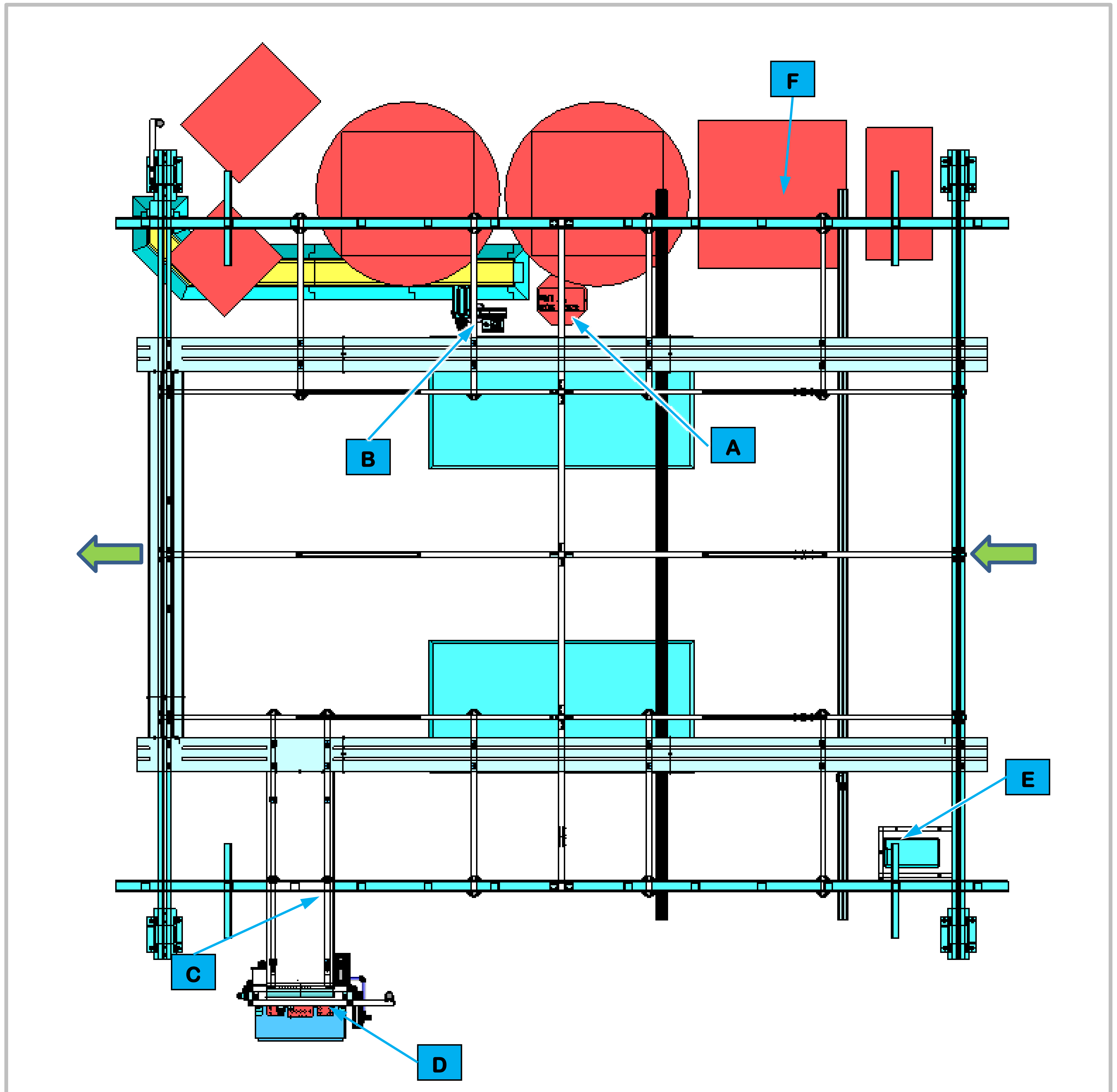
The Conveyor Equipment (EP010T01B01 and EP010T02B01, refer to callouts **K** and **N** in ***Figure 3-14***) transfers dunnage carrying trays and skid plates into the cell and empty dunnage out of the cell.

The Conveyor Equipment utilizes third-party OTP conveyance devices. For the trays, powered roller conveyor sections are used to pull full tray dunnage frames into the cell and to push empty tray dunnage frames out of the cell. Each powered roller conveyor section has its own motor and motor starter. At the Tray Robot inside the cell, a perpendicular section of chain conveyor is used to transfer containers from the input side to the output side. For the skid plates, powered roller conveyor sections are used to pull full skid plate dunnage frames into the cell and to push empty skid plate dunnage frames out of the cell. Each powered roller conveyor section has its own motor and motor starter. At the Skid Plate Robot inside the cell, a perpendicular section of chain conveyor is used to transfer containers from the input side to the output side

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 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 personnel 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 conveyor equipment, refer to the equipment supplier documentation (Omni Metalcraft Technical Handbook).*

3.6.2. EP040 BIN Label and RPIM Install Description



3.6.2.1. Station Description

Cell EP040 is a manual station for installing the BIN label, the Coolant Inlet, the Front Ground Strap, the RPIM Backing Plate, the RPIM Header and the SWB Jumper Bus Bar .

For BET batteries the Operator installs the BIN label, the Front Ground Strap, the RPIM Backing Plate, the RPIM Header and the SWB Jumper Bus Bar.

For BEV3 batteries the Operator installs the BIN label and the Coolant Inlet.

Equipment Callouts in Station EP040 Top View		
A	EP040D1	Operator Console HMI
B	EP040BC1	Barcode Scanner and AGC Release Box
C	N/A	Wireway
D	EP040P1	Power Cabinet
E	EP040PRT1	Barcode Printer
F	N/A	Dunnage

Figure 3-16. EP040 - BIN Label and RPIM Install Top View.

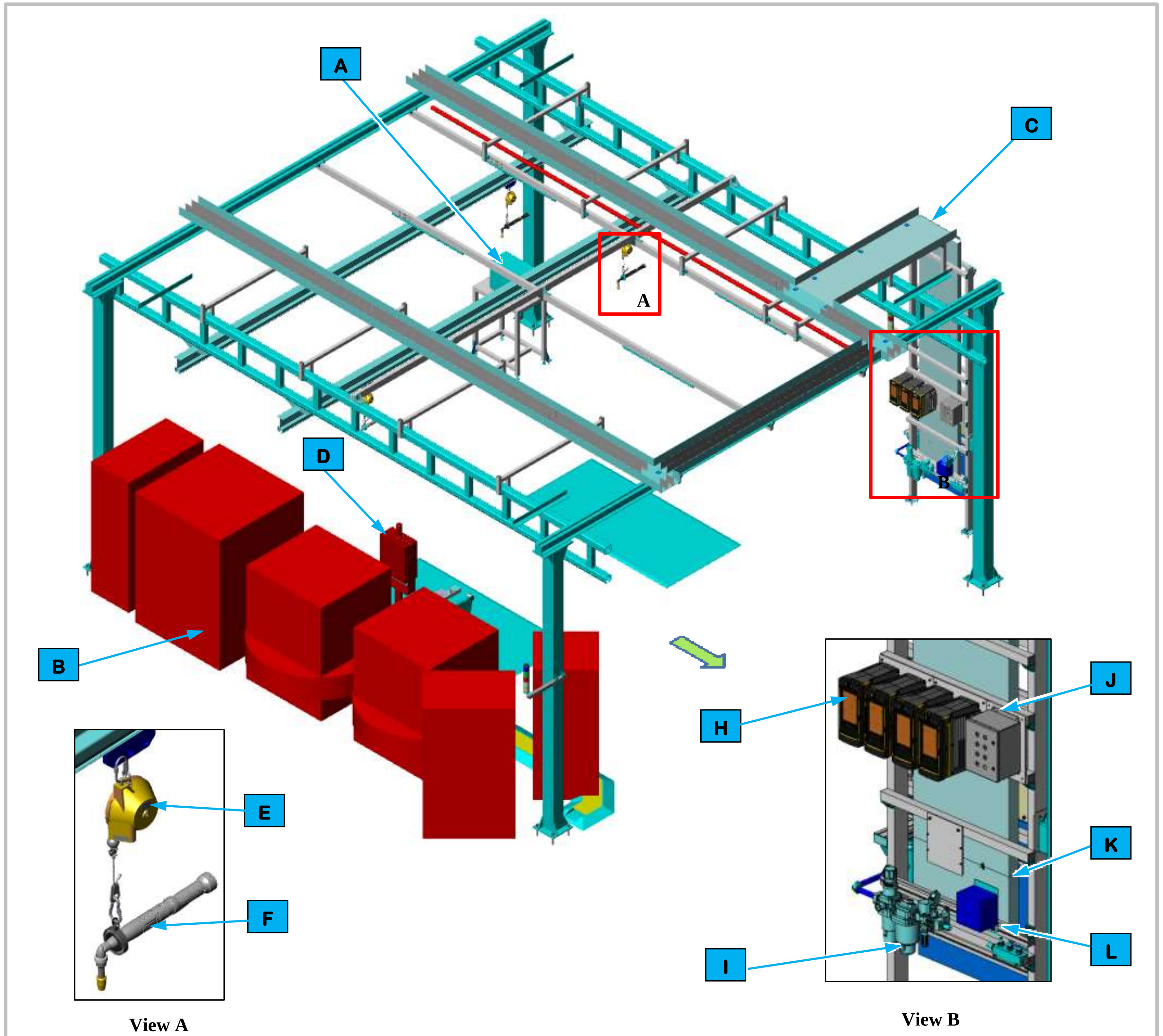


Figure 3-17. EP040 - BIN Label and RPIM Install Isometric View.

3.6.2.2. Sequence of Operation for BET

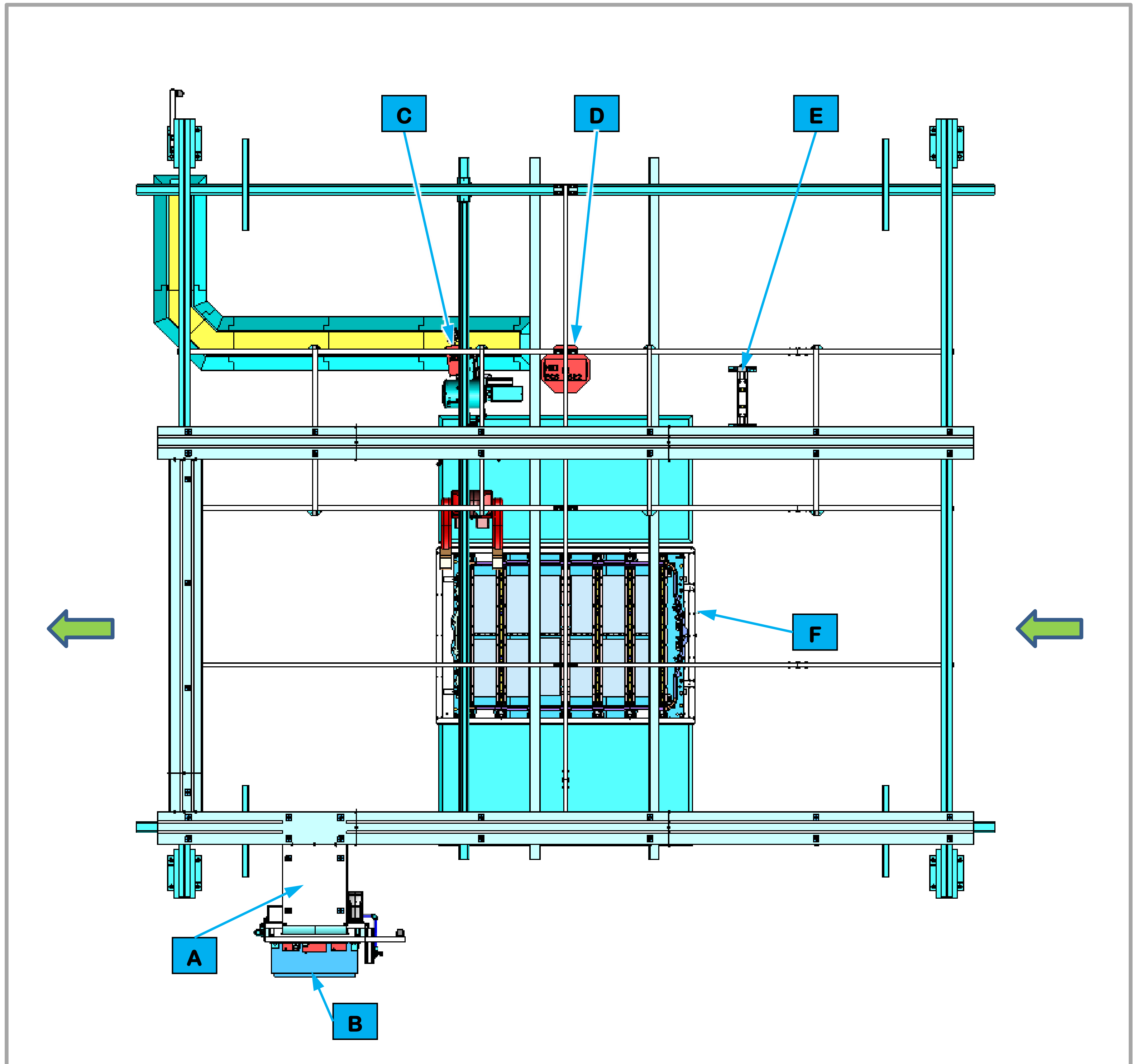
Step	Process
1	Print, install, and scan BIN labels to front and back of Battery Pack
2	Get, install, and scan Front Ground Strap
3	Scan battery assembly trace label
4	Get and install RPIM Backing Plate
5	Get and install RPIM Header
6	Get SWB Jumper Bus Bar

3.6.2.3. Sequence of Operation for BEV3

Step	Process
1	Print, install, and scan BIN label to front of Battery Pack
2	Get and install Coolant Inlet Assembly

Equipment Callouts in Station EP040 Isometric View		
A	EP040PRT1	Barcode Printer
B	N/A	Dunnage
C	N/A	Wireway
D	EP040D1	Operator Console HMI
E	N/A	Tool Balancer
F	EP040TC1-4	Nutrunner
H	EP040TC1-4	Nutrunner Controllers
I	AIRON	Air Preparation Unit
J	EP040E2	Operator Push Button Box
K	EP040E1	Operator Release Button
L	EP040RCP1	Electrical Outlet Box

3.6.3. EP060 LPIM Headers Install Station Description



3.6.3.1. Station Description

Cell EP060 is a manual station for attaching the LV Harness, LPIM, and DCFC header.

For BET batteries the Operator gets and installs the LV Harness, LPIM Backing Plate, and LPIM Header.

For BEV3 batteries the Operator gets and installs the IPE Backing Plate, DCFC Backing Plate, IPE Header, and DCFC Header.

Equipment Callouts in Station EP060 Top View		
A	N/A	Wireway
B	EP060P2	Power Cabinet
C	N/A	Lift Assist
D	EP060D1	Operator Console HMI
E	N/A	Stand
F	N/A	Automated Guided Cart

Figure 3-18. EP060 RPIM Headers Install Station Top View.

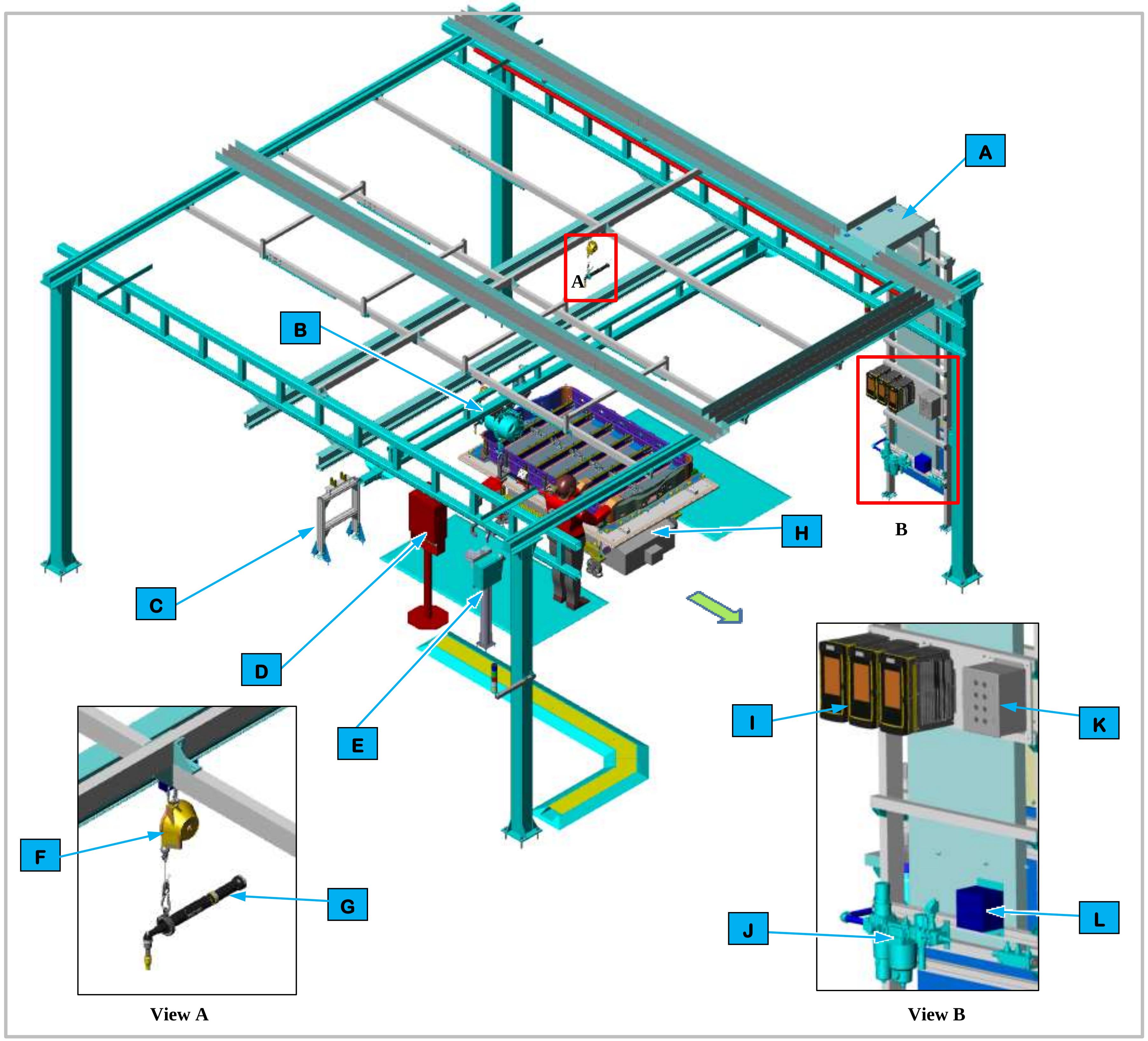


Figure 3-19. EP060 RPIM Headers Install Station Isometric View.

3.6.3.2. Sequence of Operation for BET

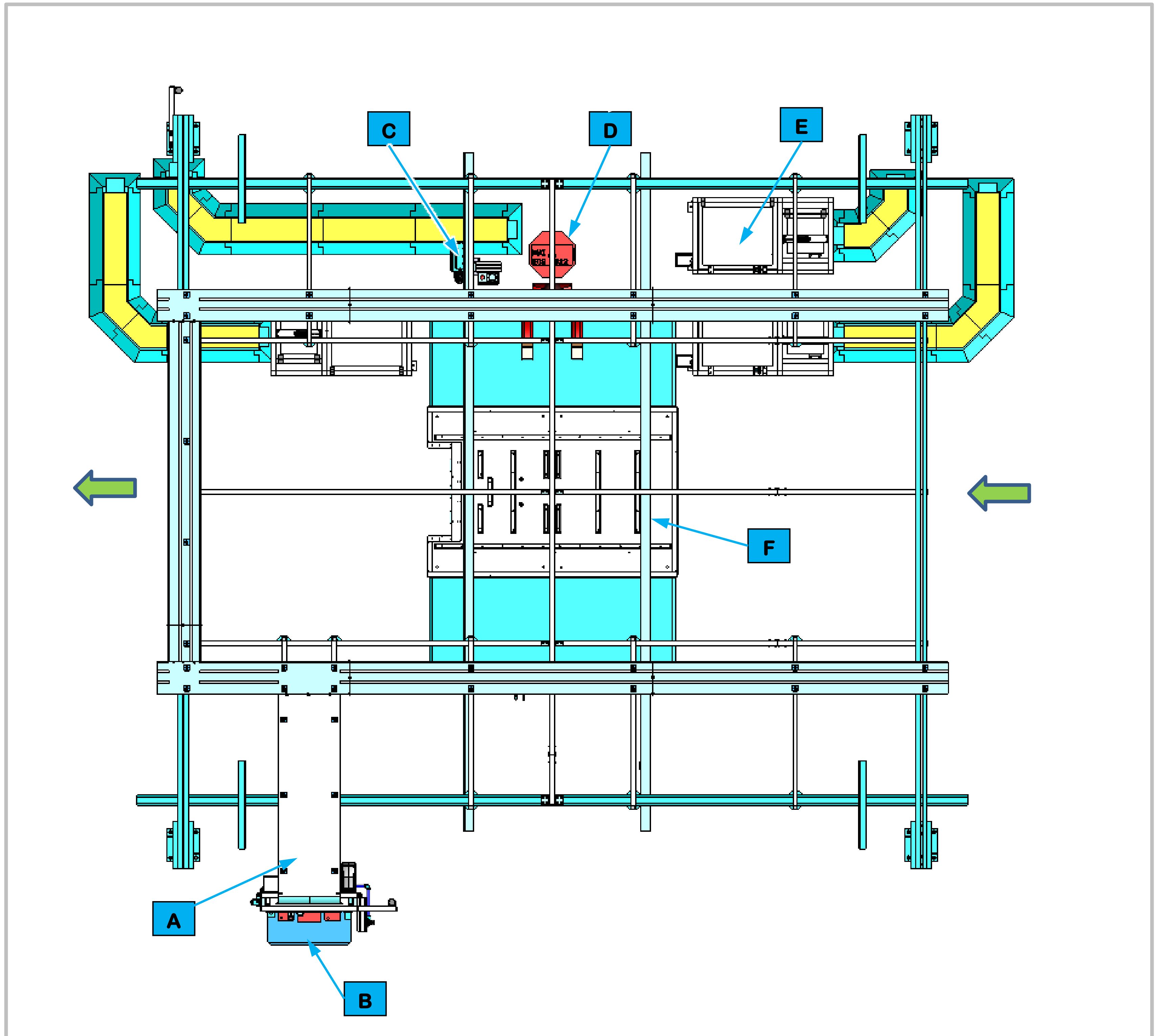
Step	Process
1	Get and install LV Harness
2	Get and install LPIM Backing Plate
3	Get and install LPIM Header
4	Install SWB Jumper Bus Bar

3.6.3.3. Sequence of Operation for BEV3

Step	Process
1	Get and install RDU Backing Plate
2	Get and install RDU Header

Equipment Callouts in Station EP060 Isometric View		
A	N/A	Wireway
B	N/A	Lift Assist
C	N/A	Stand
D	EP060D1	Operator Console HMI
E	EP060BC1	Barcode Scanner and AGC Release Box
F	N/A	Tool Balancer
G	EP060TC1 - 3	Nut Runner
H	N/A	Automated Guided Cart
I	EP060TC1 - 3	Nutrunner Controllers
J	AIRON	Air Preparation Unit
K	EP060E2	Operator Push Button Box
L	EP060RCP1	Electrical Outlet Box

3.6.4. EP080 DCFC Station Description



3.6.4.1. Station Description

Cell EP080 is a manual station for attaching the IPE Backing Plate, the DCFC Backing Plate, the IPE Header, the DCFC Header, the FPIM Backing Plate, the FPIM, and the SWB Jumper Bus Bar.

For BET batteries the Operator gets and installs FPIM Backing Plate, the FPIM, the IPE Backing Plate, the IPE Header and the SWB Jumper Bus Bar.

For BEV3 batteries the Operator gets and installs the IPE Backing Plate, the DCFC Backing Plate, the IPE Header, and the DCFC Header.

Equipment Callouts in Station EP080 Top View		
A	N/A	Wireway
B	EP080P2	Power Cabinet
C	EP080BC1	Barcode Scanner and AGC Release Box
D	EP080D1	Operator Console HMI
E	EP080SF1 - 3	Feeder (3)
F	N/A	Automated Guided Cart

Figure 3-20. EP080 DCFC Station Top View.

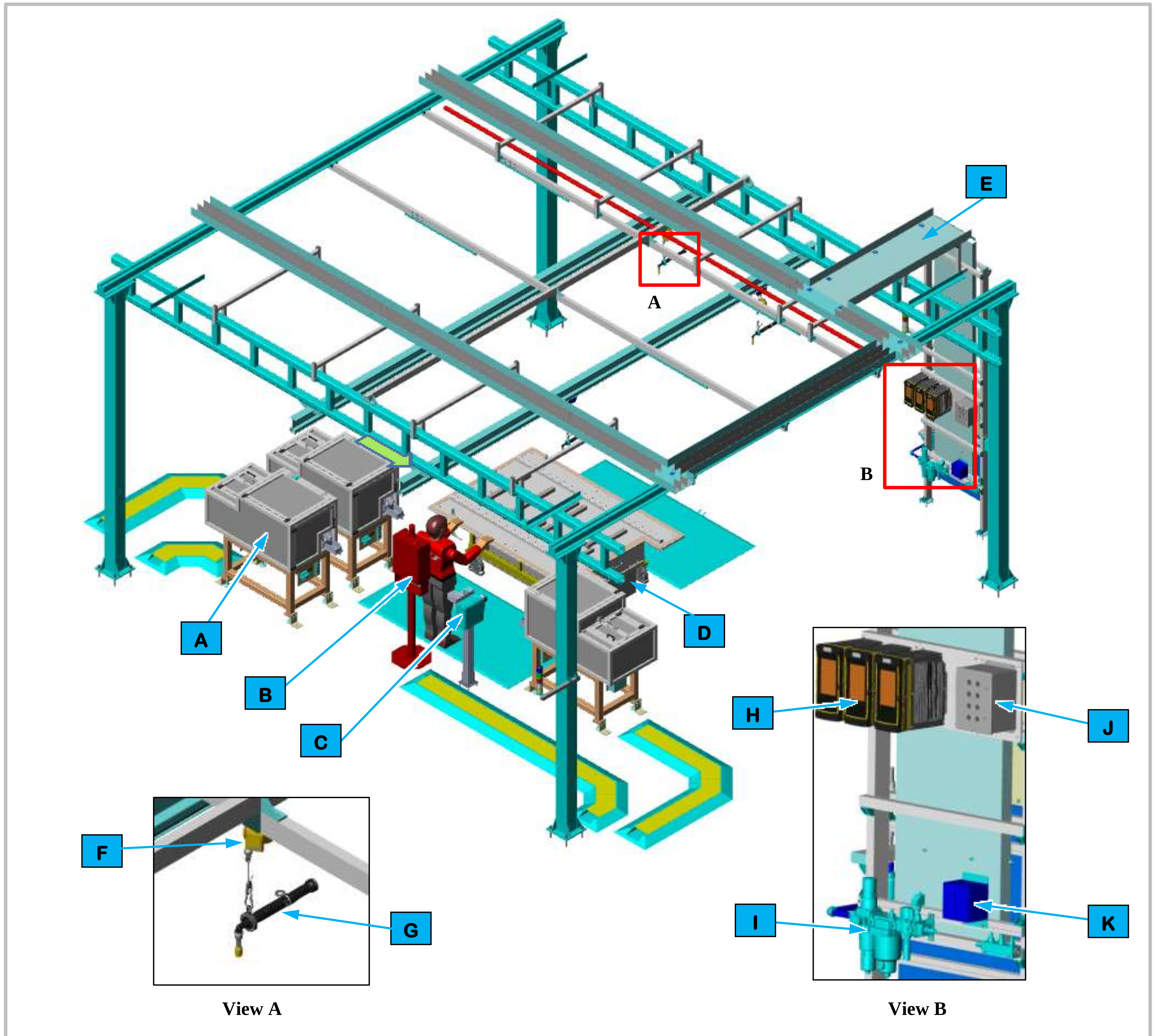


Figure 3-21. EP080 DCFC Station Isometric View.

3.6.4.2. Sequence of Operation for BET

Step	Process
1	Get and install FPIM Backing Plate
2	Get and install FPIM
3	Get and install IPE Backing Plate
4	Get and install IPE Header
5	Get SWB Jumper Bus

3.6.4.3. Sequence of Operation for BEV3

Step	Process
1	Get and install IPE Backing Plate
2	Get and install DCFC Backing Plate
3	Get and install IPE Header
4	Get and install DCFC Header

Equipment Callouts in Station EP080 Isometric View		
A	EP080SF1 - 3	Feeder (3)
B	EP080D1	Operator Console HMI
C	EP080BC1	Barcode Scanner and AGC Release Box
D	N/A	Automated Guided Cart
E	N/A	Wireway
F	N/A	Tool Balancer
G	EP080TC1- 3	Nutrunner
H	EP080TC1- 3	Nutrunner Controllers
I	AIRON	Air Preparation Unit
J	EP080E2	Operator Push Button Box
K	EP080RCP1	Electrical Outlet Box

3.6.5. EP090 DCFC Header Install Station Description

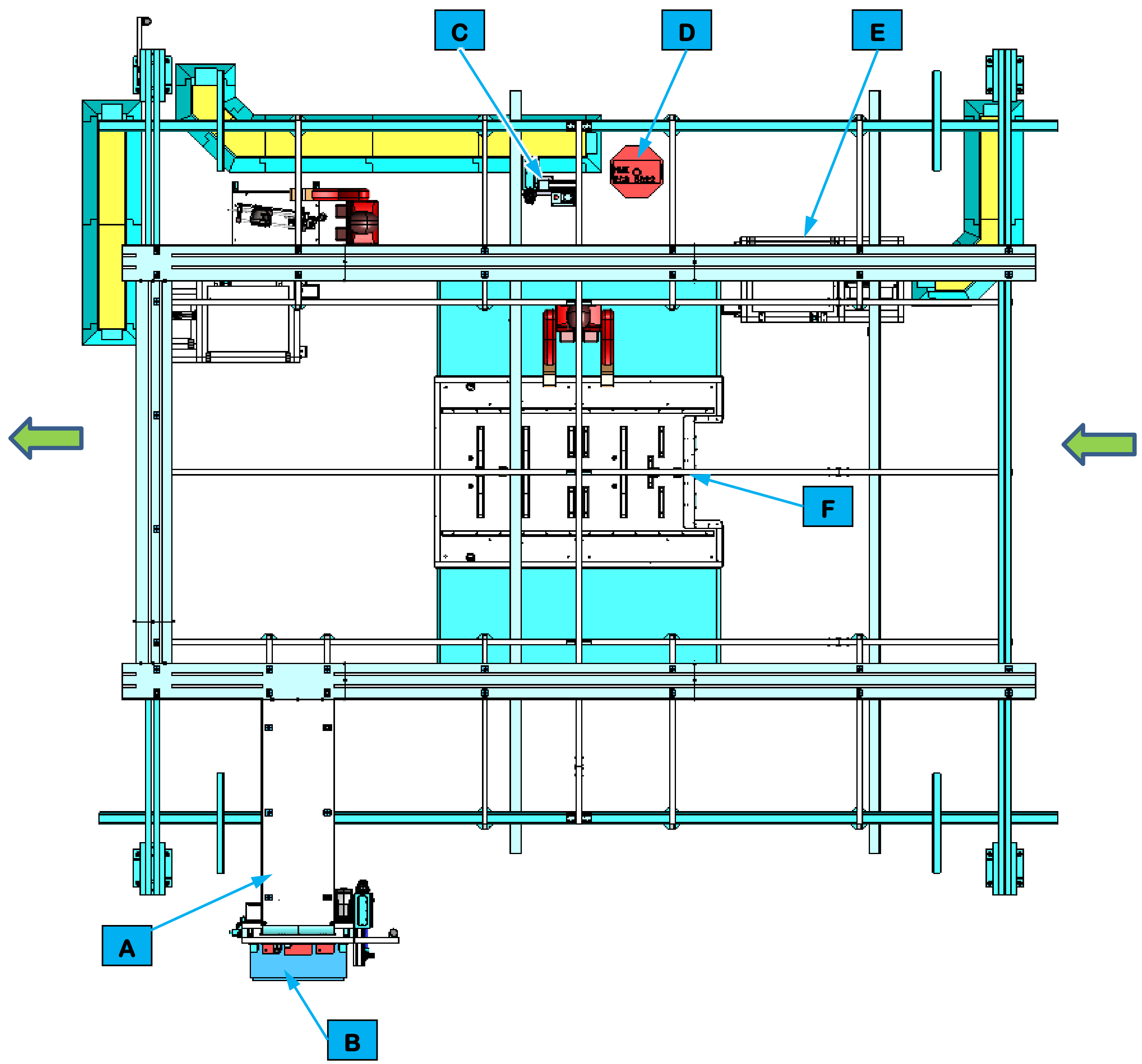


Figure 3-22. EP090 DCFC Header Station Top View.

3.6.5.1. Station Description

Cell EP090 is a manual station for attaching the Double-ended Stud, the BRFM, the BRFM Barcode Trace, the DCFC Backing Plate install, the DCFC Header and the SWB Jumper Bus Bar

For BET batteries the Operator gets and installs the DCFC Backing Plate install, the DCFC Header, and the SWB Jumper Bus Bar

For BEV3 batteries the Operator gets and installs the Double-ended Stud, the BRFM, and the BRFM Barcode Trace.

Equipment Callouts in Station EP080 Top View		
A	N/A	Wireway
B	EP090P2	Power Cabinet
C	EP090BC1	Barcode Scanner and AGC Release Box
D	EP090D1	Operator Console HMI
E	EP090SF1 - 2	Feeder (2)
F	N/A	Automated Guided Cart

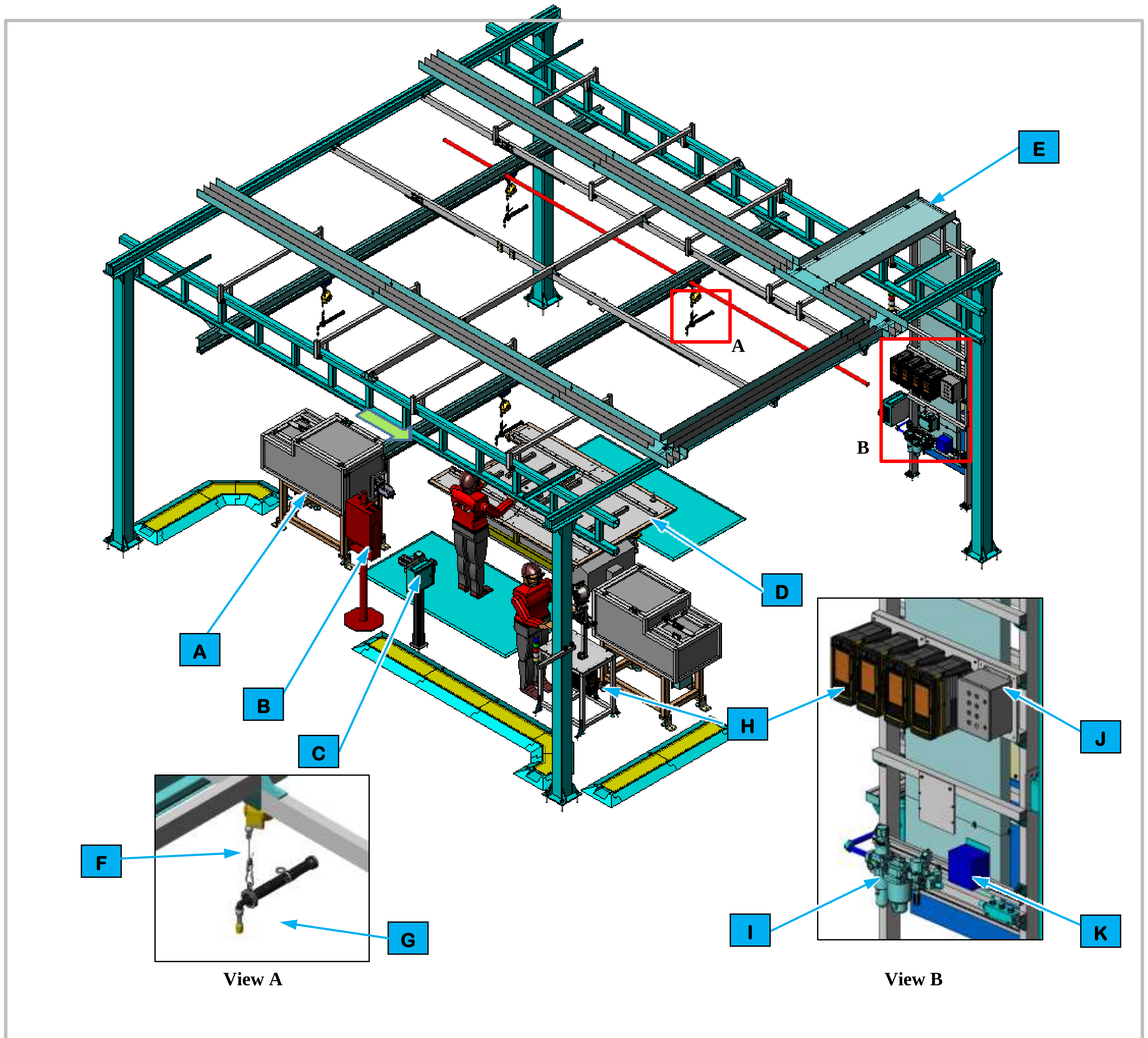


Figure 3-23. EP090 DCFC Header Station Isometric View.

3.6.5.2. Sequence of Operation for BET

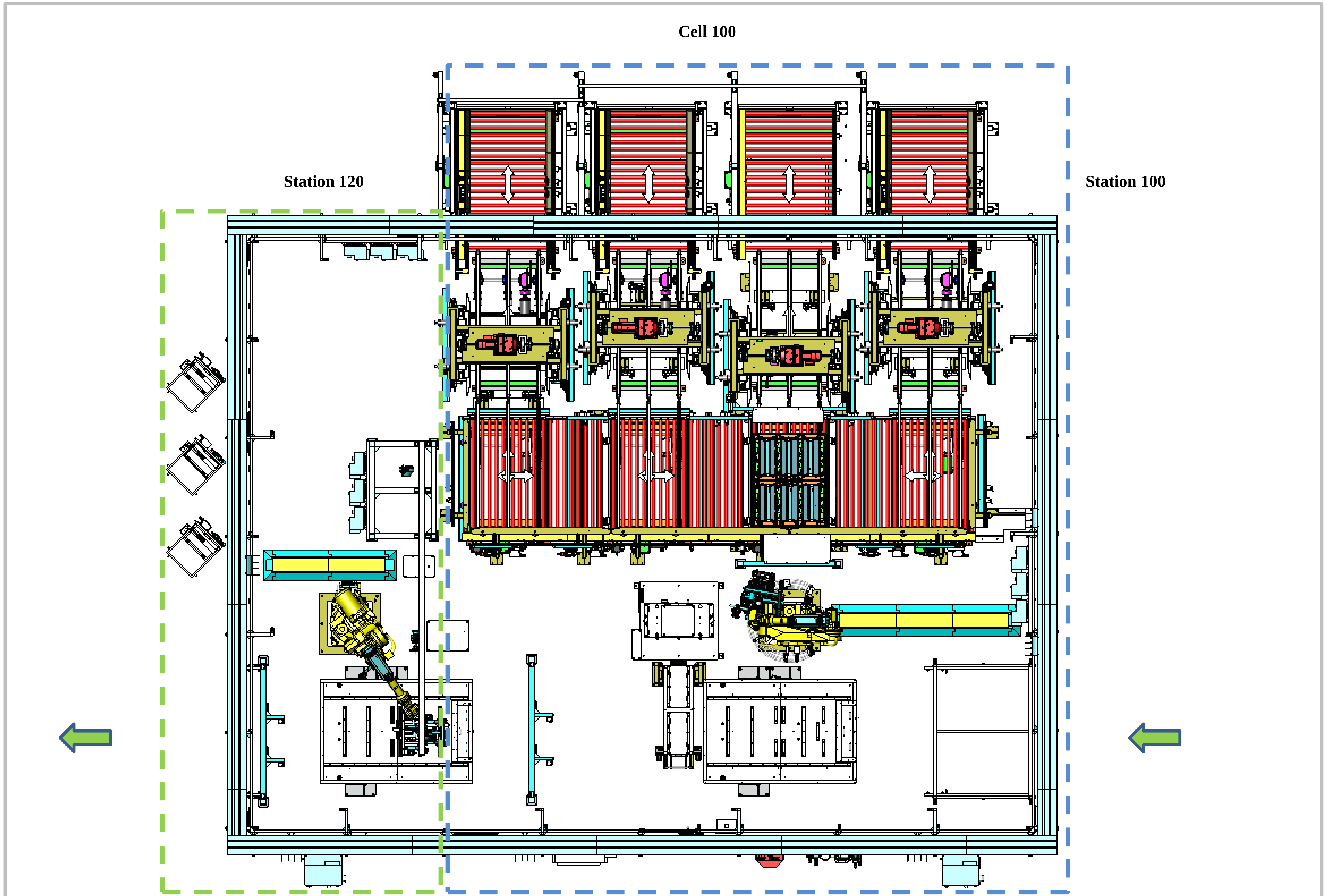
Step	Process
1	Get and install the DCFC Backing Plate.
2	Get and install the DCFC Header.
3	Get and install the SWB Jumper Bus Bar.

3.6.5.3. Sequence of Operation for BEV3

Step	Process
1	Get and install Double-Ended Stud.
2	Get and install BRFM to Bracket.
3	Get and install BRFM Sub assembly to Tray.
4	Scan BRFM Barcode

Equipment Callouts in Station EP080 Isometric View		
A	EP090SF1 - 3	Feeder (3)
B	EP090D1	Operator Console HMI
C	EP090BC1	Barcode Scanner and AGC Release Box
D	N/A	Automated Guided Cart
E	N/A	Wireway
F	N/A	Tool Balancer
G	EP090TC1- 5	Nutrunner
H	EP090TC1- 5	Nutrunner Controllers
I	AIRON	Air Preparation Unit
J	EP090E2	Operator Push Button Box
K	EP090RCP1	Electrical Outlet Box

3.6.6. EP100/EP120 Lower Module Load and Secure Station Description



3.6.6.1. Station Description

Cell EP100/EP120 is a fully automated station used to install and secure modules to the battery assemblies for both BET and BEV3 batteries.

The Automated Guided Cart enters the Cell at Station EP100 where modules in dunnage are delivered into the cell. The Load Modules Robot picks and places modules into the battery assemblies on the AGC. The AGC then moves forward into Station EP120 where the Module Fasten Robot secures the modules to the battery assembly with bolts. The AGC then moves forward and exits the station.

Figure 3-24. EP100/EP120 Lower Module Load and Secure Station Top View.

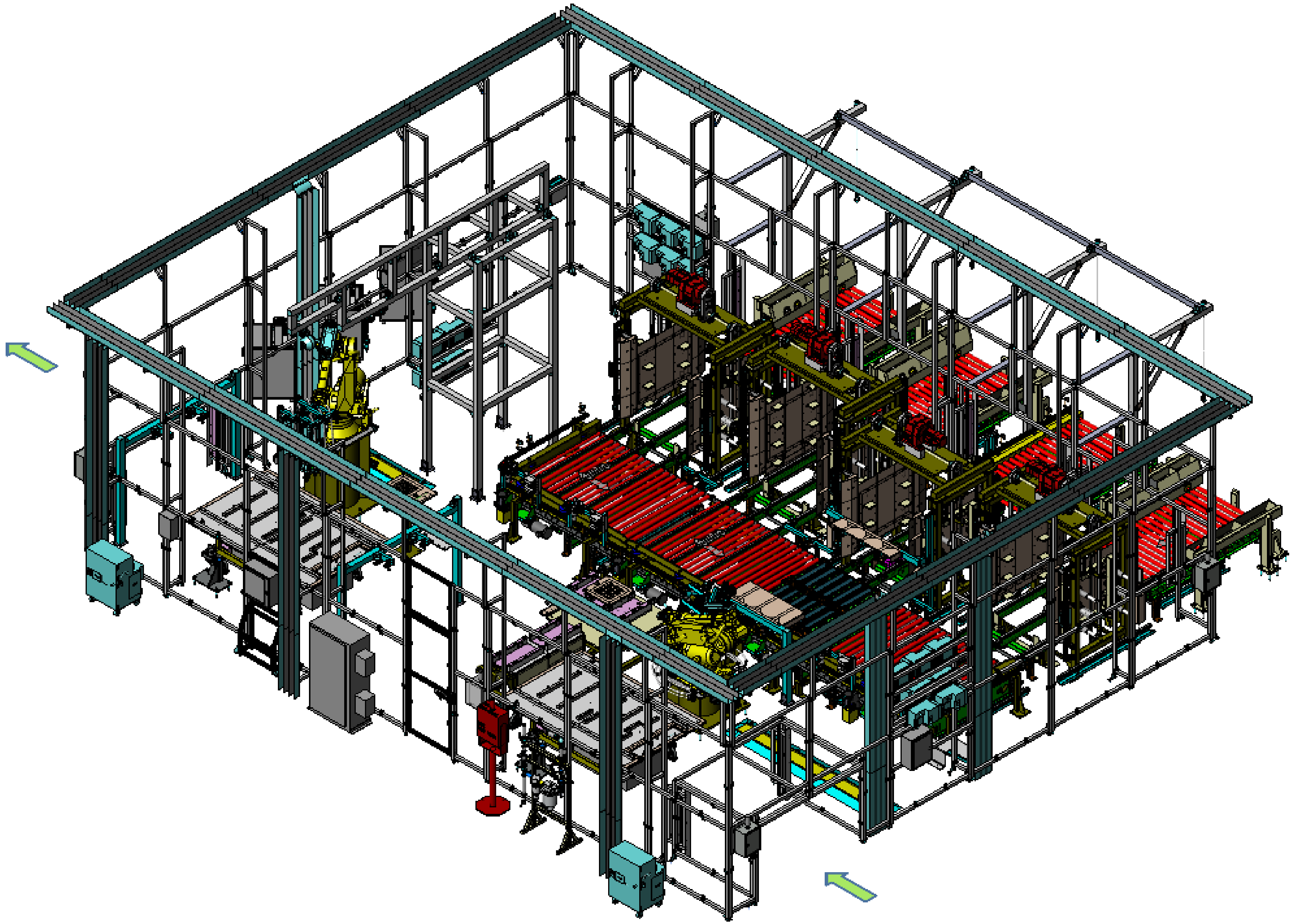
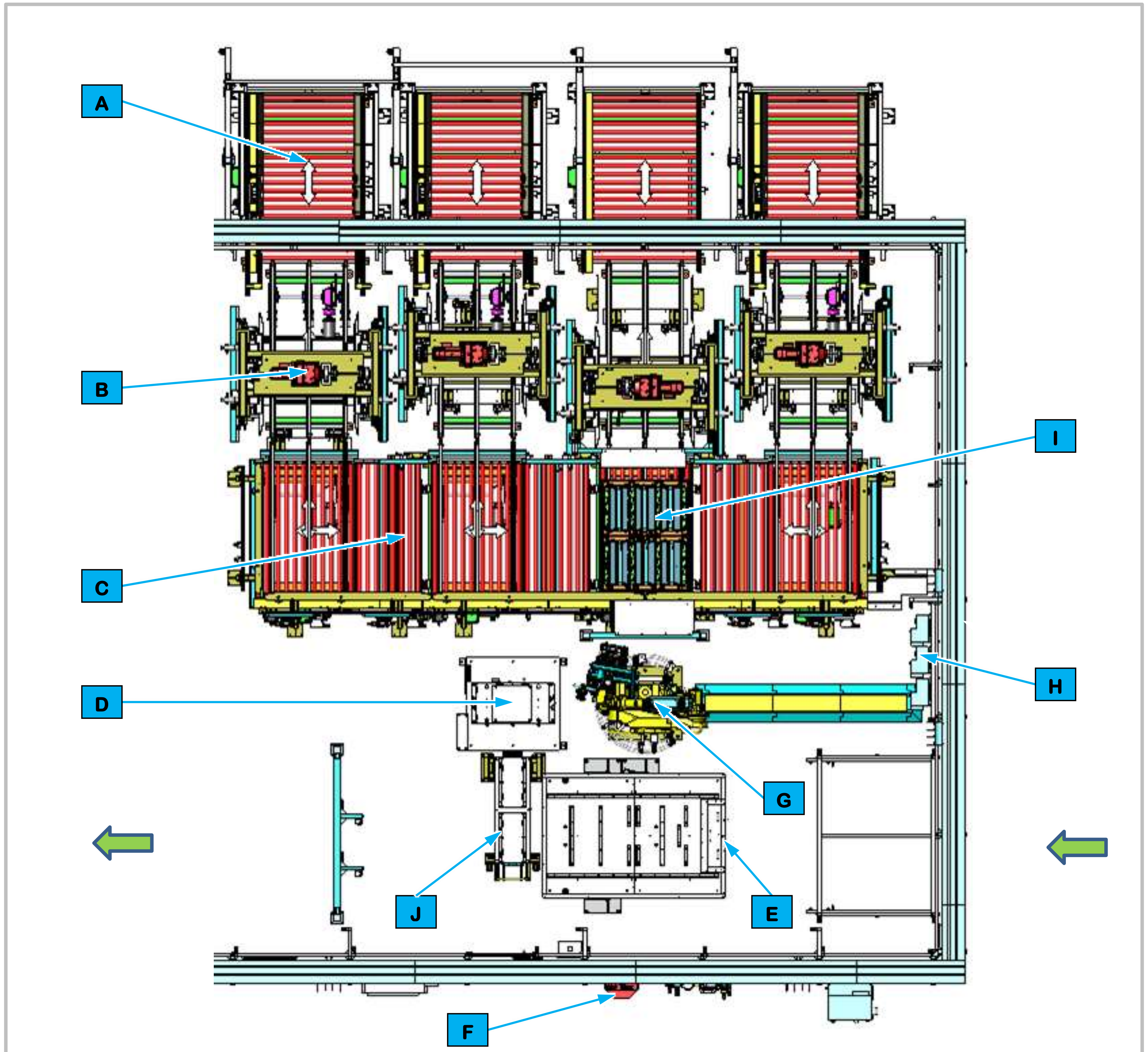


Figure 3-25. EP100/EP120 Lower Module Load and Secure Station Isometric View.



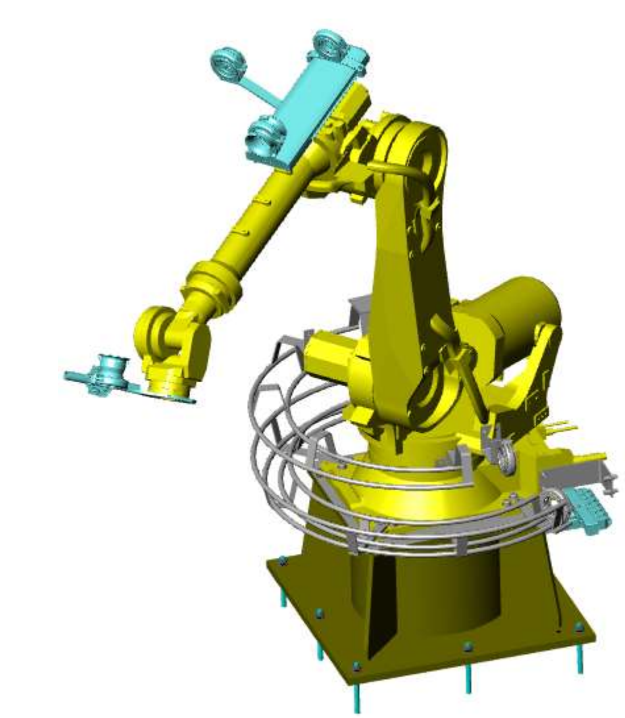
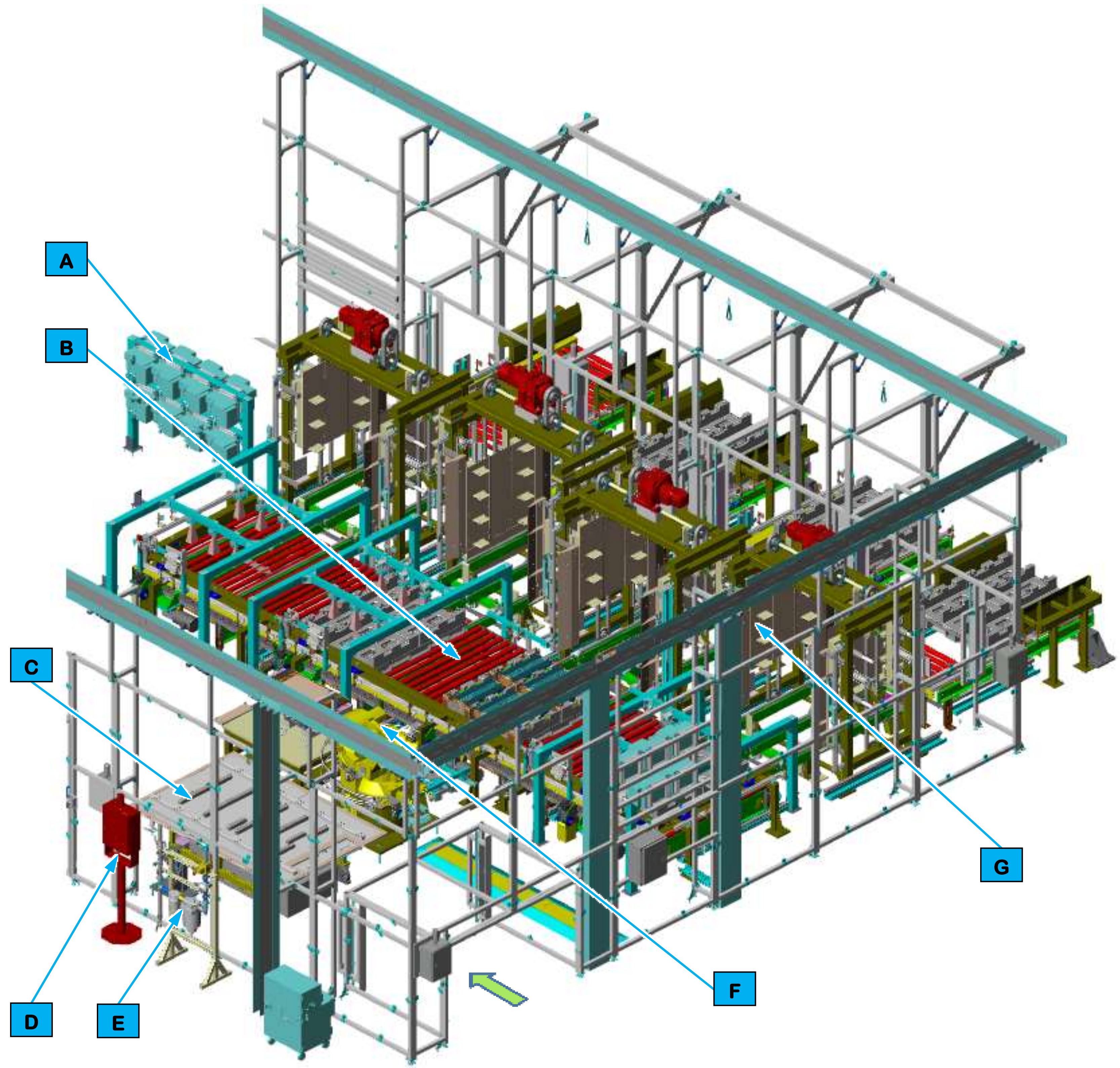


Figure 3-26. Module Load Robot

Equipment Callouts in Station EP100 Top View		
A	EP100T0XB01	Conveyors
B	N/A	Module Tray Stackers
C	EP100T0XB01	Cross Feed Conveyors
D	N/A	Spare Module Dial
E	N/A	Automated Guided Cart
F	EP100D1	Operator Console HMI
G	EP100R01	Module Load Robot
H	IDC1 -5	ArmorStart
I	N/A	Module Dunnage
J	N/A	NOK Module Tool Cart

Figure 3-27. EP100 Lower Module Load Station Top View.



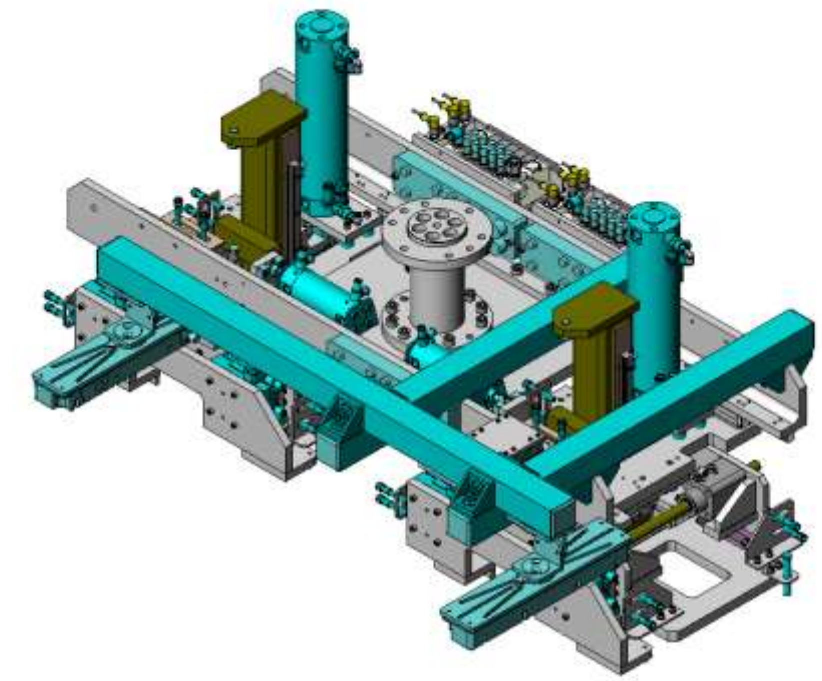


Figure 3-28. Load Module EOAT

Equipment Callouts in Station EP100 Isometric View		
A	EP100T0XB01 - IDCX	ArmorStart
B	EP100T0XB01	Cross Feed Conveyor
C	N/A	Automated Guided Cart
D	EP100D1	Operator Console HMI
E	AIRON	Air Preparation Unit
F	EP100R01	Module Load Robot
G	EP100T0XB01	Module Tray Stackers

Figure 3-29. EP100 Lower Module Load Station Isometric View.

3.6.6.2. Cell EP100 Sequence of Operation

The Lower Module Load Station equipment completes the following operations during a normal cycle:

1. The AGC enters Cell EP100 carrying a battery assembly.
2. The Module Load Robot (refer to callout **F** in ***Figure 3-29***) manipulates End of Arm Tooling (EOAT) to scan and pick two (2) modules from dunnage on Conveyor Equipment.
3. The Module Load Robot rotates to the waiting AGC.
4. The Module Load Robot uses vision cameras to align the EOAT holding the modules with the battery assembly.
5. The Module Load Robot lowers the EOAT to place the modules into the battery assembly.
6. The Module Load Robot raises to clear the battery assembly and rotates to the dunnage.
7. The Module Load Robot repeats steps 2 through 6 until the until the battery has a full complement of the appropriate modules depending on the type of battery assembly.
8. The Module Load Robot raises to clear of the battery assembly.
9. The AGC moves forward to Station EP120.

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

3.6.6.3. Module Load Robot and EOAT

Station EP100 contains one Module Load Robot (EP100R01). The FANUC R2000IC-210F (refer to ***Figure 3-26***) is a 6-axis robot with a load capacity of 462 lbs. Attached to the Module Load Robot is End of Arm Tooling (EOAT) used to scan and pick two (2) modules from dunnage, rotate to the waiting AGC, use vision cameras to algin the modules with the battery assembly, and then lowers the modules to the battery assembly. Having completed this operation, the Module Load Robot raises to clear the battery assembly and rotates back to the dunnage to pick another two (2) modules. The Module Load Robot will repeat this process until the appropriate number of modules have been placed into the battery assembly depending on the battery assembly type. Once the appropriate number of modules have been placed the Module Load Robot will raise the EOAT clear of the battery assembly allowing the AGC to move forward.

The Load Module EOAT (refer to ***Figure 3-28***) consists of a frame that holds linear lights, a camera, a scanner, and track mounted subframes holding pneumatic grippers and alignment pins. Two (2) opposing linear lights are mounted on one side of the frame with a FANUC iRVision camera used to vision align the EOAT with modules in dunnage and a barcode scanner used to scan modules are mounted between the linear lights. Attached to the frame are two track mounted subframes consisting of four (4) corner mounted pneumatic grippers and four (4) central mounted pneumatically actuated alignment pins.

When the EOAT is lowered to the modules in dunnage pneumatically actuated alignment pins are lowered to align the EOAT with the module and the grippers are actuated to pick two (2) modules from dunnage. The grippers and alignment pins remain in place while the Module Load Robot rotate from dunnage to the battery assembly on the AGC. The robot then lowers the modules to the battery assembly and the grippers and alignment pins retract releasing the modules.

REFERENCE	***For more information about the robot equipment, refer to the equipment supplier documentation (FANUC Robot R-2000 iC Operator's Manual).***

3.6.6.4. Module Tray Stacker System and Conveyor Equipment

The Module Tray Stacker System (EP100T02B01, refer to callout **G** in ***Figure 3-29***) consists of four (4) stacker assemblies, three (3) of the stackers are used to lift and hold module dunnage trays and deliver the trays one at a time into the cell and the fourth stacker is used to stack empty trays into a stack. Inside the cell a perpendicular conveyor (refer to callout **B** in ***Figure 3-29***) is used to transfer empty trays to the unload stacker.

Module dunnage trays are place onto the conveyor system outside of the cell in stacks of four (4) and are moved by power rollers into one (1) of the three (3) Module Tray Stackers. A module dunnage tray stack is moved by power rollers into the Module Tray Stacker and three (3) sets of lifting forks are advanced forward to grip and lift the top three (3) trays allowing the bottom fourth tray to be pulled into the cell. The Module Tray Stacker then lowers the stack of three (3) trays to the conveyor and retracts the lifting forks holding the bottom third tray allowing the third tray to be pulled into the cell. The Module Tray Stacker repeats this process for the remaining trays in the stack until the last tray of the stack has been released into the cell.

Empty module dunnage trays move along the conveyor system to the unload Module Tray Stacker of the system and the process is performed in reverse on the empty trays. Empty trays are lifted by lifting forks and held until a stack of four (4) trays has been created in the Module Tray Stacker and then the lifting forks are withdrawn. The stack of empty trays is then moved out of the Module Tray Stacker and out of the cell.

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 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 personnel 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 conveyor equipment, refer to the equipment supplier documentation (Omni Metalcraft Technical Handbook).***

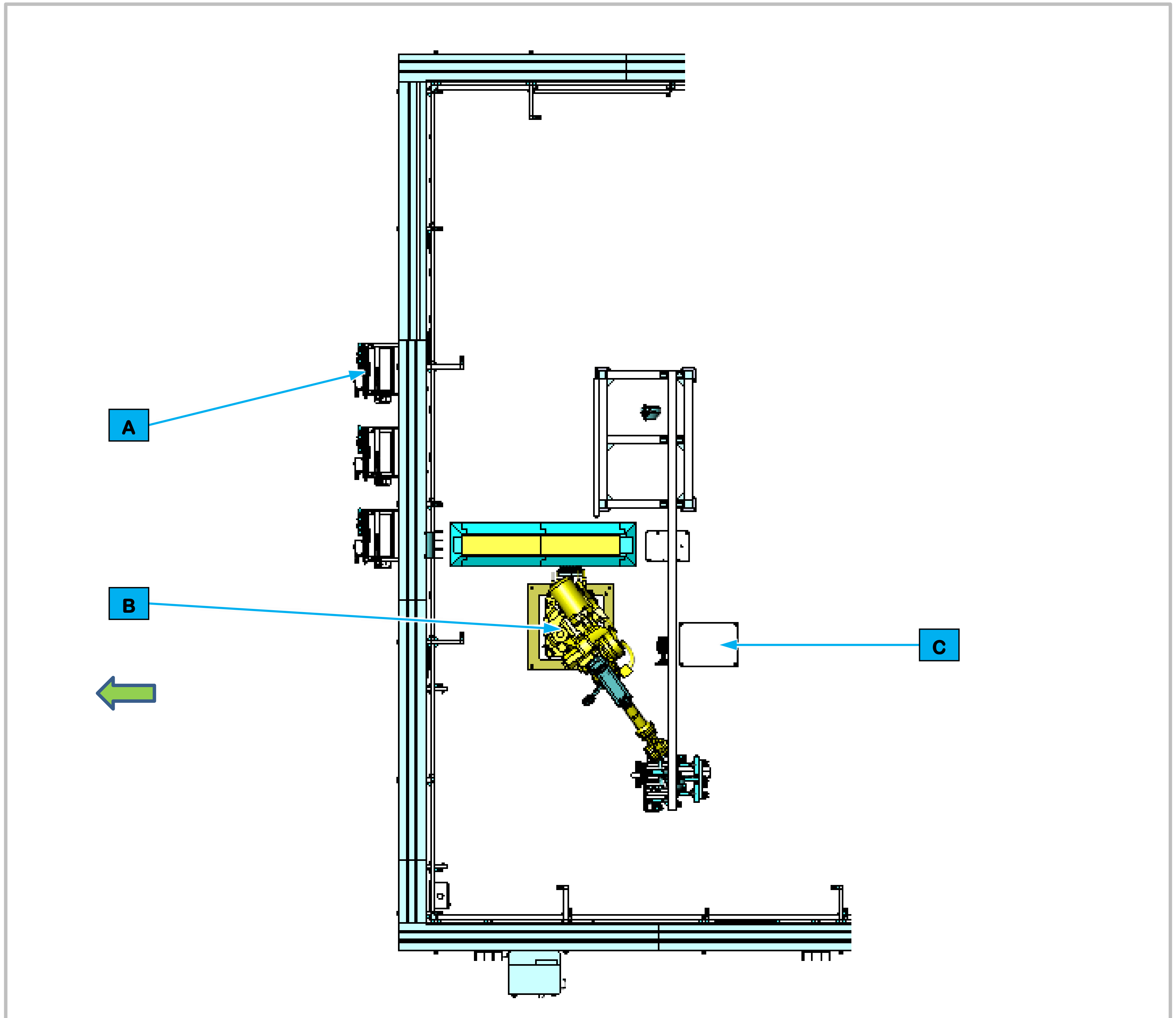


Figure 3-31. EP120 Lower Module Secure Station Top View.

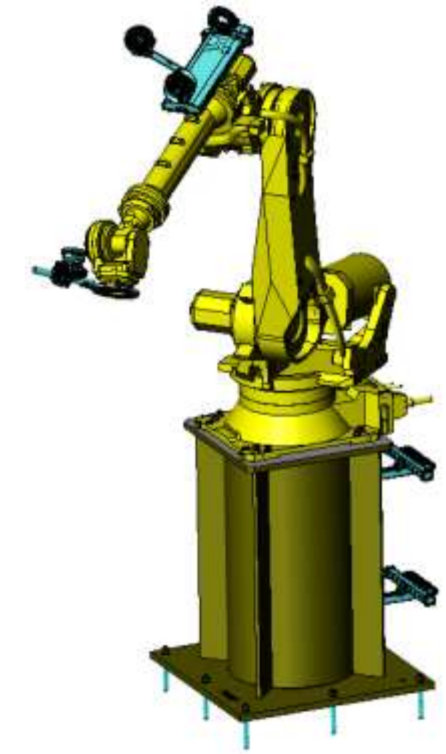


Figure 3-30. Module Secure Robot

Equipment Callouts in Station EP120 Top View		
A	EP120BF1 -3	Feeders
B	EP120R01	Module Secure Robot
C	N/A	Robot and Vision Calibration Stand

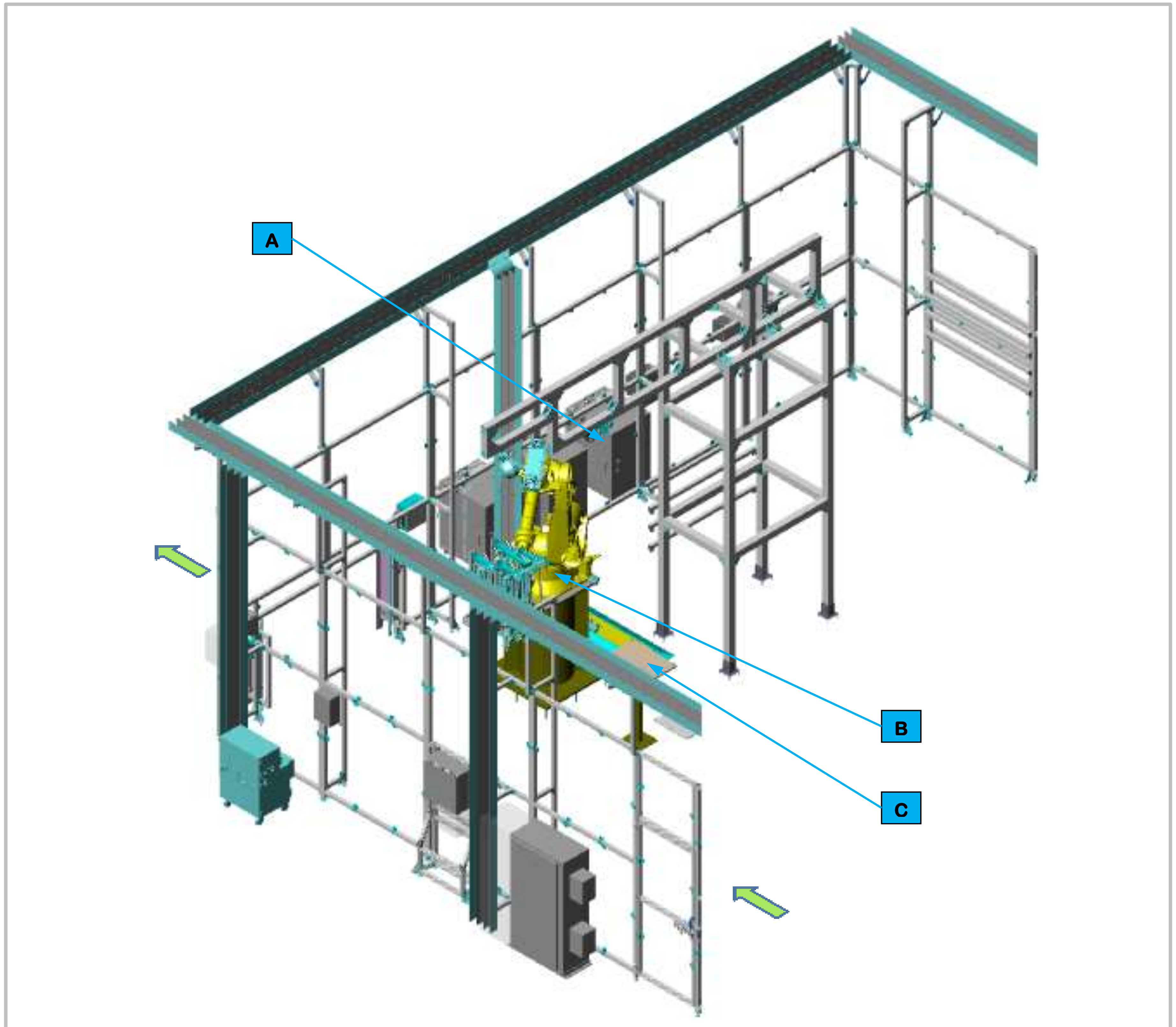


Figure 3-33. EP120 Lower Module Secure Station Isometric View.

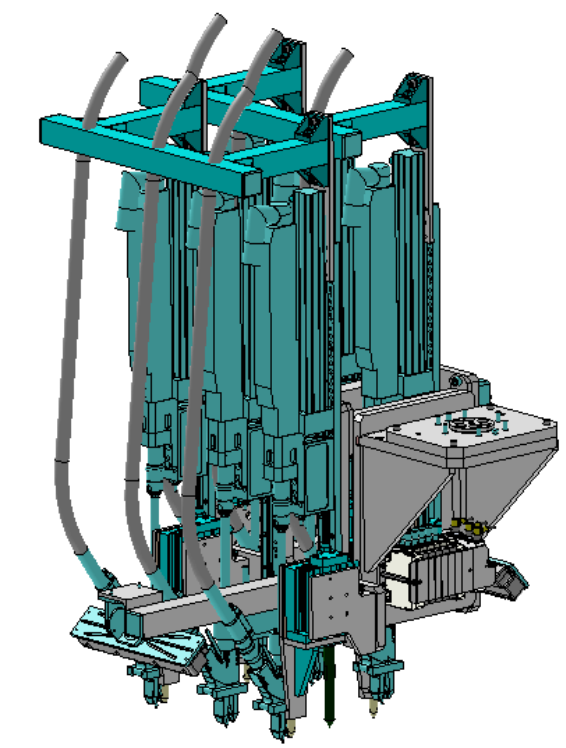


Figure 3-32. Module Secure EOAT

Equipment Callouts in Station EP120 Isometric View		
A	EP120BF1 -3	Fastener Feed System
B	EP120R01	Module Secure Robot
C	N/A	Robot and Vision Calibration Stand

3.6.6.5. Cell EP120 Sequence of Operation for BET

The Lower Module Secure Station equipment completes the following operations during a normal cycle:

1. The AGC enters Station EP120 from adjoined Station EP100.
2. The Module Secure Robot (refer to refer to callout **B** in ***Figure 3-33***) rotates and lowers to the battery assembly.
3. The Module Secure Robot manipulates vision aligned End of Arm Tooling (EOAT) to the modules.
4. The Module Secure Robot EOAT fastens the modules to the battery assembly with bolts.
5. The Module Secure Robot raises to clear the battery assembly.
6. The AGC moves forward to exit Station EP120.

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

3.6.6.6. Module Secure Robot and EOAT

Stations EP120 contains one Module Secure Robot (EP120R01). The FANUC R2000IC-210F (refer to ***Figure 3-30***) is a 6-axis robot with a load capacity of 462 lbs. The robot rotates and lowers the vision aligned EOAT to the battery assembly, receives blow-fed bolts to the EOAT and then fastens the bolts 6 at a time using drivers. Having completed this operation, the Module Load Robot raises to clear the battery assembly allowing the AGC to move forward and exit the cell.

The Module Secure EOAT (refer to ***Figure 3-28***) consists of frame that holds two (2) opposing light bars on each side with a center aligned FANUC iRVision camera. Within the frame are 2 rows of 3 drivers aligned beside each other allowing for 2 rows of 3 bolts to be secured at the same time. When the EOAT is lowered into the battery assembly the drivers are fed bolts that are vision aligned and torqued to a consistent value.

REFERENCE	***For more information about the robot equipment, refer to the equipment supplier documentation (FANUC Robot R-2000 iC Operator's Manual).***

3.6.6.7. Robot and Vision Calibration Stand

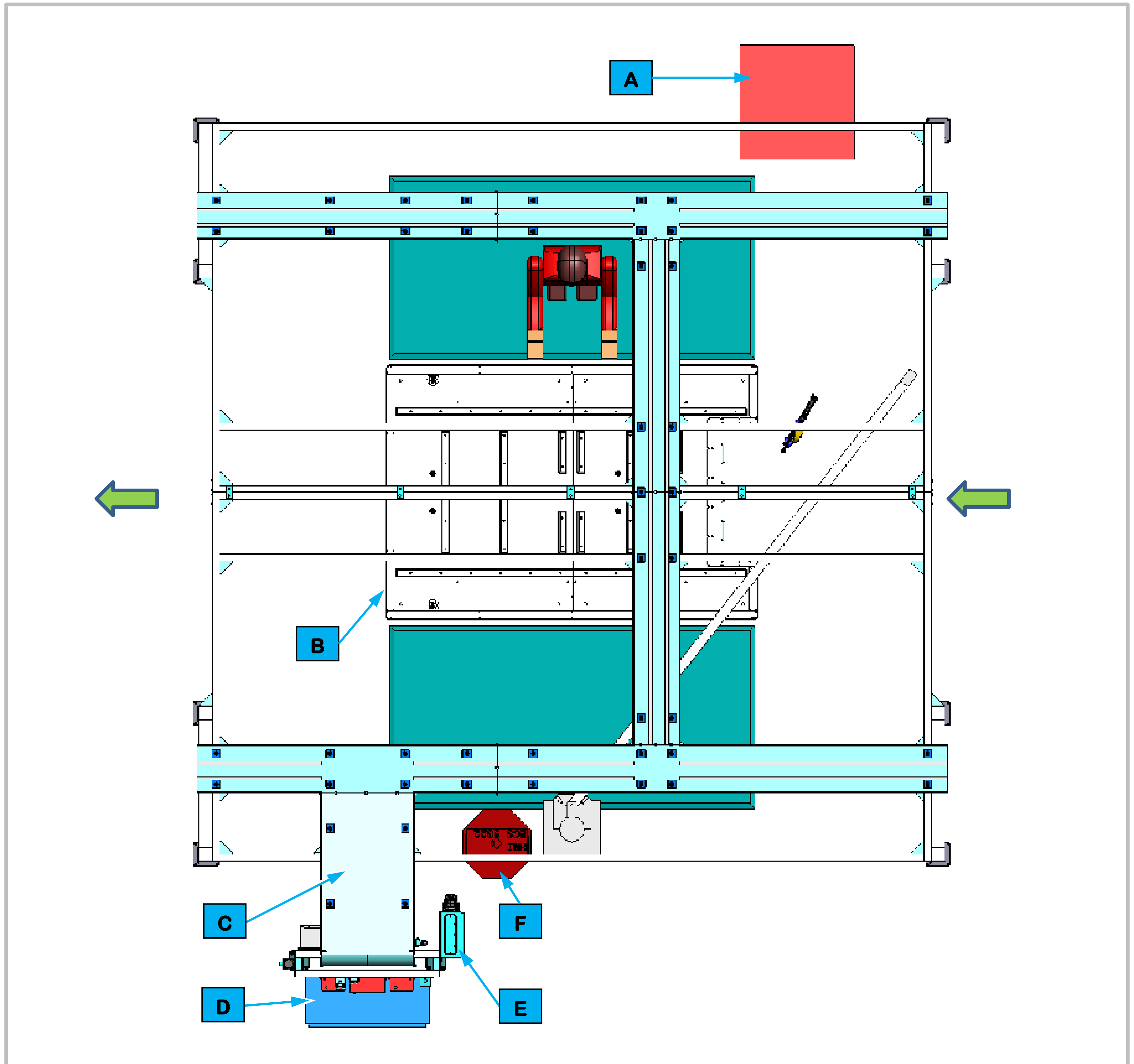
The Robot and Vision Calibration Stand (refer to callout **D** in ***Figure 3-27***) provides a calibration grid that is used as a reference when calibrating the robot and robot vision equipment. Calibration of the robot and robot vision equipment is documented in the associated FANUC documentation.

3.6.6.8. Fastener Feed System

The Carlson S12 Fastener Feed System (EP120BF1 -3, refer to callout **C** in ***Figure 3-29***) is an electrically motorized fastener assembly that sorts and aligns bolts into an inline track that are then blow fed into an air hose to the Midplate Fasten Robot EOAT.

REFERENCE	***For more information about fastener feed system equipment, refer to the equipment supplier documentation (Carlson S12 Technical Manual).***

3.6.7. EP125 Module Secure, Lower Deck Manual Repair Station Description



3.6.7.1. Station Description

Cell EP125 is a manual cell that adjoins automated Cell 100. An Operator makes required repairs to the module installation operation performed for both battery module types in Cell 100.

Equipment Callouts in Station EP125 Top View		
A	N/A	Dunnage
B	N/A	Automated Guided Cart
C	N/A	Wireway
D	EP125P1	Power Cabinet
E	EP125BC1	Barcode Reader
F	EP125D1	Operator Console HMI

Figure 3-34. EP125 Module Secure, Lower Deck Manual Repair Station Top View.

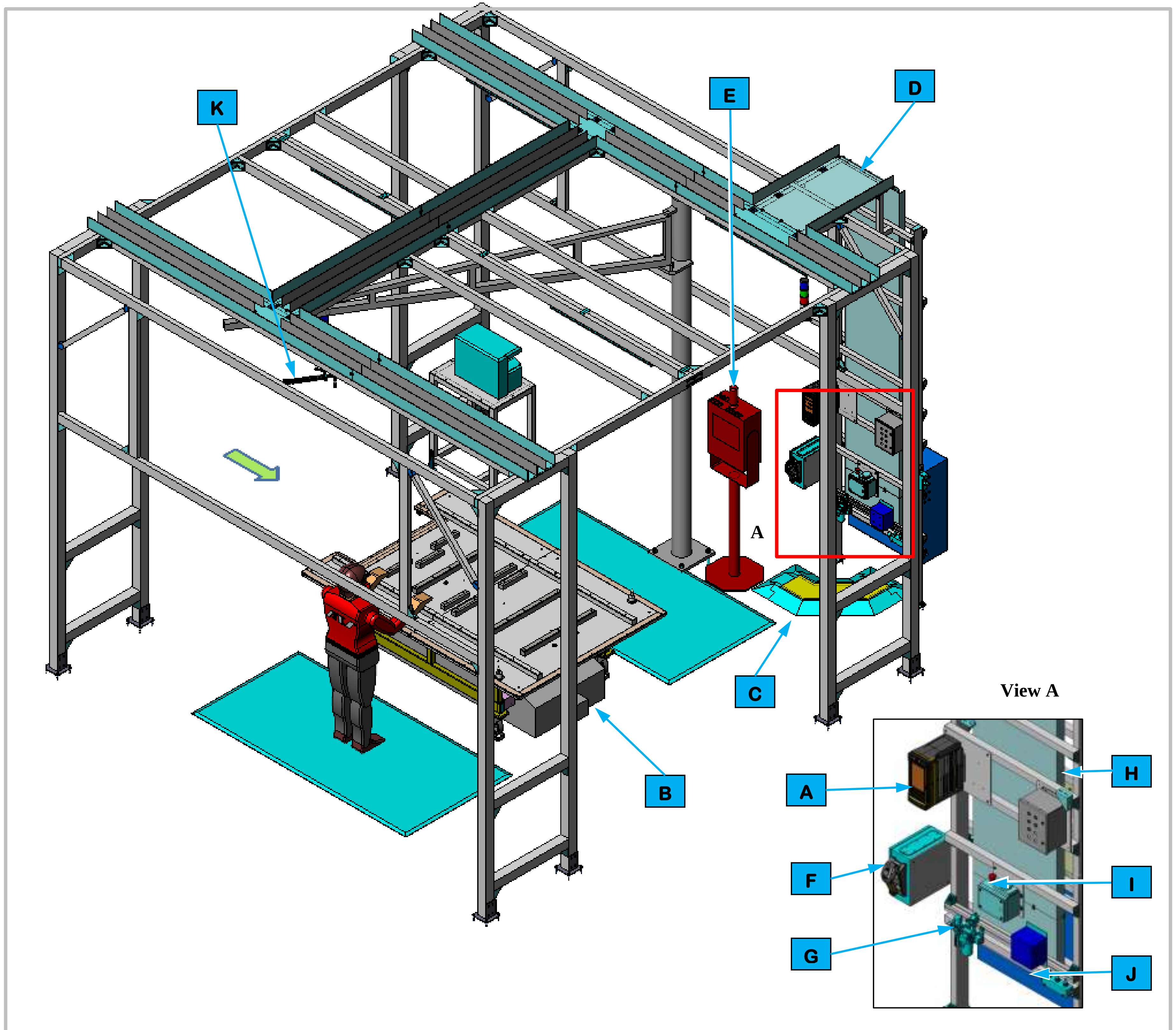


Figure 3-35. EP125 Module Secure, Lower Deck Manual Repair Station Isometric View

3.6.7.2. Sequence of Operation for BET

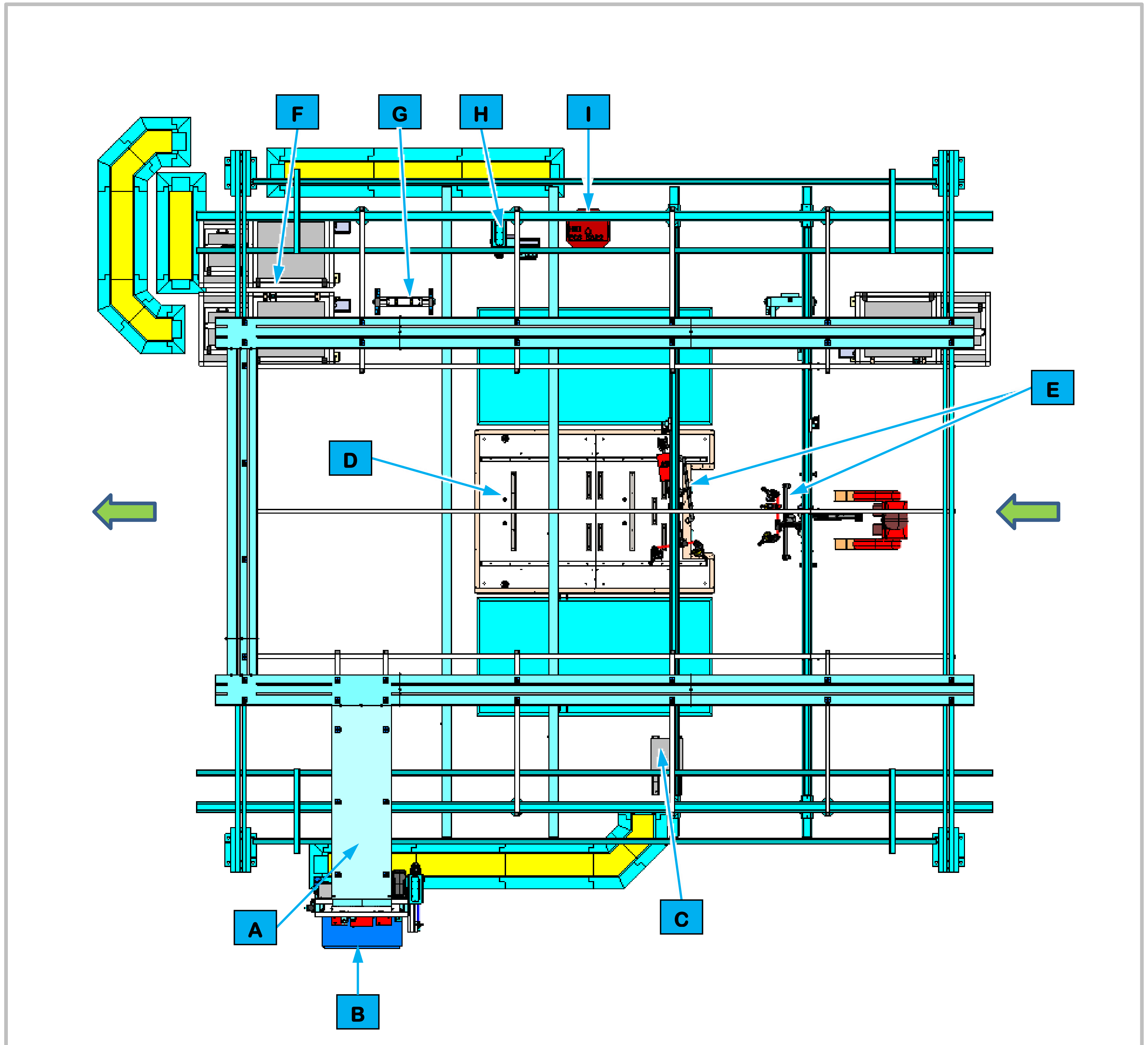
Step	Process
1	Follow repair procedure

3.6.7.3. Sequence of Operation for BEV3

Step	Process
1	Follow repair procedure

Equipment Callouts in Station EP125 Isometric View		
A	EP125TC1	Nutrunner Controller
B	N/A	Automated Guided Cart (AGC)
C	N/A	Cable Protector
D	N/A	Wireway
E	EP125D1	Operator Console HMI
F	EP125BC1	Barcode Reader
G	AIRON	Air Preparation Unit
H	EP125E2	Operator Push Button Box
I	EP125E1	Operator Release/E-Stop
J	EP125RCP1	Electrical Outlet Box
K	EP125TC1	Nutrunner

3.6.8. EP160 Coolant Inlet Install Station Description



3.6.8.1. Station Description

Cell EP160 is a manual station for attaching Battery Disconnect Units (BDU) to the battery pack and the Coolant Inlet.

For BET batteries an Operator installs and secures the Coolant Inlet to the battery pack and scans the BDU Barcode.

For BEV3 batteries the Operator installs and secures the BDU to the battery pack and scans the BDU Barcode.

Equipment Callouts in Station EP160 Top View		
A	N/A	Wireway
B	EP160P2	Power Cabinet
C	N/A	Charger Stand
D	N/A	Automated Guided Cart
E	EP160D1	Operator Console HMI
F	EP160SF1 - 3	Feeder (3)
G	N/A	Stand
H	EP160BC1	Barcode Scanner and AGC Release Box
I	EP160D1	Operator Console HMI

Figure 3-36. EP160 Coolant Inlet Install Station Top View.

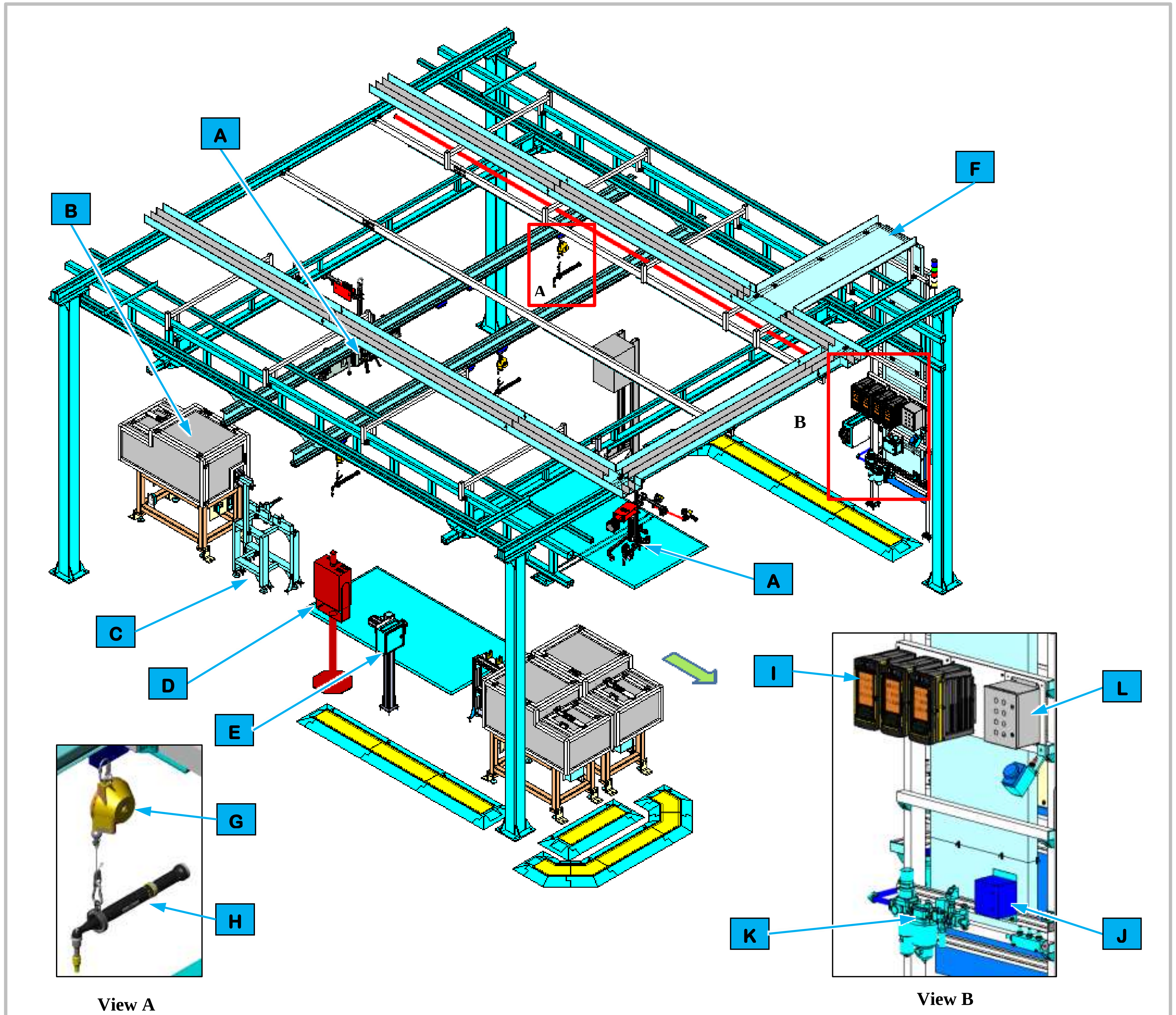


Figure 3-37. EP160 Coolant Inlet Install Station Isometric View

3.6.8.2. Sequence of Operation for BET

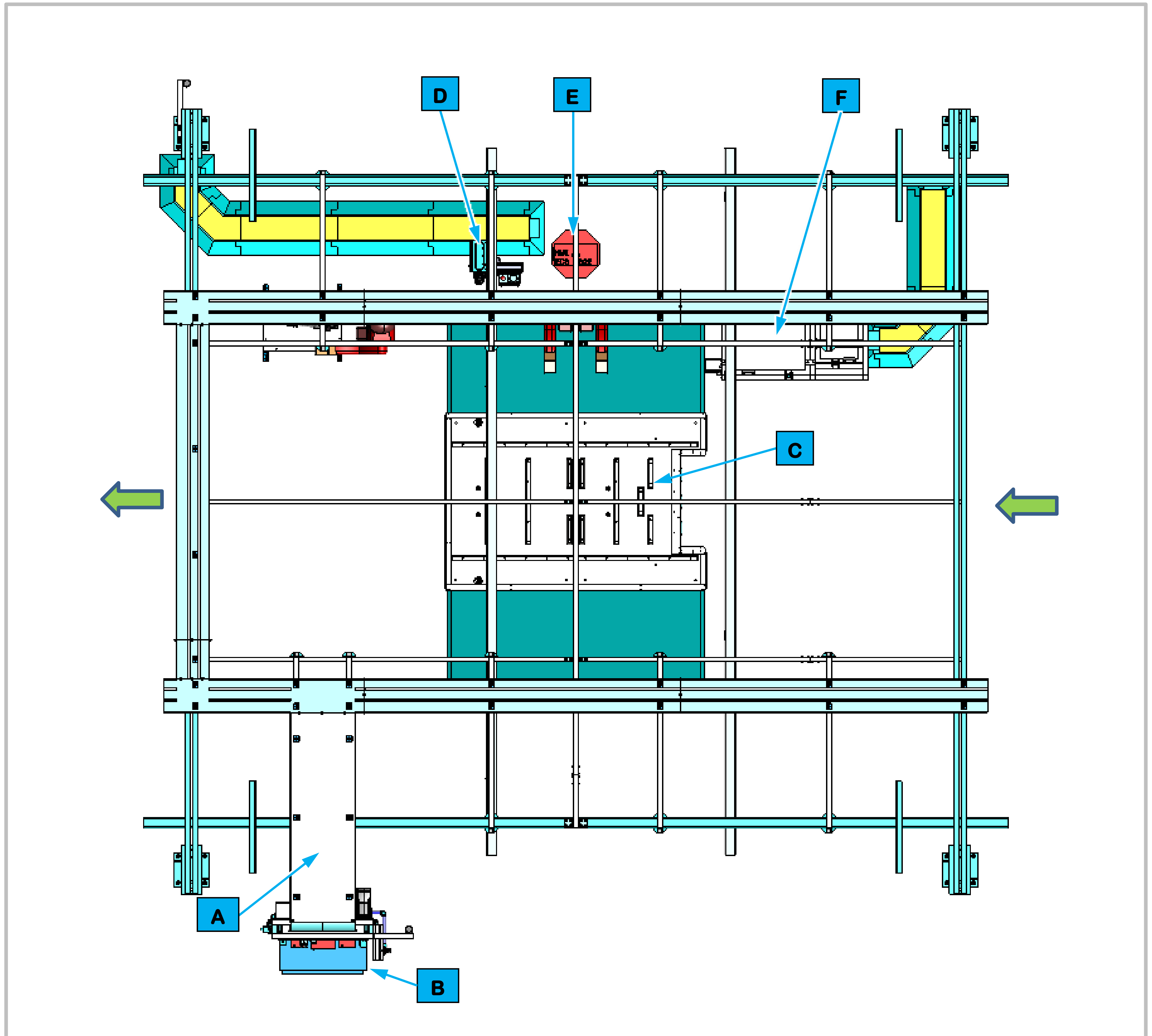
Step	Process
1	Get and install Coolant Inlet
2	Install Coolant Inlet to Cross-Rail Fastener Dispense
	Install Coolant Inlet to Tray Cross-Rail
	Get and install String B Bus Bar
	Get and install String B Bus Bar Mod Side.

3.6.8.3. Sequence of Operation for BEV3

Step	Process
1	Get and install BDU to battery assembly
2	Scan the BDU Barcode

Equipment Callouts in Station EP160 Isometric View		
A	N/A	Lift Assist (2)
B	EP160SF1 -3	Feeder (3)
C	N/A	Stand
D	EP160D1	Operator Console HMI
E	EP160BC1	Barcode Scanner and AGC Release Box
F	N/A	Wireway
G	N/A	Tool Balancer
H	EP160TC1 -3	Nutrunner
I	EP160TC1 -3	Nutrunner Controller
J	EP160RCP1	Electrical Outlet Box
K	AIRON	Air Preparation Unit
L	EP160E2	Operator Push Button Box

3.6.9. EP180 BDU Install Station Description



3.6.9.1. Station Description

Cell EP180 is a manual station for attaching the Diode Bracket, Positive and Negative Bus, BDU and Periscope Bus Bar.

For BET batteries an Operator gets and installs the BDU, the String B Bus Bar and the Periscope Bus Bar.

For BEV3 batteries the Operator gets and installs the Diode Bracket, the Positive and Negative Bus (POA Diode).

Equipment Callouts in Station EP180 Top View		
A	N/A	Wireway
B	EP180P2	Power Cabinet
C	N/A	Automated Console Cart (AGC)
D	EP180BC1	Barcode Scanner and AGC Release Box
E	EP180D1	Operator Console HMI
F	EP180SF1	Feeder

Figure 3-38. EP180 BDU Install Station Top View.

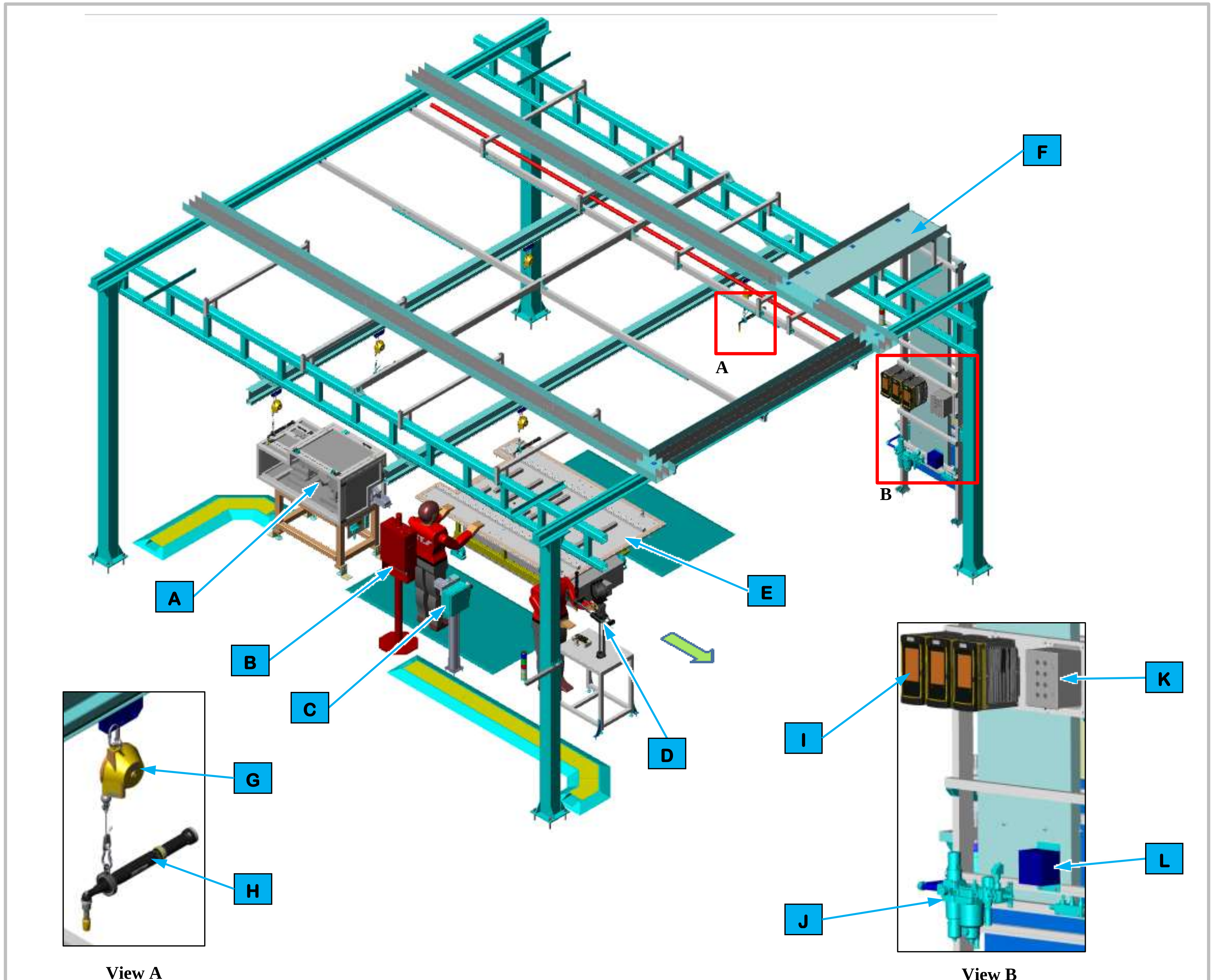


Figure 3-39. EP180 BDU Install Station Isometric View

3.6.9.2. Sequence of Operation for BET

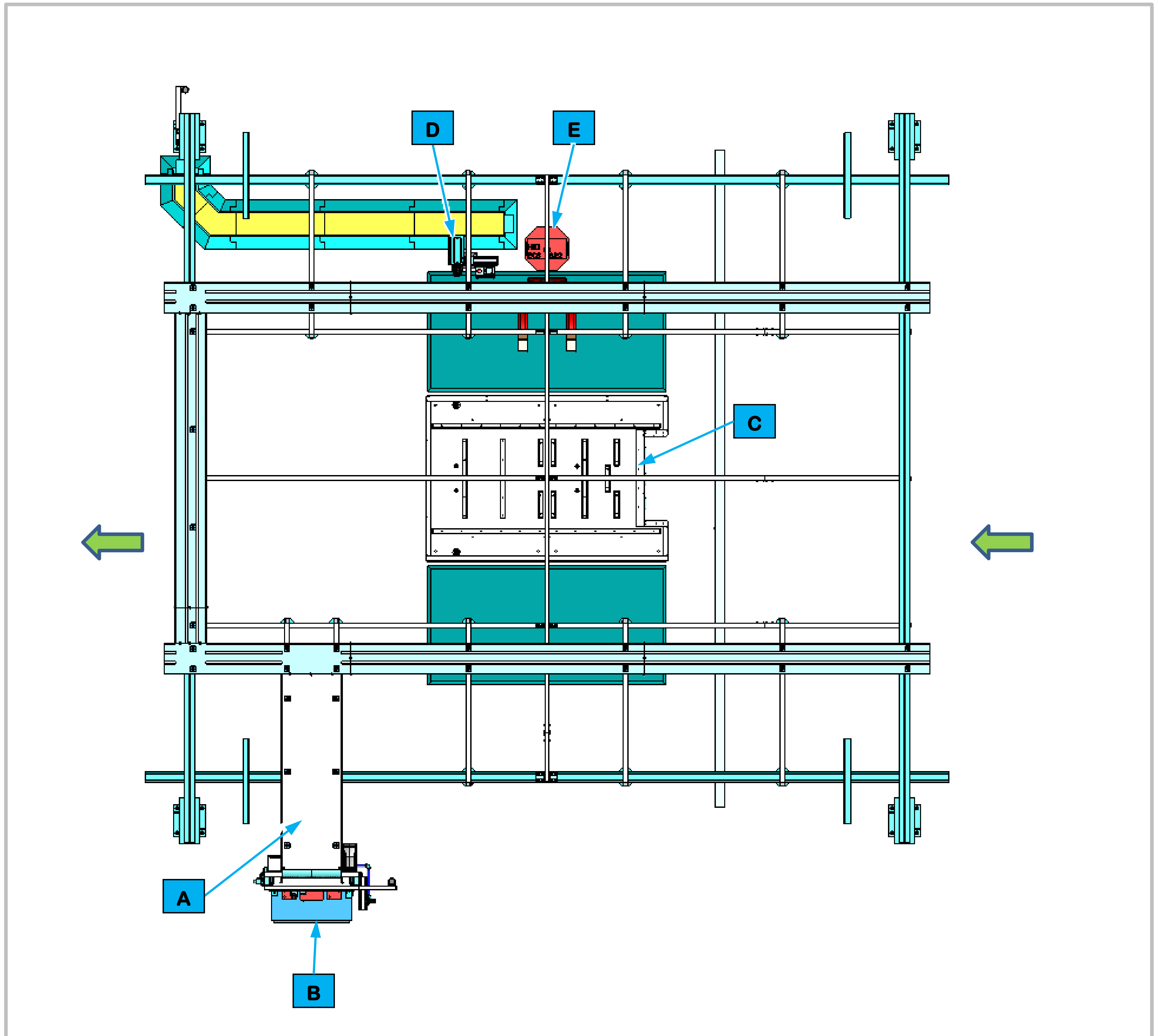
Step	Process
1	Get and Install the BDU
2	Scan BDU Barcode
3	Get and install the String B Bus Bar
4	Get and install the Periscope Bus Bar

3.6.9.3. Sequence of Operation for BEV3

Step	Process
1	Get and install the Diode Bracket
2	Get and install the Positive and Negative Bus (POA Diode)

Equipment Callouts in Station EP180 Isometric View		
A	EP180SF1	Feeder
B	EP180D1	Operator Console HMI
C	EP180BC1	Barcode Scanner and AGC Release Box
D	N/A	BFRM Bracket Fixture
E	N/A	Automated Console Cart (AGC)
F	N/A	Wireway
G	N/A	Tool Balancer
H	EP180TC1- 3	Nutrunner
I	EP180TC1- 3	Nutrunner Controllers
J	AIRON	Air Preparation Unit
K	EP180E2	Operator Push Button Box
L	EP180RCP1	Electrical Outlet Box

3.6.10. EP200 Coolant Outlet Install Station Description



3.6.10.1. Station Description

Cell EP200 is a manual station for attaching the BDU, LV Harness, and the Coolant Outlet.

For BET batteries the Operator gets and installs the BDU, and the Coolant Hoses

For BEV3 batteries the Operator gets and installs the BDU, and the LV Harness.

Equipment Callouts in Station EP200 Top View		
A	N/A	Wireway
B	EP200P2	Power Cabinet
C	N/A	Automated Guided Cart (AGC)
D	EP200BC1	Barcode Scanner and AGC Release Box
E	EP200D1	Operator Console HMI

Figure 3-40. EP200 Coolant Outlet Install Station Top View.

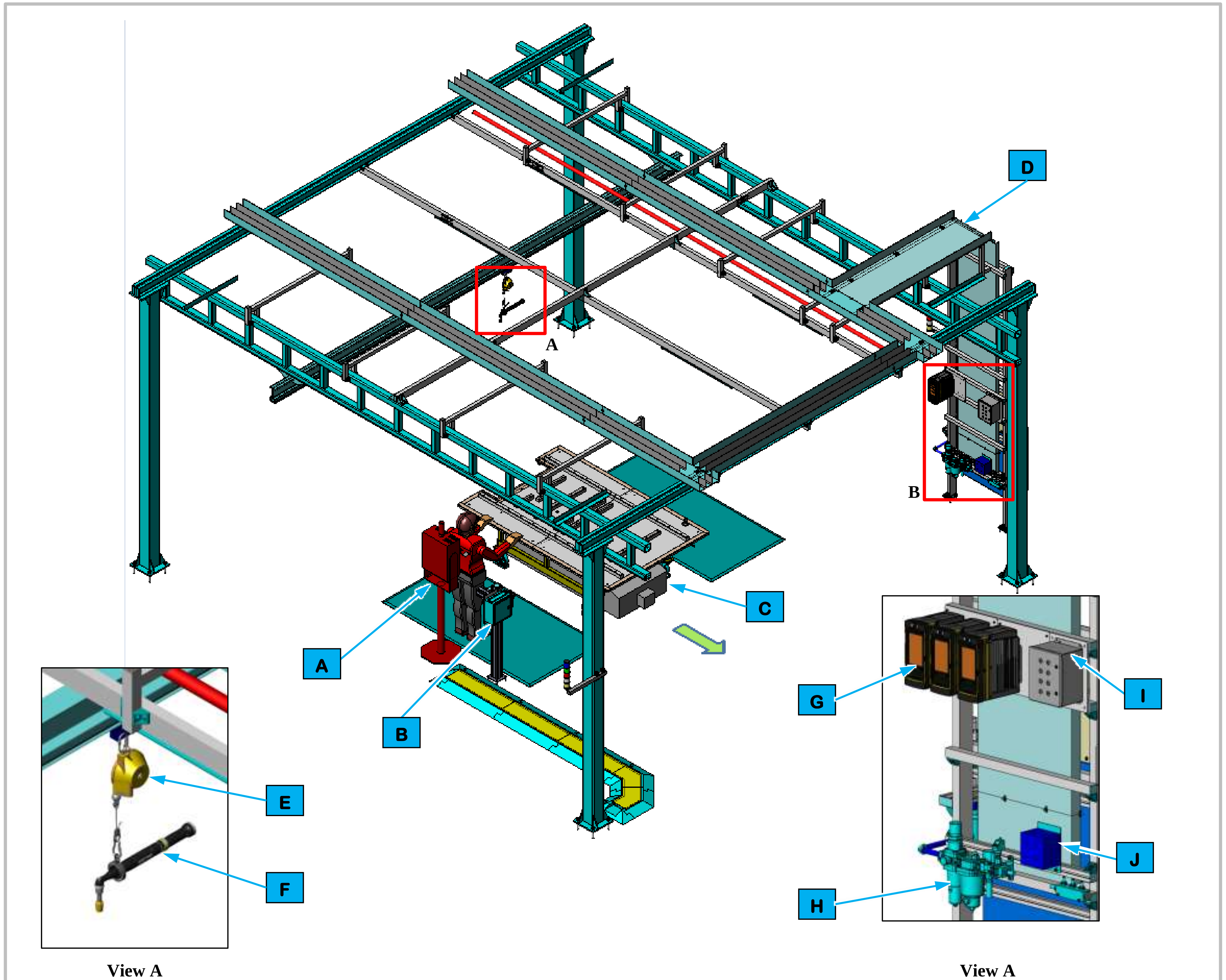


Figure 3-41. EP200 Coolant Outlet Install Station Isometric View

3.6.10.2. Sequence of Operation for BET

Step	Process
1	Get and install the BDU
2	Get and install Coolant Outlet

3.6.10.3. Sequence of Operation for BEV3

Step	Process
1	Get and install the BDU
2	Get and install the LV Harness

Equipment Callouts in Station EP200 Isometric View		
A	EP200D1	Operator Console HMI
B	EP200BC1	Barcode Scanner and AGC Release Box
C	N/A	Automated Ground Cart (AGC)
D	N/A	Wireway
E	N/A	Tool Balancer
F	EP200TC1- 3	Nutrunner
G	EP200TC1- 3	Nutrunner Controllers
H	AIRON	Air Preparation Unit
I	EP200E2	Operator Push Button Box
J	EP20RCP1	Electrical Outlet Box

3.6.11. EP220 BRFM and BDU Awning Install Station Description

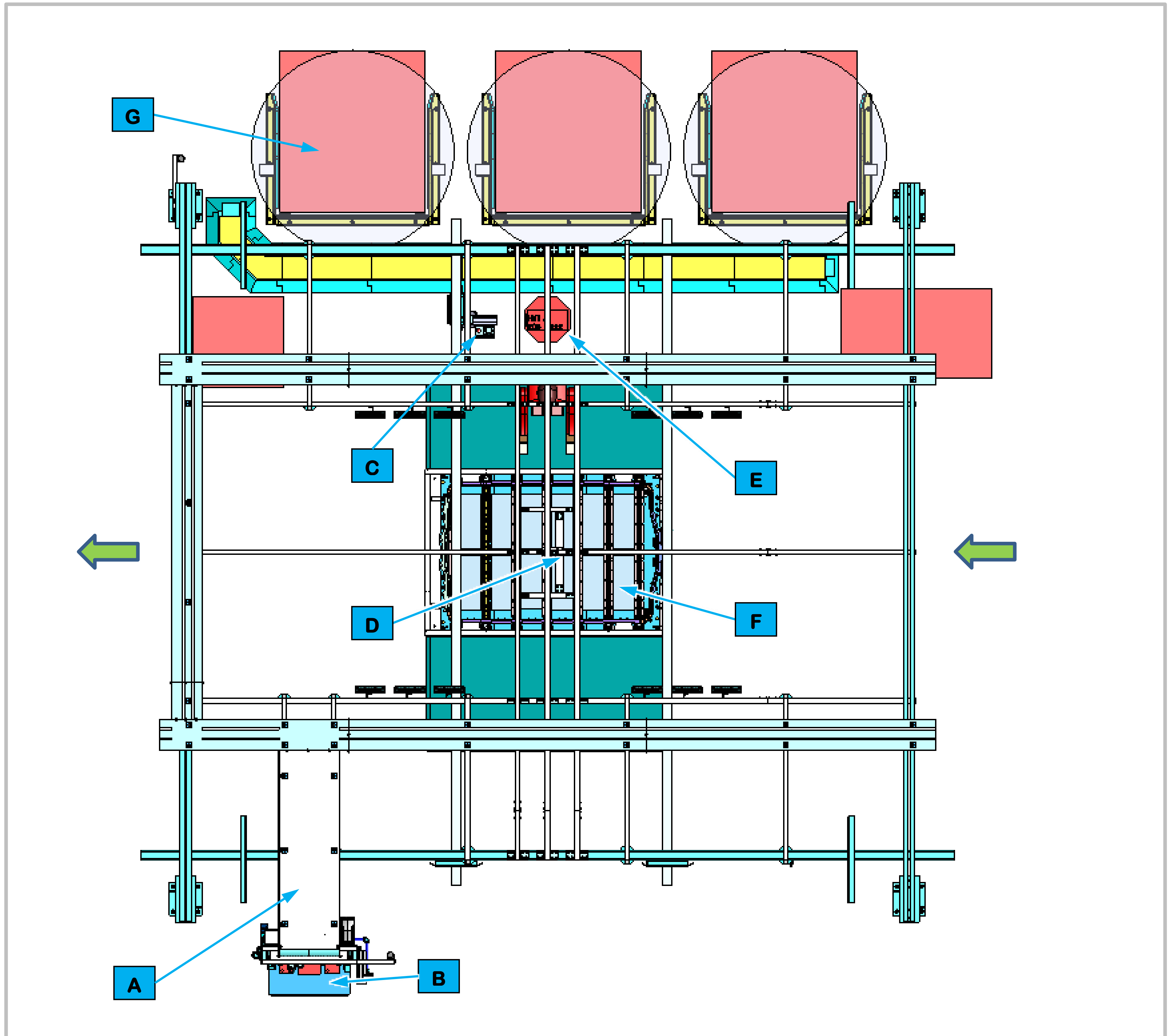


Figure 3-42. EP220 BRFM and BDU Awning Install Station Top View.

3.6.11.1. Station Description

Cell EP220 is a manual station for attaching the BDU, Midpack Bus Bar, BRFM, BDU LWB or SWB Awning

For BET batteries an Operator gets and installs the BRFM and BDU LWB or SWB Awning

For BEV3 batteries the Operator gets and installs the BDU, and the Midpack Bus Bar.

Equipment Callouts in Station EP220 Top View		
A	N/A	Wireway
B	EP220P2	Power Cabinet
C	EP220BC1	Barcode Scanner and E-Stop
D	EP220C1	Inspection Camera
E	EP220D1	Operator Console HMI
F	N/A	Automated Guided Cart (AGC)
G	N/A	Dunnage

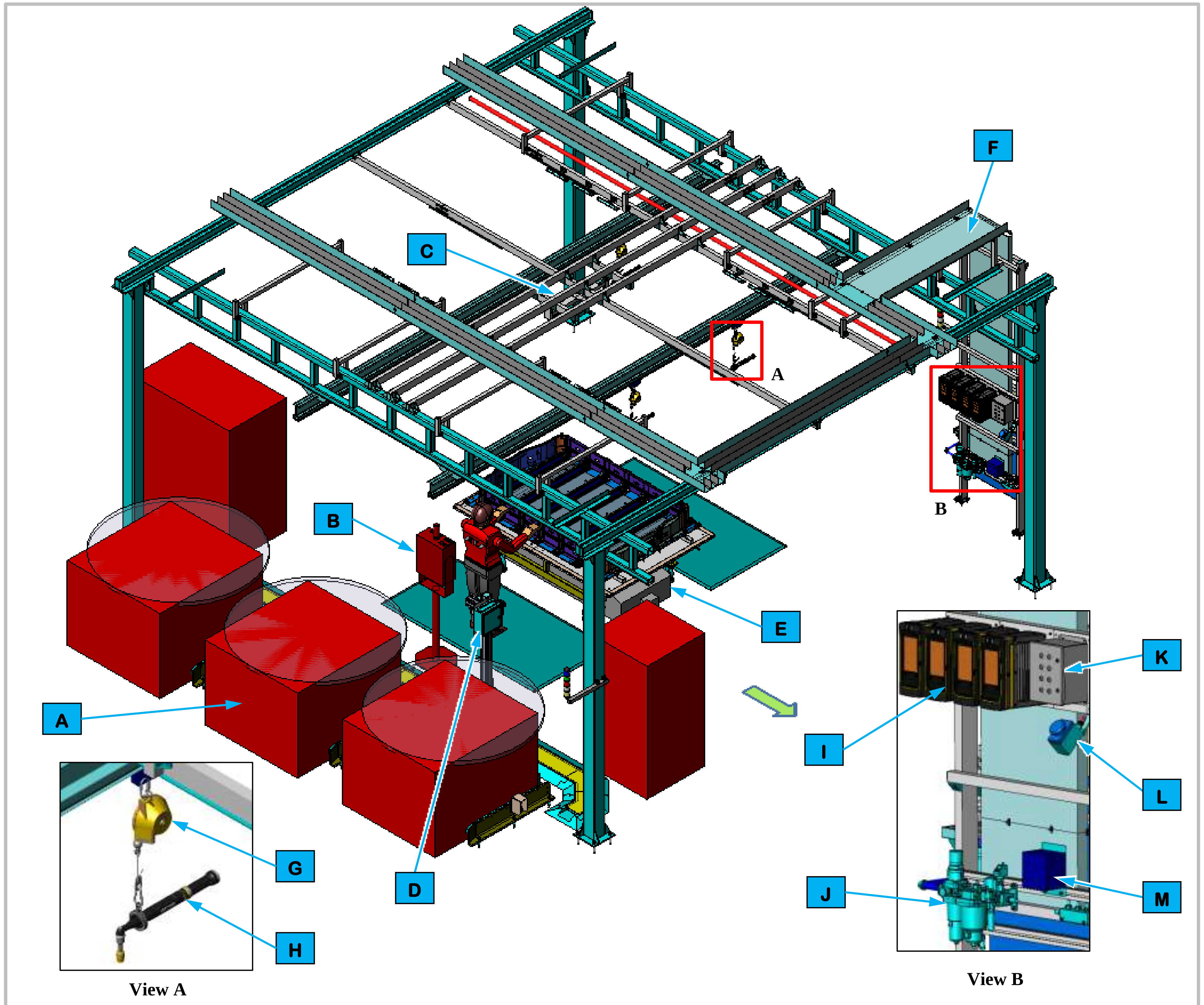


Figure 3-43. EP220 BRFM and BDU Awning Install Station Isometric View

3.6.11.2. Sequence of Operation for BET

Step	Process
1	Get and install BRFM
2	Scan and trace BRFM Barcode
3	Get and install BDU Awning

3.6.11.3. Sequence of Operation for BEV3

Step	Process
1	Get and install the BDU
2	Get and install the Midpack Bus Bar
3	Scan and trace Midpack Bus Bar

Equipment Callouts in Station EP220 Isometric View		
A	N/A	Dunnage
B	EP220D1	Operator Console HMI
C	EP220C1	Inspection Camera
D	EP220BC1	Barcode Scanner and E-Stop
E	N/A	Automated Guided Cart (AGC)
F	N/A	Wireway
G	N/A	Tool Balancer
H	EP220TC1- 4	Nutrunner
I	EP220TC1- 4	Nutrunner Controllers
J	AIRON	Air Preparation Unit
K	EP220E2	Operator Push Button Box
L	EP220E1	Operator Release
M	EP220RCP1	Electrical Outlet Box

3.6.12. EP230 Lower Bus Bar Install and Secure Station Description

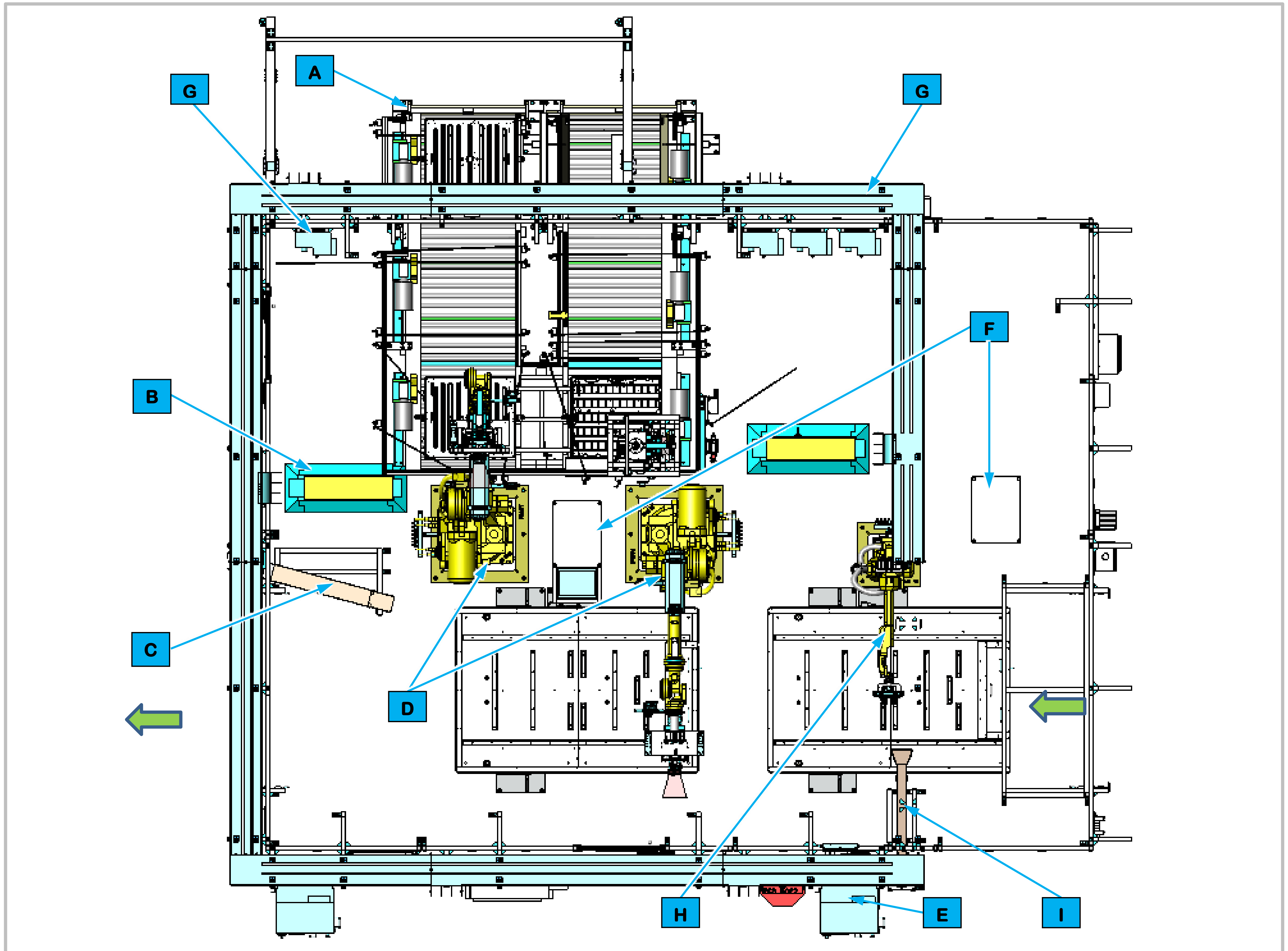


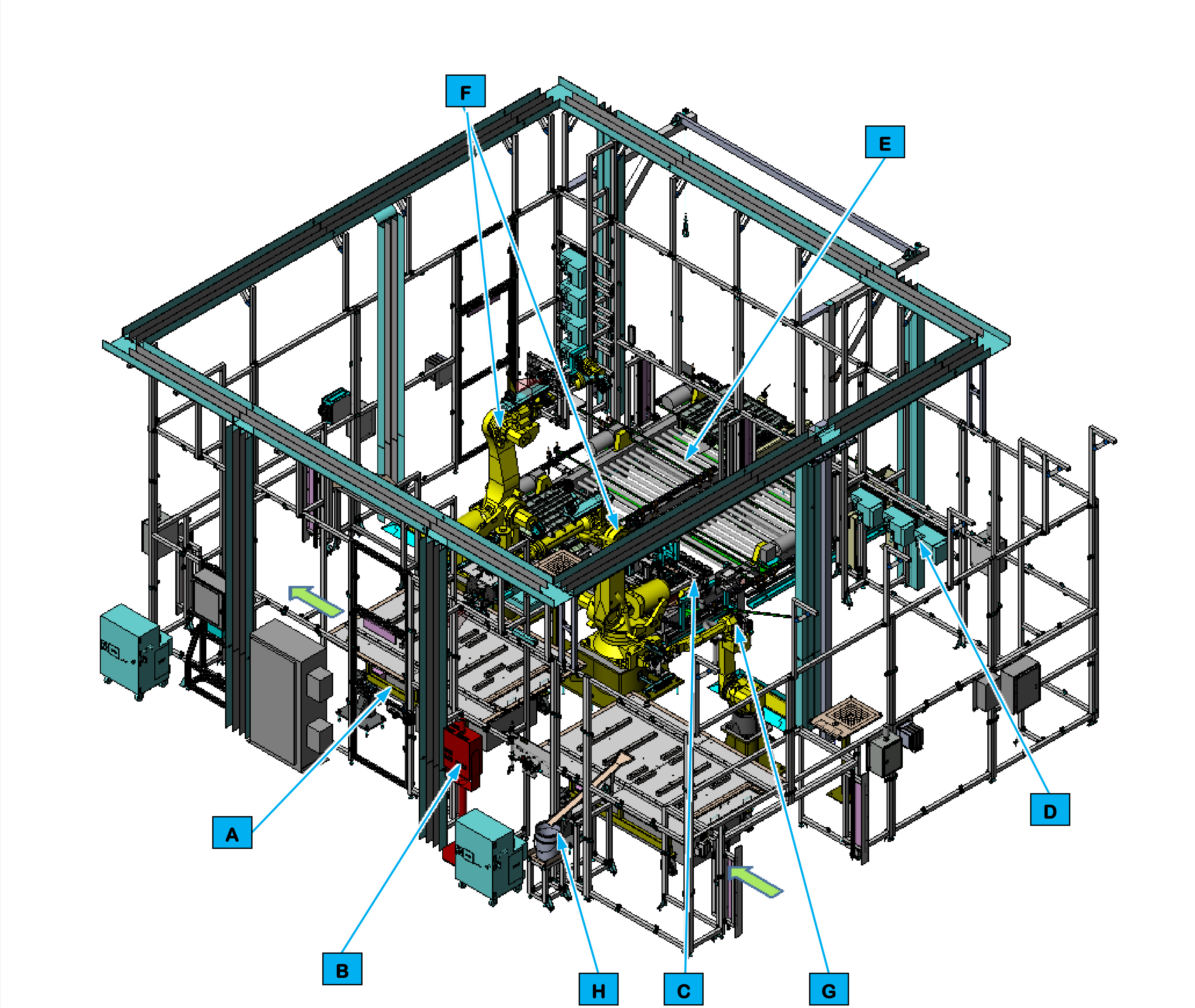
Figure 3-44. EP230 Lower Bus Bar Install and Secure Top View.

3.6.12.1. Station Description

Cell EP230 is a fully automated station used to install and secure bus bars onto the modules for BET and BEV3 modules.

The Automated Guided Cart enters the station where bus bars in dunnage are delivered into the cell. One Terminal End Cap Robot removes the caps from the modules. Two Bus Bar Load and Secure Robots pick bus bars from dunnage and place them onto the modules of the battery assembly. The Bus Bar and Secure Robots then use EOAT drivers to secure the bus bars. The Robots repeat this process until the appropriate number of bus bars have been placed and secured for the type of battery assembly worked on. The AGC then moves forward and exits the station.

Equipment Callouts in Station EP230 Top View		
A	EP230T01B01	Conveyors
B	N/A	Cable Protector (2)
C	N/A	Bus Bar Repair Chute
D	EP230R01- 2	Bus Bar Load and Secure Robot (2)
E	EP230D1	Operator Console HMI
F	N/A	Robot and Vision Calibration Stand
G	IDC1 -7	ArmorStart
H	EP230R03B01	End Cap Robot
I	N/A	End Cap Chute



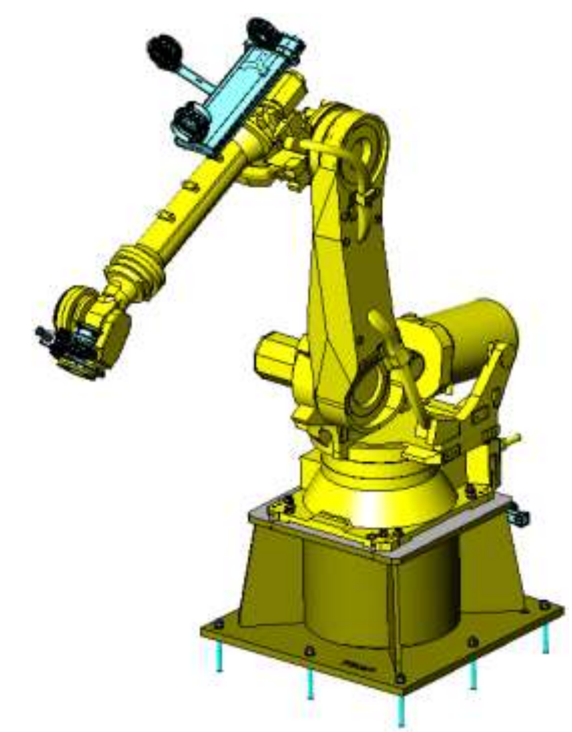
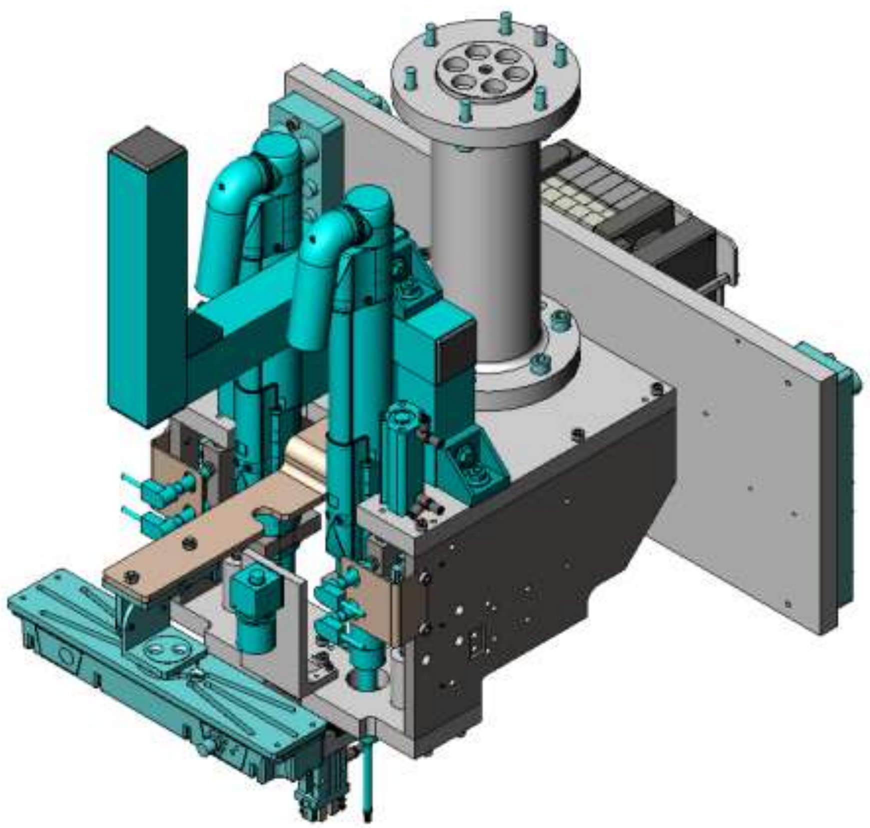


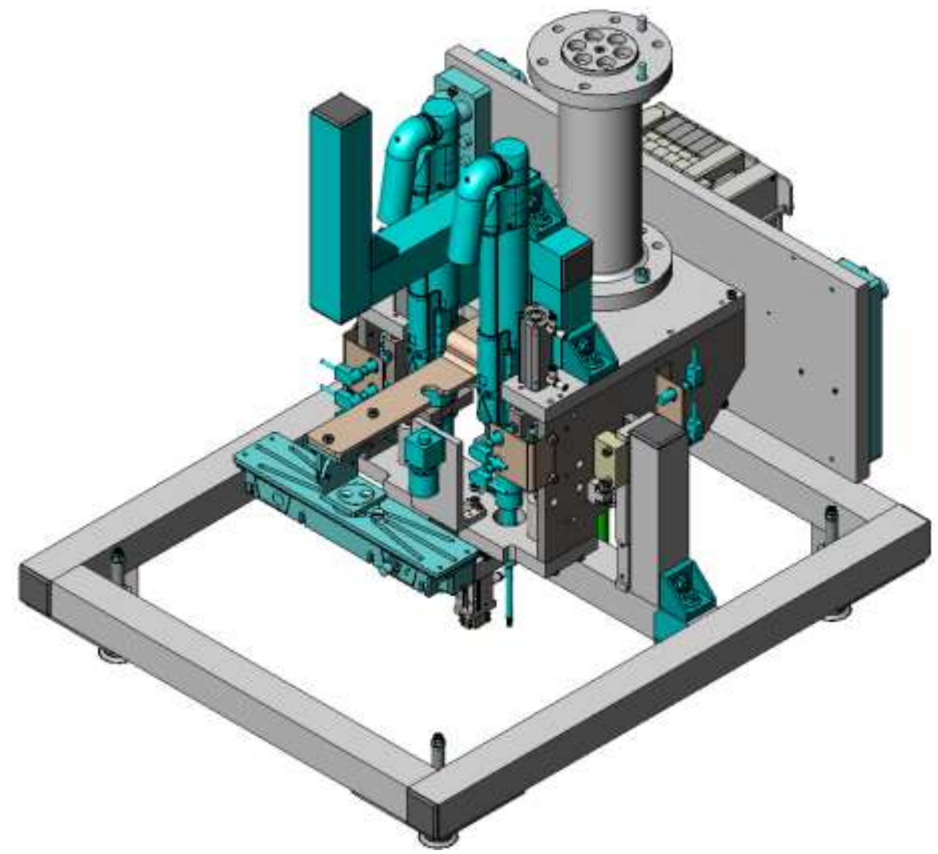
Figure 3-45. Bus Bar Load and Secure Robot

Equipment Callouts in Station 230 Isometric View		
A	N/A	Automated Guided Cart
B	EP230D1	Operator Console HMI
C	N/A	Bus Bar Dunnage
D	IDC1 -7	ArmorStart
E	EP230T01B01	Conveyors
F	EP230R01- 2	Bus Bar Load and Secure Robot (2)
G	EP230R03B01	End Cap Robot
H	N/A	End Cap Chute

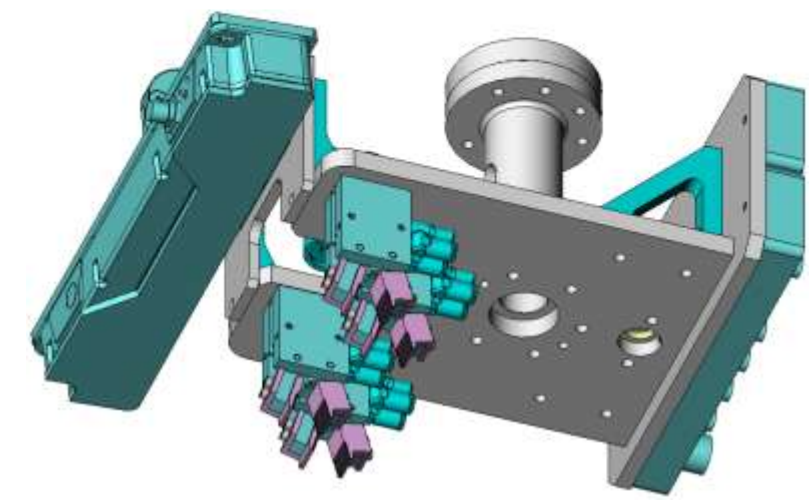
Figure 3-46. EP230 Lower Bus Bar Install and Secure Isometric View



Bus Bar Load and
Secure EOAT
(Without Tray Gripper)



Bus Bar Load and
Secure EOAT
(With Tray Gripper)



End Cap

EOAT

Figure 3-47. EP230 Lower Bus Bar Install and Secure End of Arm Tool View

3.6.12.2. Cell EP230 Sequence of Operation

The Lower Bus Bar Install and Secure Station equipment completes the following operations during a normal cycle:

Note: Two (2) Bus Bar Load and Secure Robots perform the same actions.

1. The AGC enters Cell EP230 carrying a battery assembly.
2. The End Cap Robot removes the End Cap from the Battery Assembly and places the End Caps on the Cap Chute.
3. The Bus Bar Load and Secure Robot (refer to callout **F** in ***Figure 3-34)*** manipulates End of Arm Tooling (EOAT) to pick bus bars from dunnage on Conveyor Equipment.
4. The Bus Bar Load and Secure Robot rotates to the waiting AGC.
5. The Bus Bar Load and Secure Robot uses a vision camera to align the EOAT holding a bus bar with the battery assembly.
6. The Bus Bar Load and Secure Robot lowers the EOAT to the place a bus bar into the battery assembly.
7. The Bus Bar Load and Secure Robot uses attached drivers to fasten the bus bar to the battery assembly with bolts.
8. The Bus Bar Load and Secure Robot raises to clear the battery assembly and rotates to the dunnage.
9. The Bus Bar Load and Secure Robot repeats steps 2 through 7 until the correct number of bus bars are placed into the battery assembly depending on the type of battery assembly.
10. The Bus Bar Load and Secure Robot raises to clear the battery assembly.
11. The AGC moves forward and exits the Cell.

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

3.6.12.3. Module Load Robot and EOAT

Cell EP230 contains two Bus Bar Load and Secure Robots (EP230R01 and 2). The FANUC R2000IC-210F (refer to ***Figure 3-45***) is a 6-axis robot with a load capacity of 462 lbs. Attached to a Bus Bar Install and Secure Robot is End of Arm Tooling (EOAT) used to pick a bus bar from dunnage, rotate to the waiting AGC, use a vision camera to algin the bus bar with the battery assembly, and then lowers the bus bar to the battery assembly. Having completed this operation, the Bus Bar Install and Secure Robot raises to clear the battery assembly and rotates back to the dunnage to pick another bus bar. The Bus Bar Install and Secure Robot will repeat this process until the appropriate number of bus bars have been placed into the battery assembly depending on the battery assembly type. Once the appropriate number of bar bars have been placed the Bus Bar Install and Secure Robot raise the EOAT clear of the battery assembly allowing the AGC to move forward.

Two Bus Bar Install and Secure Robots work on the same battery assembly on an AGC at the same time within this Cell with one of the one of the Robot's EOAT equipped with a vacuum pad tray gripper that allows the Robot to transfer an empty tray from the infeed conveyor and places it on the outfeed conveyor allowing for a full dunnage tray to move forward.

The Bus Bar Install and Secure EOAT (refer to ***Figure 3-47***) consists of a frame that holds a center aligned linear light, a FANUC iRVision camera used to scan bus bar and align the bus bars with modules within the battery assembly. A center mounted bus bar gripper uses two (2) pneumatic actuators to close two (2) gripper pads to pick a bus bar from dunnage. Before the bus bar is placed onto modules within the battery assembly, the EOAT scans the modules to find an appropriate location for the bus bar and then places the busbar into the battery assembly. The EOAT will then use two (2) attached drivers located on both sides of the gripper to secure bolts that are attached to the bus bar. The two (2) pneumatic actuators motors then open the (2) gripper pads to release the bus bar.

If after scanning the modules within the battery assembly the EOAT does not find an appropriate location to place the bus bar, the Bus Bar Install and Secure Robot will rotate to the Repair Chute and place the bus bar into the Repair Chute.

Attached to one of the Bus Bar Install and Secure EOATs is an outer square frame that consists of five (5) vacuum pads attached to a vacuum generator with four (4) vacuum pads located at each corner of the frame and a center mounted pad. When a bus bar dunnage tray on the infeed conveyor has been emptied of bus bars, this robot will rotate to the empty tray and manipulate attached EOAT to the empty tray. When the EOAT is lowered to the empty tray the vacuum pads are activated by the vacuum generator to apply suction again the empty tray to pick the tray. The robot then raises and rotates to the outfeed conveyor and lowers the tray to the conveyor. The EOAT then stops the vacuum generator releasing the empty tray from the vacuum pads.

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

REFERENCE	***For more information about the robot equipment, refer to the equipment supplier documentation (FANUC Robot R-2000 iC Operator's Manual).***

3.6.12.4. Robot and Vision Calibration Stand

The Robot and Vision Calibration Stand (refer to callout **F** in ***Figure 3-44***) provides a calibration grid that is used as a reference when calibrating the robot and robot vision equipment. Calibration of the robot and robot vision equipment is documented in the associated FANUC documentation.

3.6.12.5. Bus Bar Repair Chute

The Bus Bar Repair Chute (refer to callout **C** in ***Figure 3-44***) is a sloped channel where unusable bus bars are placed by one Bus Bar Load and Secure Robot after the robot attempt to place the bus bar on battery assembly but cannot find an appropriate module. The other Bus Bar Load and Secure Robot uses a bin to place any bus bar that cannot be placed into a module.

3.6.12.6. Conveyor Equipment

The Conveyor Equipment (EP230T01B01, refer to callout **E** in ***Figure 3-34***) transfers dunnage carrying bus bars into the cell and empty dunnage out of the cell.

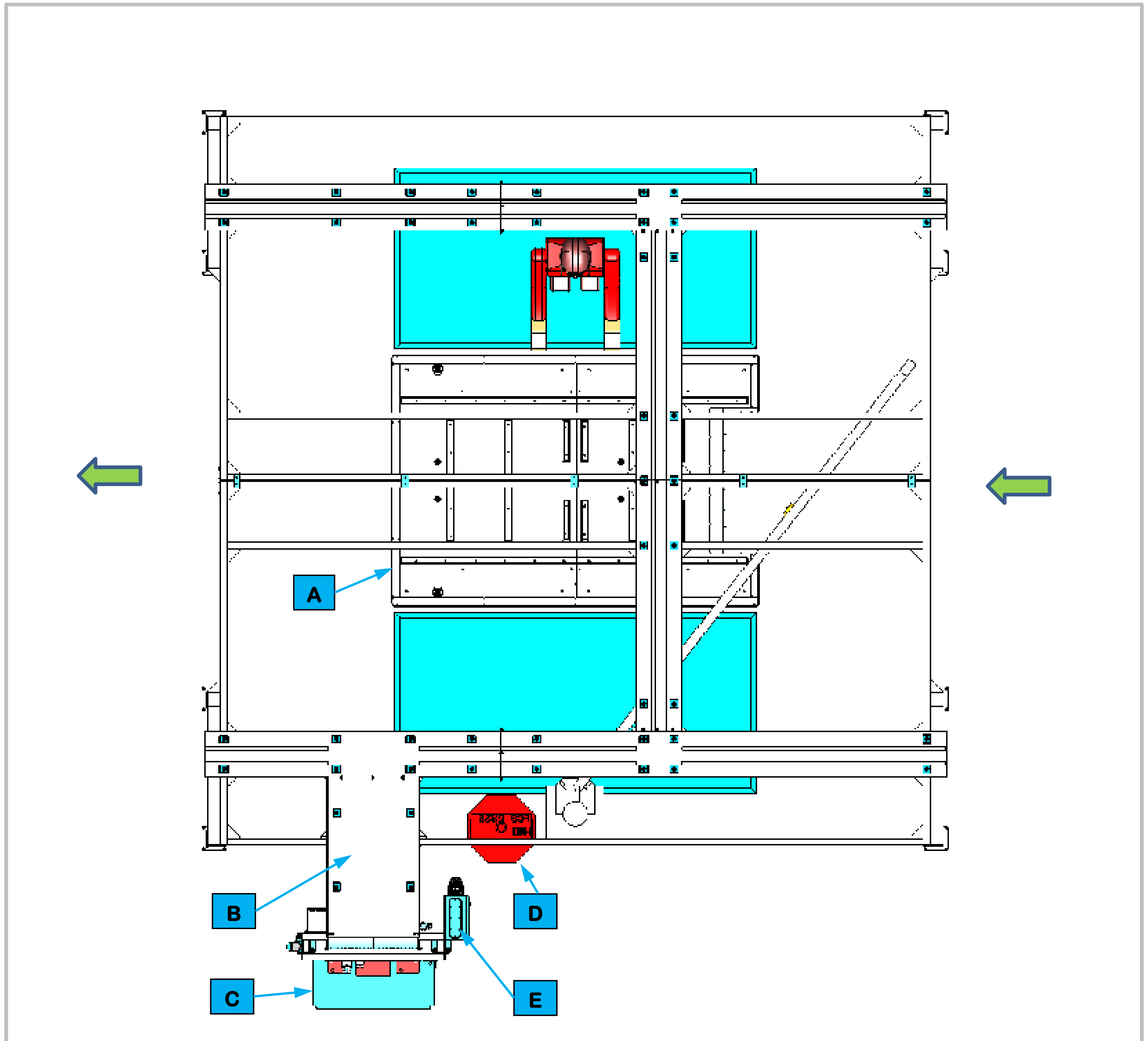
The Conveyor Equipment utilizes third-party OTP conveyance devices. Powered roller conveyor sections are used to pull full bus bar dunnage trays into the cell and to push empty bus bar dunnage trays out of the cell. Each powered roller conveyor section has its own motor and motor starter. At the Bus Bar Load and Secure Robots, one of the Robot’s EOAT is equipped with a vacuum pad tray gripper that allows the Robot to transfer an empty tray from the infeed conveyor and places it on the outfeed conveyor allowing for a full dunnage tray to move forward.

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 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 personnel 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 conveyor equipment, refer to the equipment supplier documentation (Omni Metalcraft Technical Handbook).

3.6.13. EP235 Lower Bus Bar Install and Secure, Lower Deck Manual Repair Station Description



3.6.13.1. Station Description

Cell EP235 is a manual cell that adjoins automated Cell 230. An Operator makes required repairs to the bus bar installation operation performed for both battery module types in Cell 230.

Equipment Callouts in Station EP235 Top View		
A	N/A	Automated Guided Cart (AGC)
B	N/A	Wireway
C	EP235P1	Power Cabinet
D	EP235D1	Operator Console HMI
E	EP235BC1	Barcode Scanner

Figure 3-48. EP235 Lower Bus Bar Install and Secure, Lower Deck Manual Repair Station Top View.

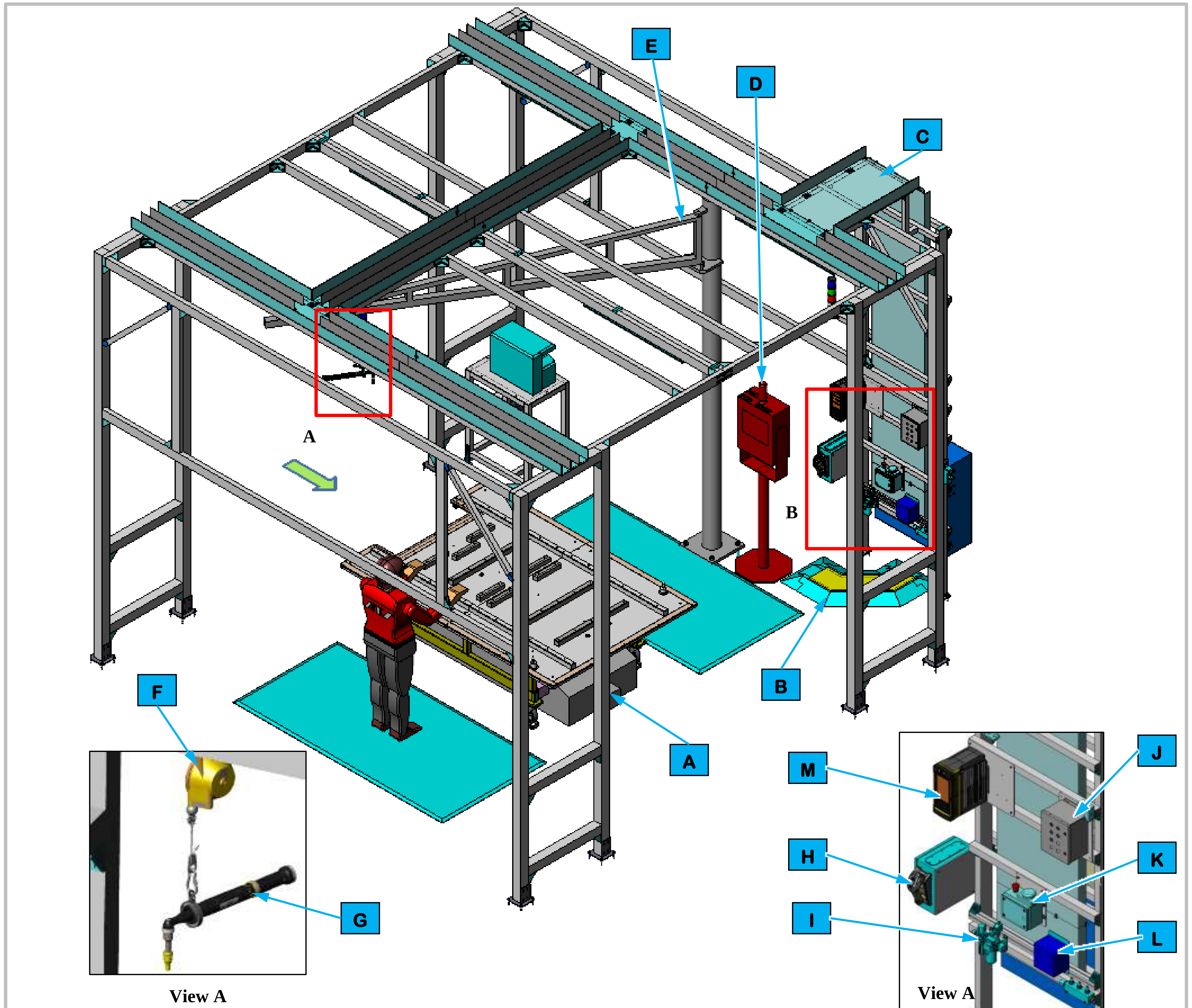


Figure 3-49. EP235 Lower Bus Bar Install and Secure, Lower Deck Manual Repair Station Isometric View

3.6.13.2. Sequence of Operation for BET

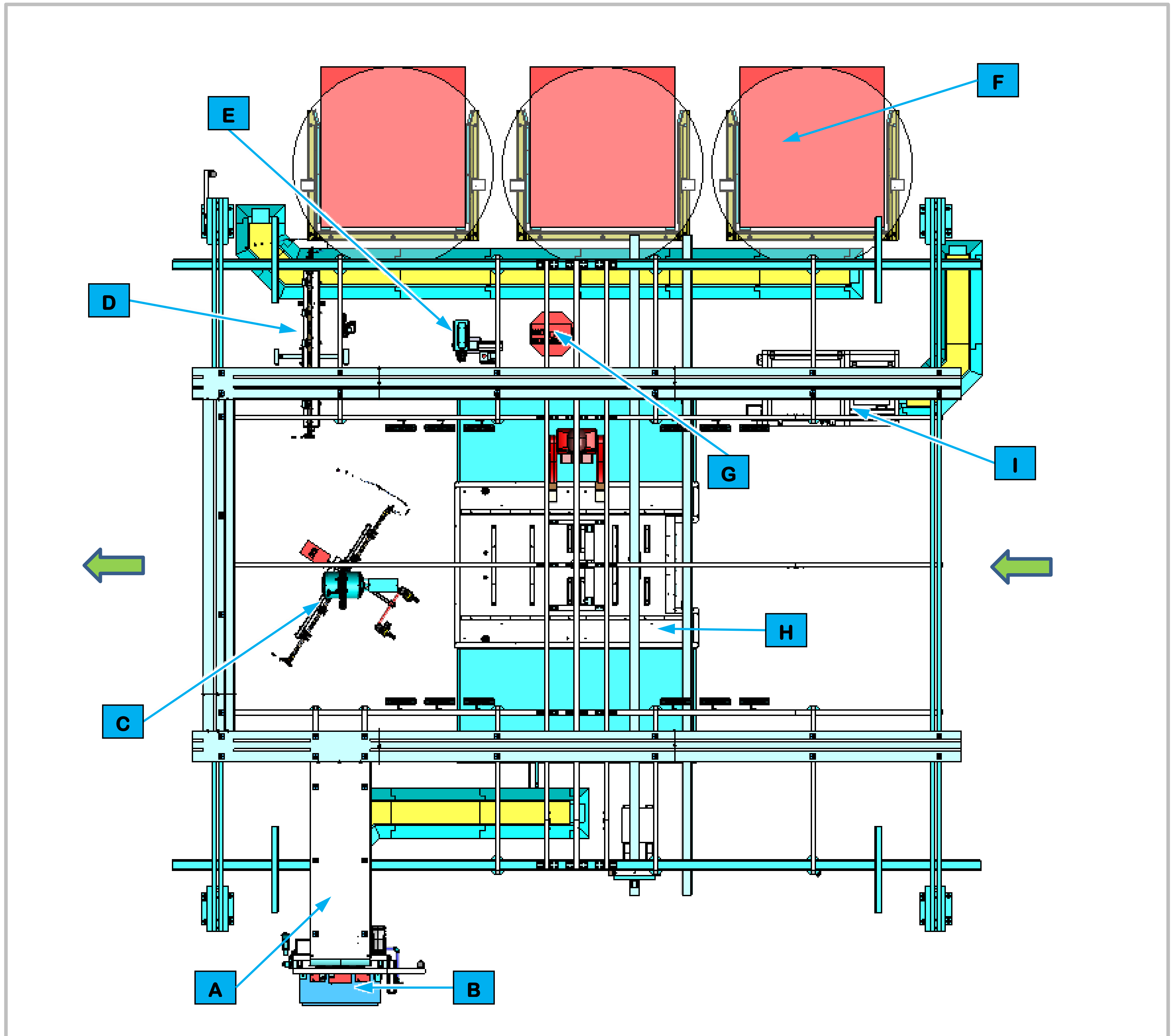
Step	Process
1	Follow repair procedure

3.6.13.3. Sequence of Operation for BEV3

Step	Process
1	Follow repair procedure

Equipment Callouts in Station EP235 Isometric View		
A	N/A	Automated Guided Cart (AGC)
B	N/A	Cable Protector
C	N/A	Wireway
D	EP235D1	Operator Console HMI
E	N/A	Jib Crane
F	N/A	Tool Balancer
G	EP235TC1	Nut Runner
H	EP235BC1	Barcode Scanner
I	AIRON	Air Preparation Unit
J	EP235E2	Operator Push Button Box
K	EP235E1	Operator Release/E-Stop
L	EP235RCP1	Electrical Outlet Box
M	EP235TC1	Nutrunner Controller

3.6.14. EP240 RH & LH Outboard Install Station Description



3.6.14.1. Station Description

Cell EP240 is a manual station for attaching the RH and LH Outboard for BET and BEV batteries.

Equipment Callouts in Station EP240 Top View		
A	N/A	Wireway
B	EP240P2	Power Cabinet
C	N/A	Lift Assist
D	N/A	RDU Fixture
E	EP240BC1	Barcode Scanner and E-Stop
F	N/A	Dunnage
G	EP240D1	Operator Console HMI
H	N/A	Automated Guided Cart (AGC)
I	EP240SF1	Feeder

Figure 3-50 EP240 RH & LH Outboard Install Station Top View.

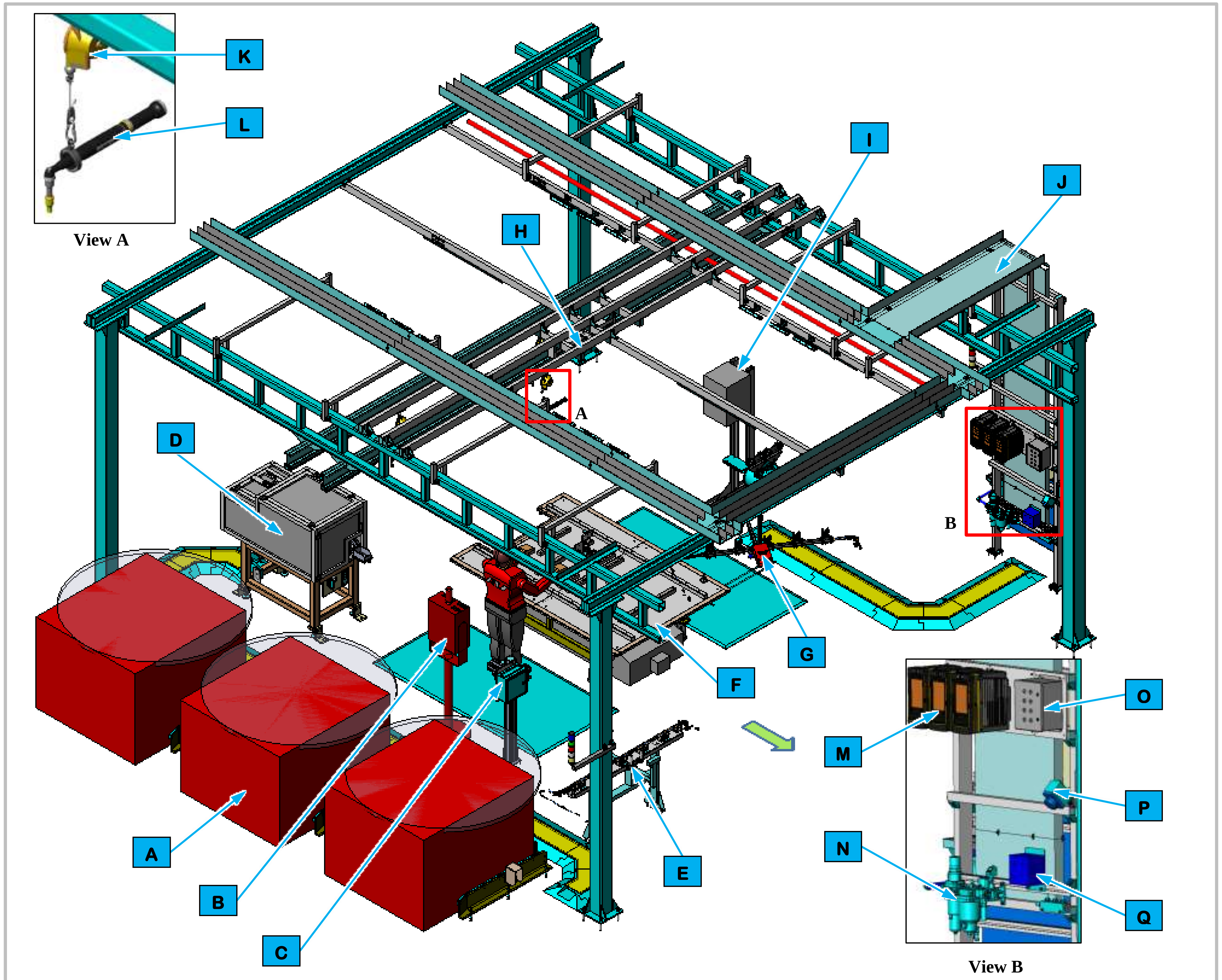


Figure 3-51. EP240 RH & LH Outboard Install Station Isometric View

3.6.14.2. Sequence of Operation for BET

Step	Process
1	Get and error-proof the RH Outboard Hose.
2	Install the RH Outboard Hose
3	Get and error-proof the LH Outboard Hose.
4	Install the LH Outboard Hose

3.6.14.3. Sequence of Operation for BEV3

Step	Process
1	Get and error-proof the RH Outboard Hose.
2	Install the RH Outboard Hose
3	Get and error-proof the LH Outboard Hose.
4	Install the LH Outboard Hose

Equipment Callouts in Station EP240 Isometric View		
A	N/A	Dunnage
B	EP240D1	Operator Console HMI
C	EP240BC1	Barcode Scanner and E-Stop
D	EP240SF1	Feeder
E	N/A	RDU Fixture
F	N/A	Automated Guided Cart (AGC)
G	N/A	Lift Assist
H	EP240C1	Inspection Camera
I	N/A	Charger Stand
J	N/A	Wireway
K	EP240TC1- 3	Nutrunner
L	N/A	Tool Balancer
M	EP240TC1- 3	Nutrunner Controllers
N	AIRON	Air Preparation Unit
O	EP240E2	Operator Push Button Box
P	EP240E1	Operator Release/E-Stop
Q	EP240RCP1	Electrical Outlet Box

3.6.15. EP260 Coolant Outlet, SFM, SFM Ground Strap Station Description

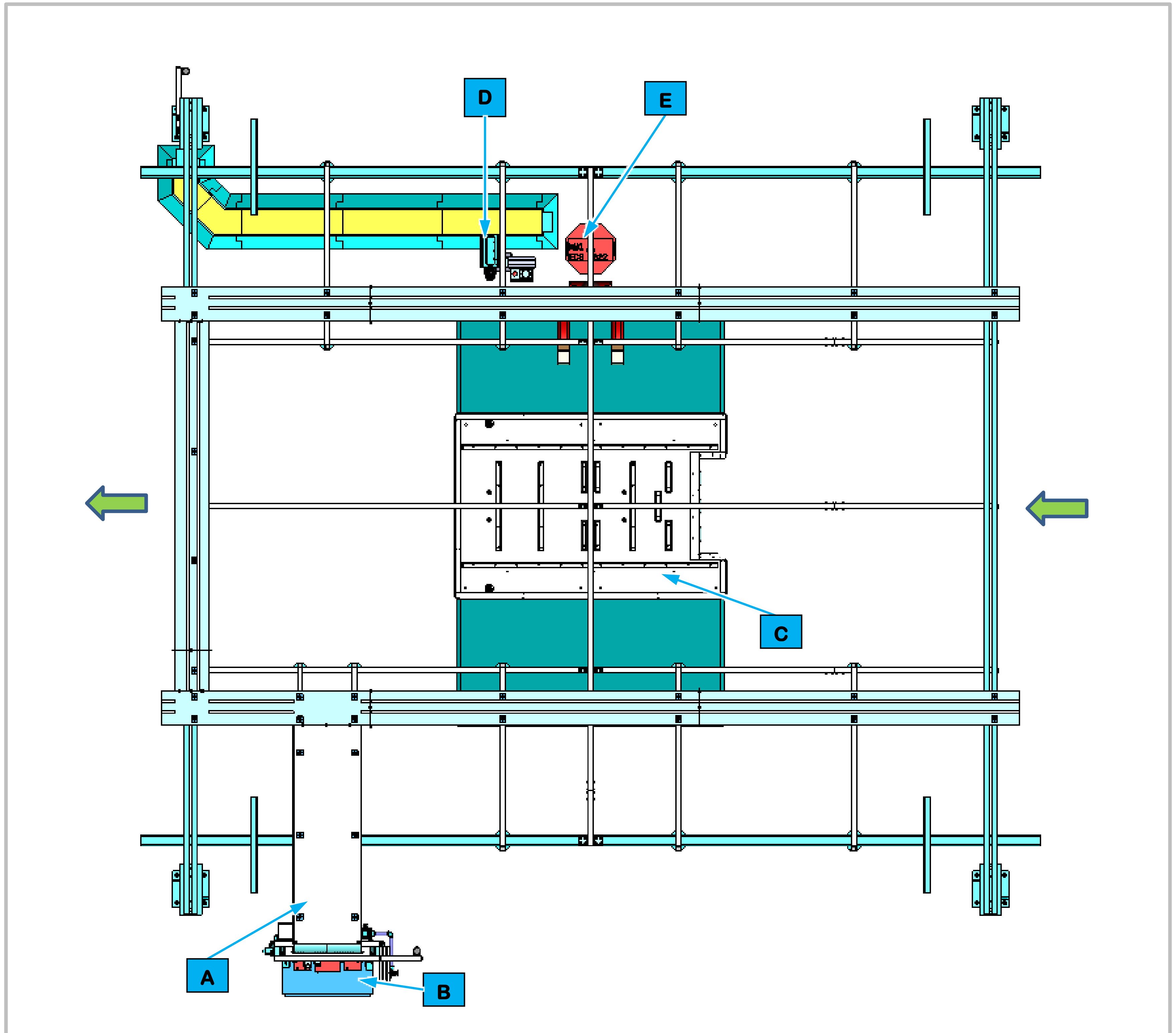


Figure 3-52. EP260 Coolant Outlet, SFM, SFM Ground Strap Station Top View.

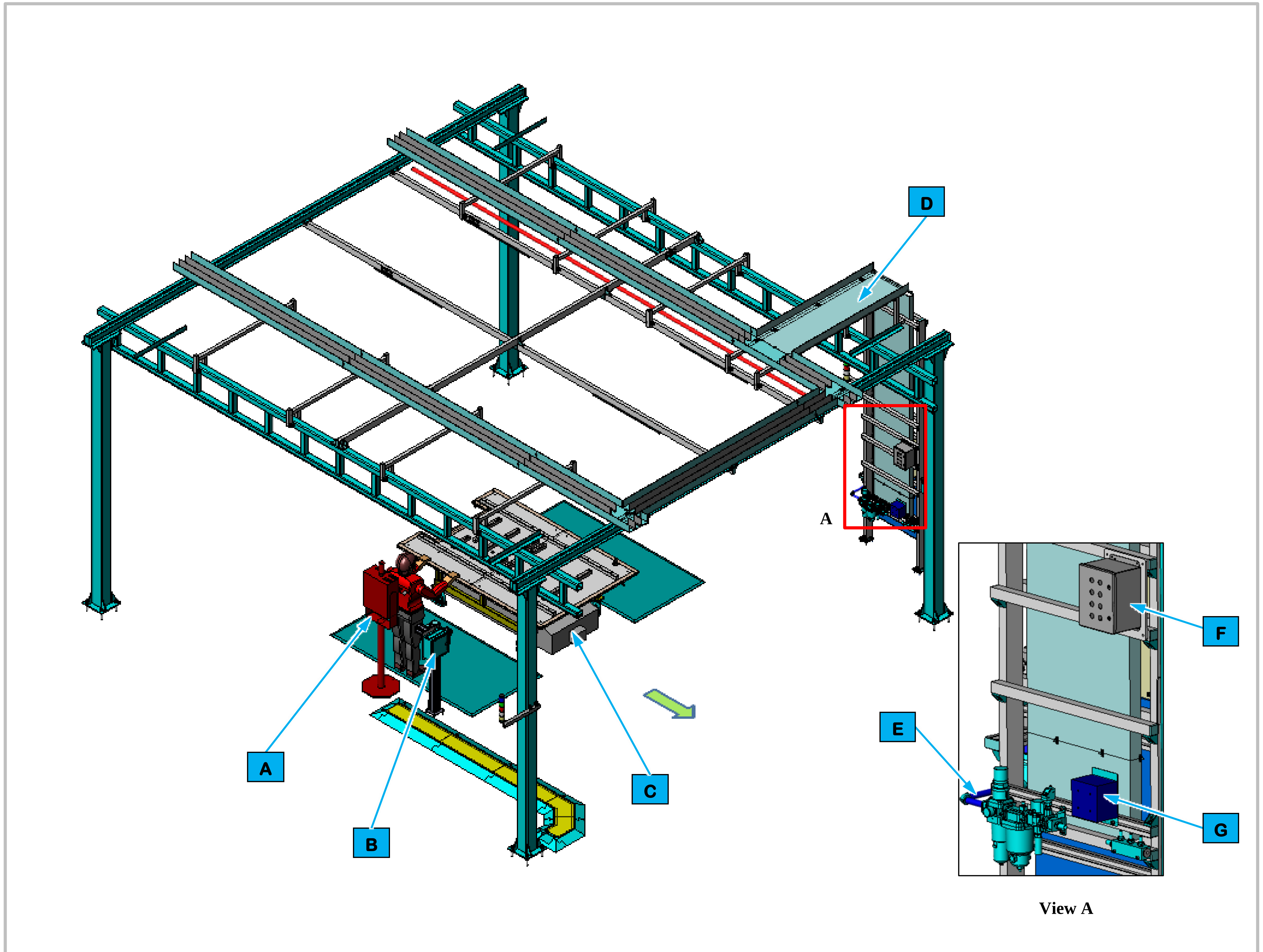
3.6.15.1. Station Description

Cell EP260 is a manual station to install the Coolant Outlet, the Thermal Barrier, SFM Backing Plate, the SFM and the SFM ground strap.

For BET Batteries an operator installs the SFM Backing Plate, the SFM and the SFM ground strap.

For BEV Batteries an operator installs the Coolant Outlet and the Thermal Barrier.

Equipment Callouts in Station EP260 Top View		
A	N/A	Wireway
B	EP260P2	Power Cabinet
C	N/A	Automated Guided Cart (AGC)
D	EP260BC1	Barcode Scanner and E-Stop
E	EP260D1	Operator Console HMI



3.6.15.2. Sequence of Operation for BET

Step	Process
1	Get and install the SFM Backing Plate
2	Get and install the SFM
3	Scan and trace the SFM
4	Get and install the SFM ground strap

3.6.15.3. Sequence of Operation for BEV3

Step	Process
1	Get and install the Coolant Outlet
	Get and install the Thermal Barrier

Equipment Callouts in Station EP260 Isometric View		
A	EP260D1	Operator Console HMI
B	EP260BC1	Barcode Scanner and E-Stop
C	N/A	Automated Guided Cart (AGC)
D	N/A	Wireway
E	AIRON	Air Preparation Unit
F	EP260E2	Operator Push Button Box
G	EP260RCP1	Electrical Outlet Box

Figure 3-53. EP260 Coolant Outlet, SFM, SFM Ground Strap Station Isometric View

3.6.16. EP270 RDU, Thermal Barrier, and MCP1 Install Description

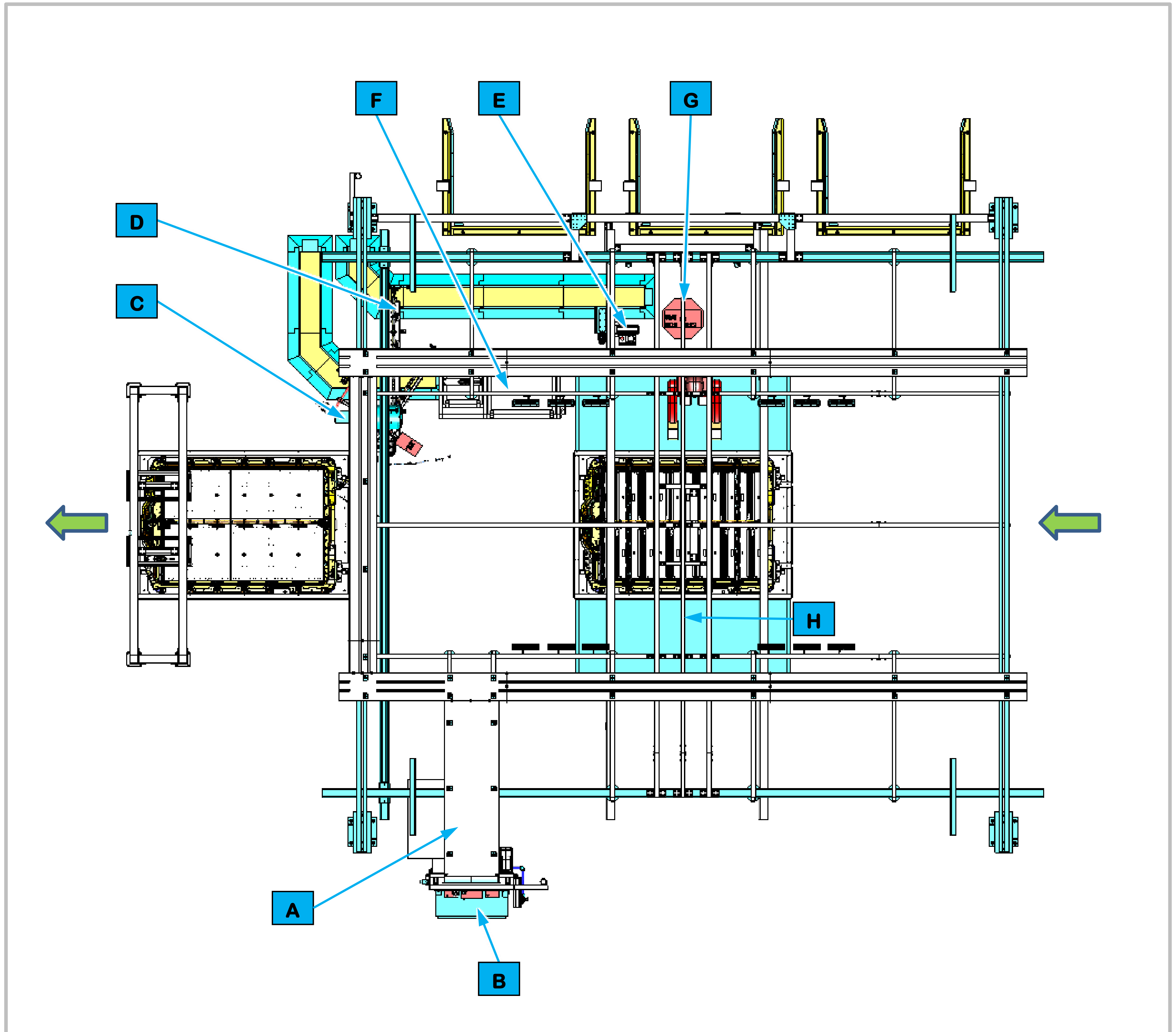


Figure 3-54. EP270 RDU, Thermal Barrier, and MCP1 Install Top View.

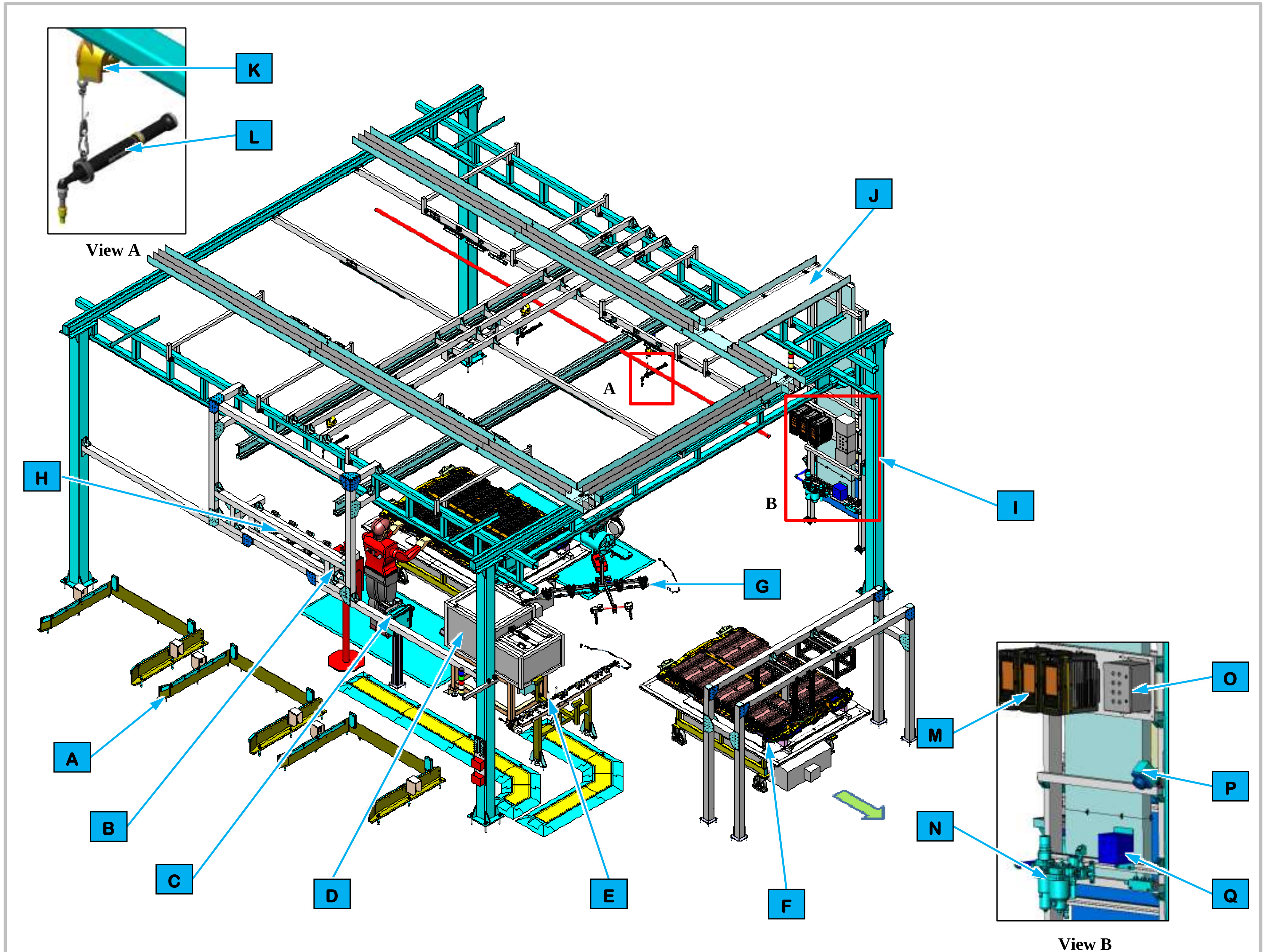
3.6.16.1. Station Description

Cell EP270 is a manual station for attaching the Rear Ground Strap, BDU Blocker, Thermal Barrier, MCP1 Module Bracket, and RDU Cable.

For BET batteries an Operator gets and installs the Rear Ground Strap, the BDU Blocker, and Thermal Barrier.

For BEV3 batteries the Operator gets and installs the RDU Cable to the RDU Fixture and then installs the RDU to the battery pack.

Equipment Callouts in Station EP260 Top View		
A	N/A	Wireway
B	EP270P2	Power Cabinet
C	N/A	Lift Assist
D	N/A	RDU Fixture
E	EP270BC1	Barcode Scanner and E-Stop
F	EP270SF1	Feeder
G	EP270D1	Operator Console HMI
H	N/A	Automated Guided Cart (AGC)



3.6.16.2. Sequence of Operation for BET

Step	Process
1	Get and install Rear Ground Strap.
2	Get and install BDU Blocker.
3	Get and install MCP1.
4	Get and install Thermal Barrier.
5	Inspect BDU Blocker and Thermal Barrier.
6	Trace Therman Barrier.

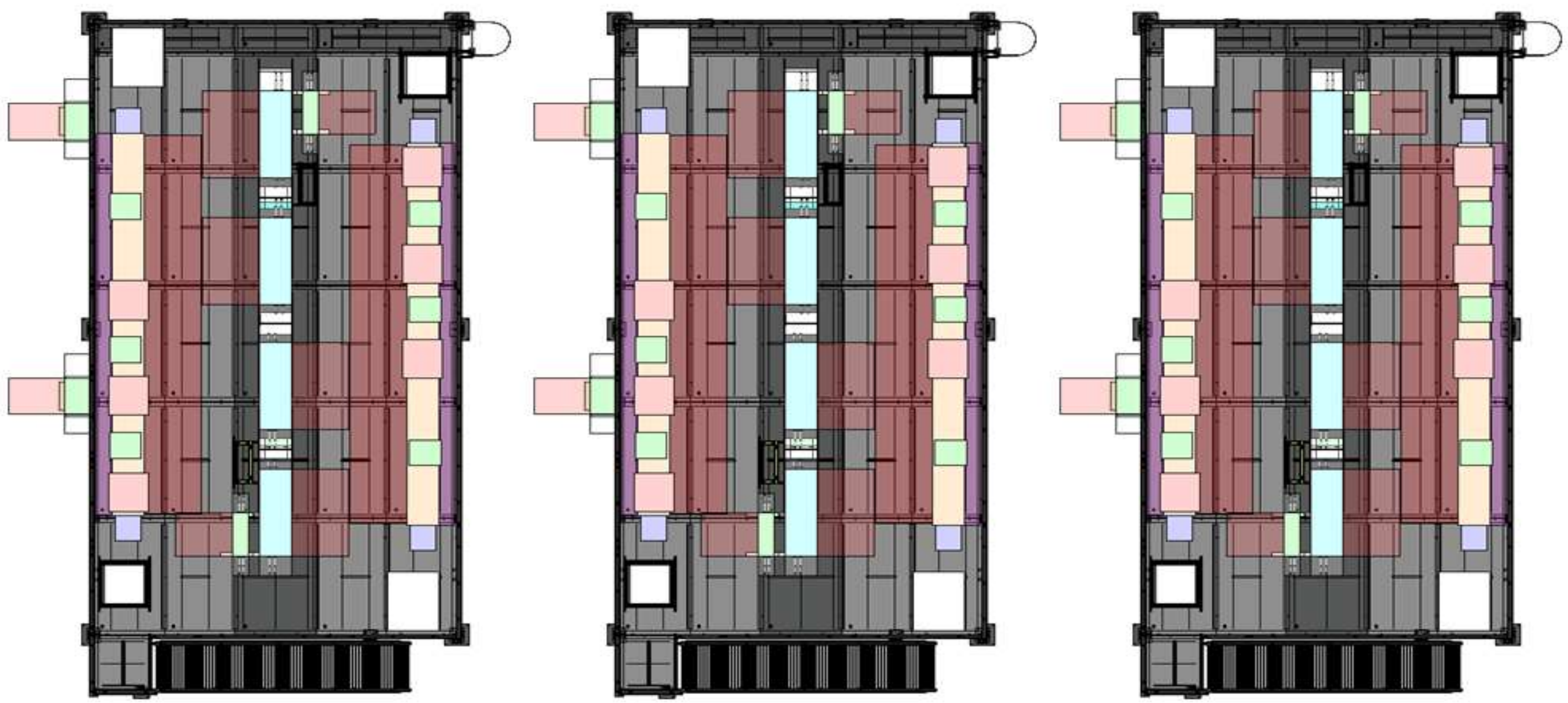
3.6.16.3. Sequence of Operation for BEV3

Step	Process
1	Get and install the RDU Cable to RDU Fixture.
2	Install RDU Cable to BDU.
3	Install RDU Cable to RDU.
4	Secure RDU Cable to Tray.
5	Trace RDU Cable.

Equipment Callouts in Station EP260 Isometric View		
A	N/A	Dunnage
B	EP270D1	Operator Console HMI
C	EP270BC1	Barcode Scanner and E-Stop
D	EP270SF1	Feeder
E	N/A	RDU Fixture
F	N/A	Automated Guided Cart (AGC)
G	N/A	Lift Assist
H	EP270CAM2-6	Inspection Camera
I	N/A	Charger Stand
J	N/A	Wireway
K	EP270TC1- 3	Nutrunner
L	N/A	Tool Balancer
M	EP270TC1- 3	Nutrunner Controllers
N	AIRON	Air Preparation Unit
O	EP270E2	Operator Push Button Box
P	EP270E1	Operator Release/E-Stop
Q	EP270RCP1	Electrical Outlet Box

Figure 3-55. EP270 RDU, Thermal Barrier, and MCP1 Install Isometric View

3.6.17. EP280 Electrical Leak Test Station Description



For information regarding equipment located in Cell EP280, refer to *Battery Pack Test and Cover Leak Test Operation and Maintenance Manual.*

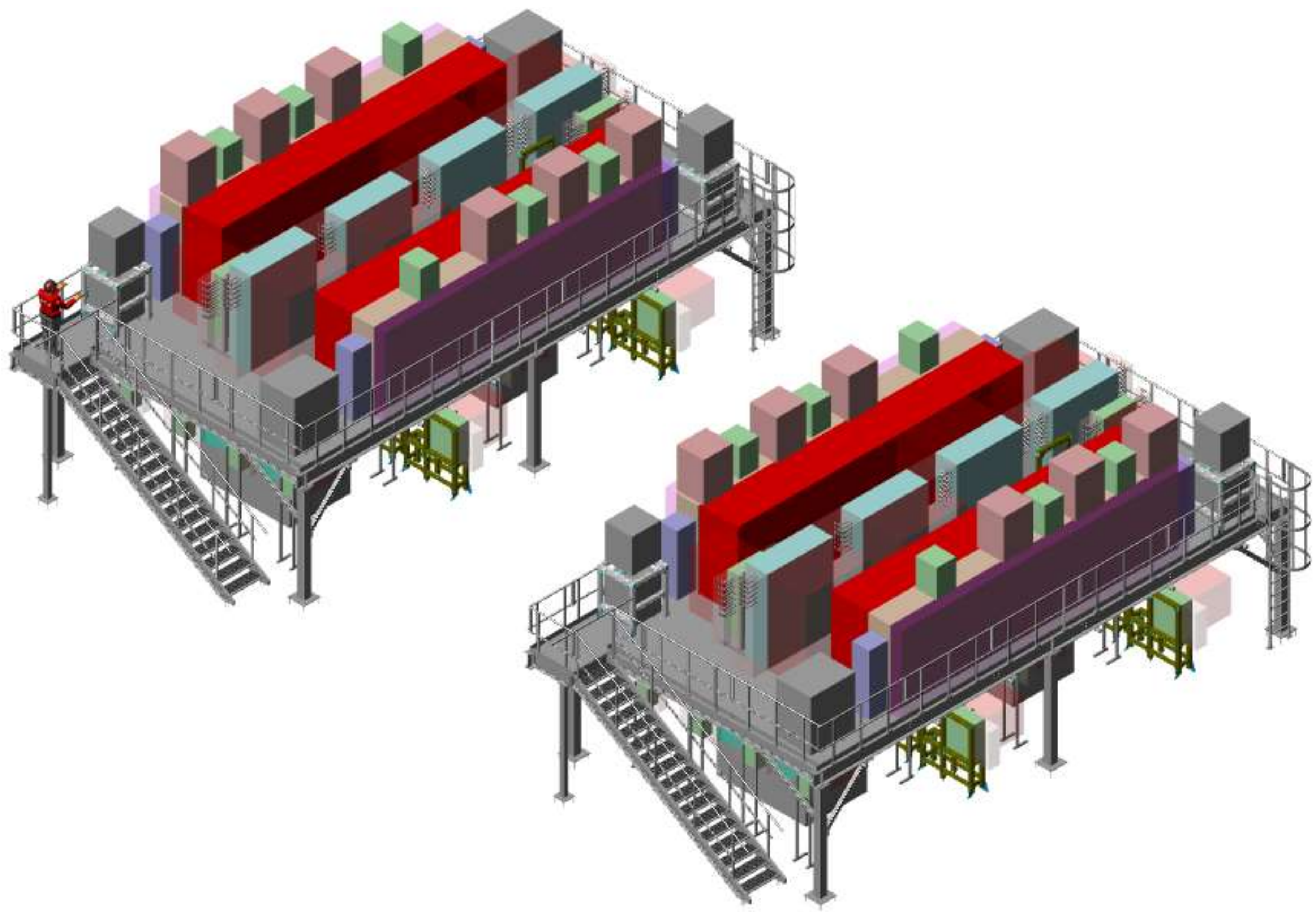
Figure 3-56. EP280 Electrical Leak Test Station Top View.

3.6.17.1. Station Description

Cell EP280 is a test station for performing an electrical test on BET and BEV3 battery assemblies.

An AGC enters this station where an Operator performs a quality check and an electrical leak test on the battery assembly.

For more detailed information about Cell 280, refer to *Battery Pack Test and Cover Leak Test Operation and Maintenance Manual.*



For information regarding equipment located in Cell EP280, refer to *Battery Pack Test and Cover Leak Test Operation and Maintenance Manual.*

Figure 3-57. EP280 Electrical Leak Test Station Isometric View

3.6.17.2. Sequence of Operation for BET

Step	Process
1	Operator performs a quality check on battery assembly
2	Operator performs an electrical leak test on battery assembly
	For more detailed information about Cell 280, refer to *Battery Pack Test and Cover Leak Test Operation and Maintenance Manual.*

3.6.17.3. Sequence of Operation for BEV3

Step	Process
1	Operator performs a quality check on battery assembly
2	Operator performs an electrical leak test on battery assembly
	For more detailed information about Cell 280, refer to *Battery Pack Test and Cover Leak Test Operation and Maintenance Manual.*

3.6.18. EP300/EP320 Midplate Load and Secure Station Description

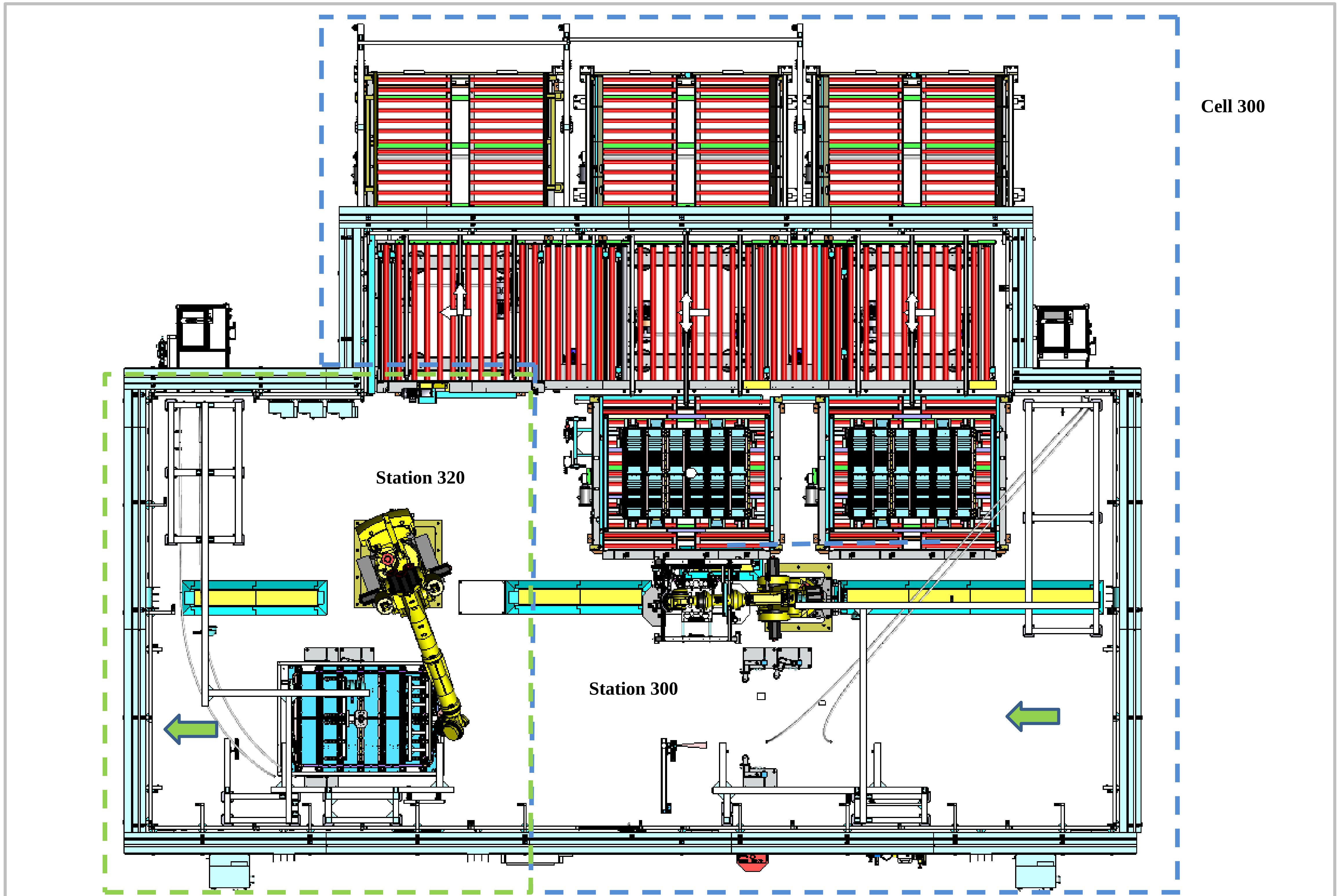


Figure 3-58. EP300/EP320 Midplate Load and Secure Station Top View.

3.6.18.1. Station Description

Cell EP300/EP320 is a fully automated station for installing the midplate on BET modules.

The Automated Guided Cart (AGC) enters the station EP300 where midplates are delivered to dunnage by the infeed conveyor system. The Load Midplate Robot picks a midplate from dunnage and places the midplate in battery assembly on the AGC. The AGC then moves forward into Station EP320 where the Midplate Fasten Robot secures the midplate to the battery assembly with bolts. The AGC then moves forward and exits the station.

BEV3 battery assemblies do not use this station

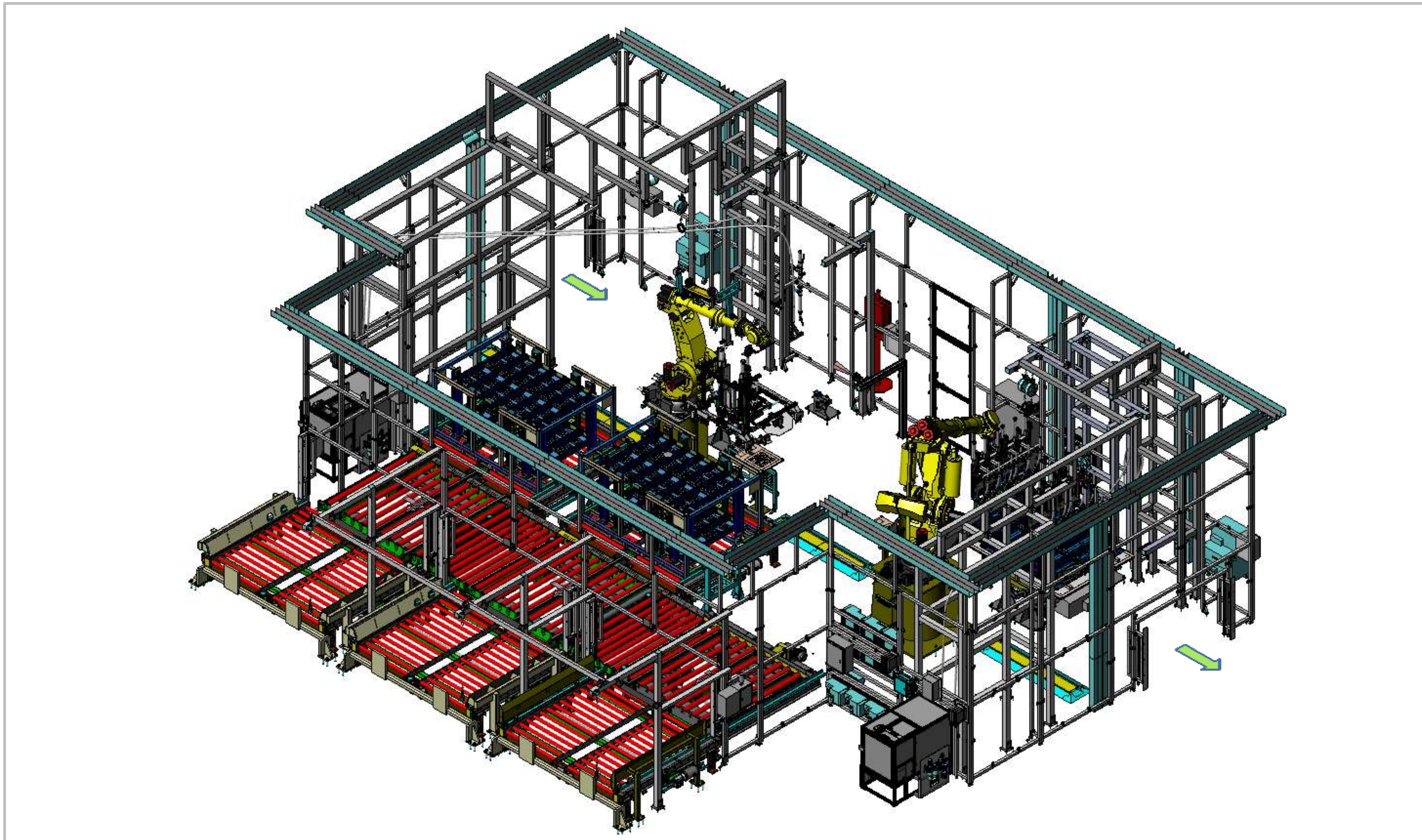
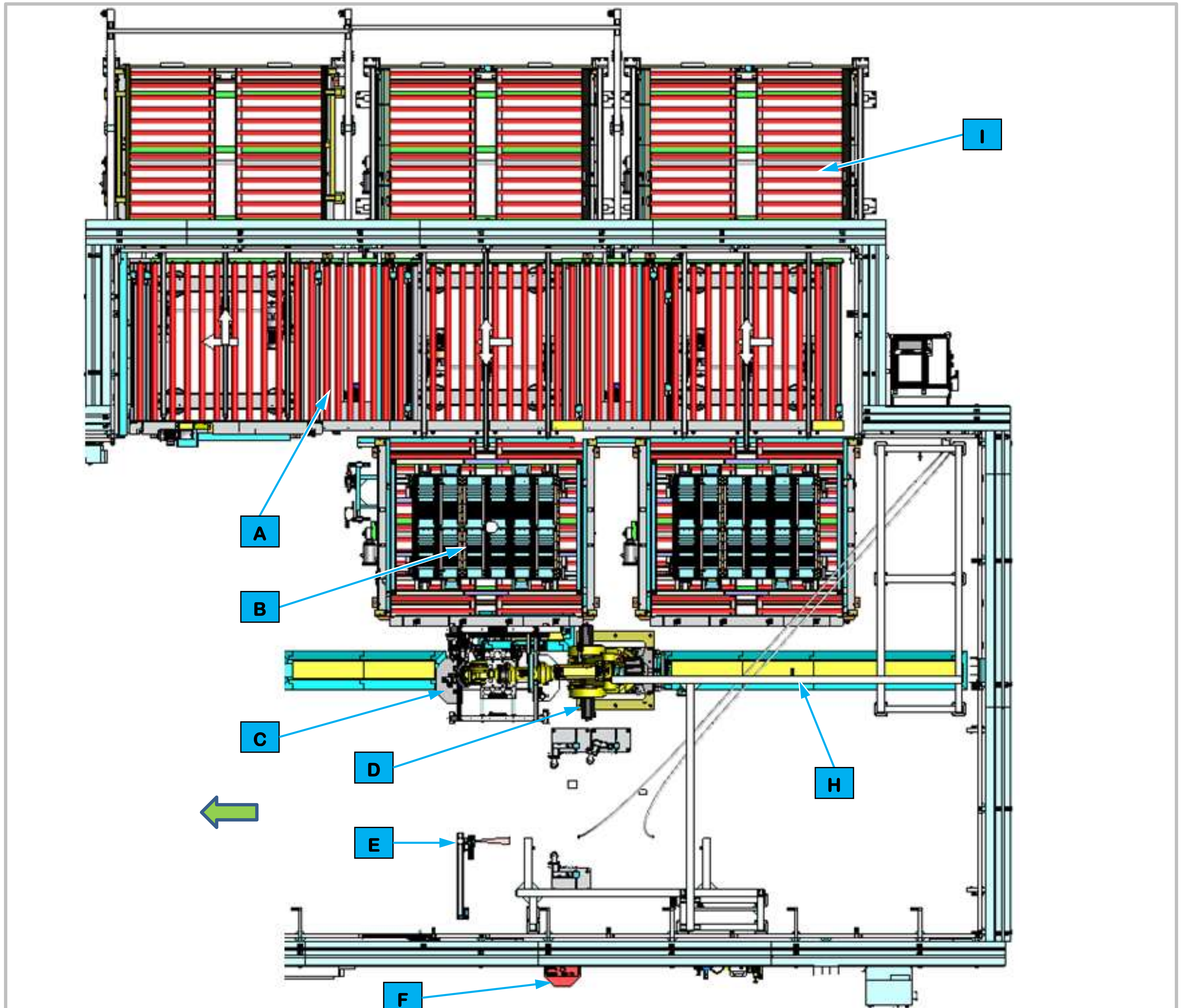


Figure 3-59. EP300/EP320 Midplate Load and Secure Station Isometric View



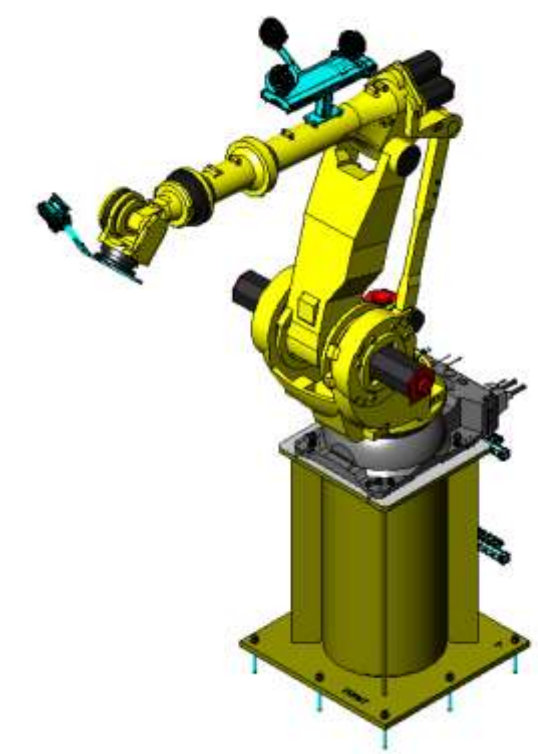
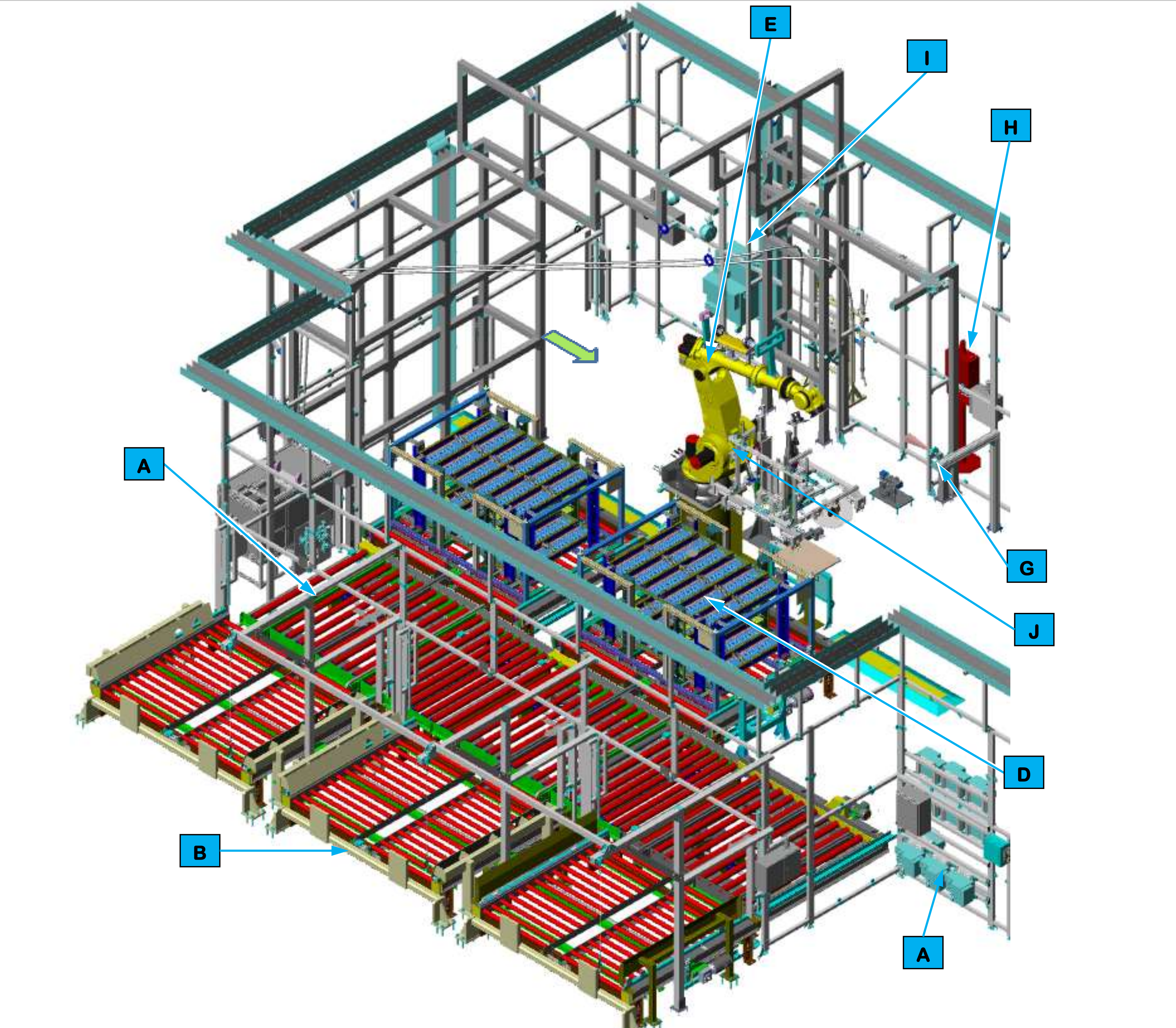


Figure 3-60. Midplate Load Robot

Equipment Callouts in Station EP300 Top View		
A	EP300T01B01	Cross Feed Conveyor
B	N/A	Midplates in Dunnage
C	N/A	Robot and Vision Calibration Stand
D	EP300R01	Midplate Load Robot
E	N/A	Barcode Scanner
F	EP300D1	Operator Console HMI
G	N/A	Automated Guided Cart (AGC)
H	N/A	Cable Protector
I	EP300T01B01	Conveyors

Figure 3-61. EP300 Midplate Load Station Top View.



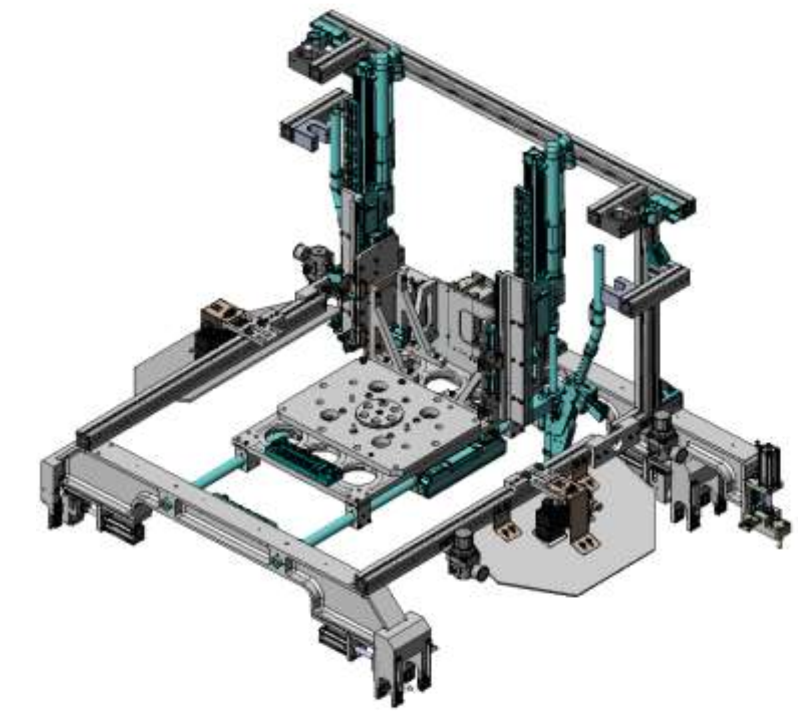


Figure 3-62. Midplate Load EOAT

Equipment Callouts in Station EP300 Isometric View		
A	IDC1 - 11	ArmorStart
B	EP300T01B01	Conveyors
C	EP300T01B01	Cross Feed Conveyors
D	N/A	Midplates in Dunnage
E	EP300R01	Midplate Load Robot
F	N/A	Automated Guided Cart
G	N/A	Barcode Scanner
H	EP300D1	Operator Console HMI
I	N/A	Robot Controller
J	N/A	Robot and Vision Calibration Stand

Figure 3-63. EP300 Midplate Load Station Isometric View

3.6.18.2. Cell EP300 Sequence of Operation

The Midplate Load station equipment completes the following operations during a normal cycle:

1. The AGC enters Station EP300 carrying a battery assembly.
2. The Midplate Load Robot (refer to callout **E** in ***Figure 3-63***) manipulates End of Arm Tooling (EOAT) to scan and pick a midplate from dunnage on Conveyor Equipment
3. The Midplate Load Robot rotates to the waiting AGC.
4. The Midplate Load Robot uses vision cameras to align the EOAT holding the Midplate with the battery assembly.
5. The Midplate Load Robot lowers the EOAT to place the Midplate into the battery assembly.
6. The Midplate Load Robot fastens rear section of the midplate to the battery assembly with bolts.
7. The Midplate Load Robot raises to clear of the battery assembly.
8. The AGC moves forward to Station EP320.

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

3.6.18.3. Midplate Load Robot and EOAT

Station EP300 contains one Midplate Load Robot (EP300R01). The FANUC M900IB-280L (refer to ***Figure 3-60***) is a 6-axis robot with a load capacity of 617 lbs. Attached to the Midplate Load Robot is End of Arm Tooling (EOAT) used to pick a Midplate from dunnage, rotate to the waiting AGC, use vision cameras to algin the Midplate with the battery assembly, and then lowers the midplate to the battery assembly. Having completed this operation, the Midplate Load Robot raises to clear the battery assembly allowing the AGC to move forward.

The Midplate Load EOAT (refer to ***Figure 3-62***) consist of a square frame with linear lights, cameras, pneumatic holding pins, and blow-fed pneumatic drivers. Two (2) opposing light bars and two (2) opposing FANUC iRVision cameras are located on the outside of the frame and are used to align the EOAT with the midplate. Four (4) pneumatic holding pins are located on each corner of the frame and two (2) drivers are align on the center of the frame. When the EOAT is lowered to a midplate in dunnage, holding pins are actuated to pick the midplate from dunnage. The holding pins remain in place while the Midplate Load Robot rotates the midplate to the AGC. The Robot then lowers the midplate to the AGC and places the midplate onto the battery assembly and the drivers are fed bolts to secure the inner section of the midplate to the AGC. The holding pins are then actuated to release the midplate and the EOAT is raised clear of the battery assembly.

REFERENCE	***For more information about the robot equipment, refer to the equipment supplier documentation (FANUC Robot M-900 iB Operator's Manual).***

3.6.18.4. Robot and Vision Calibration Stand

The Robot and Vision Calibration Stand (refer to callout **J** in ***Figure 3-63***) provides a calibration grid that is used as a reference when calibrating the robot and robot vision equipment. Calibration of the robot and robot vision equipment is documented in the associated FANUC documentation.

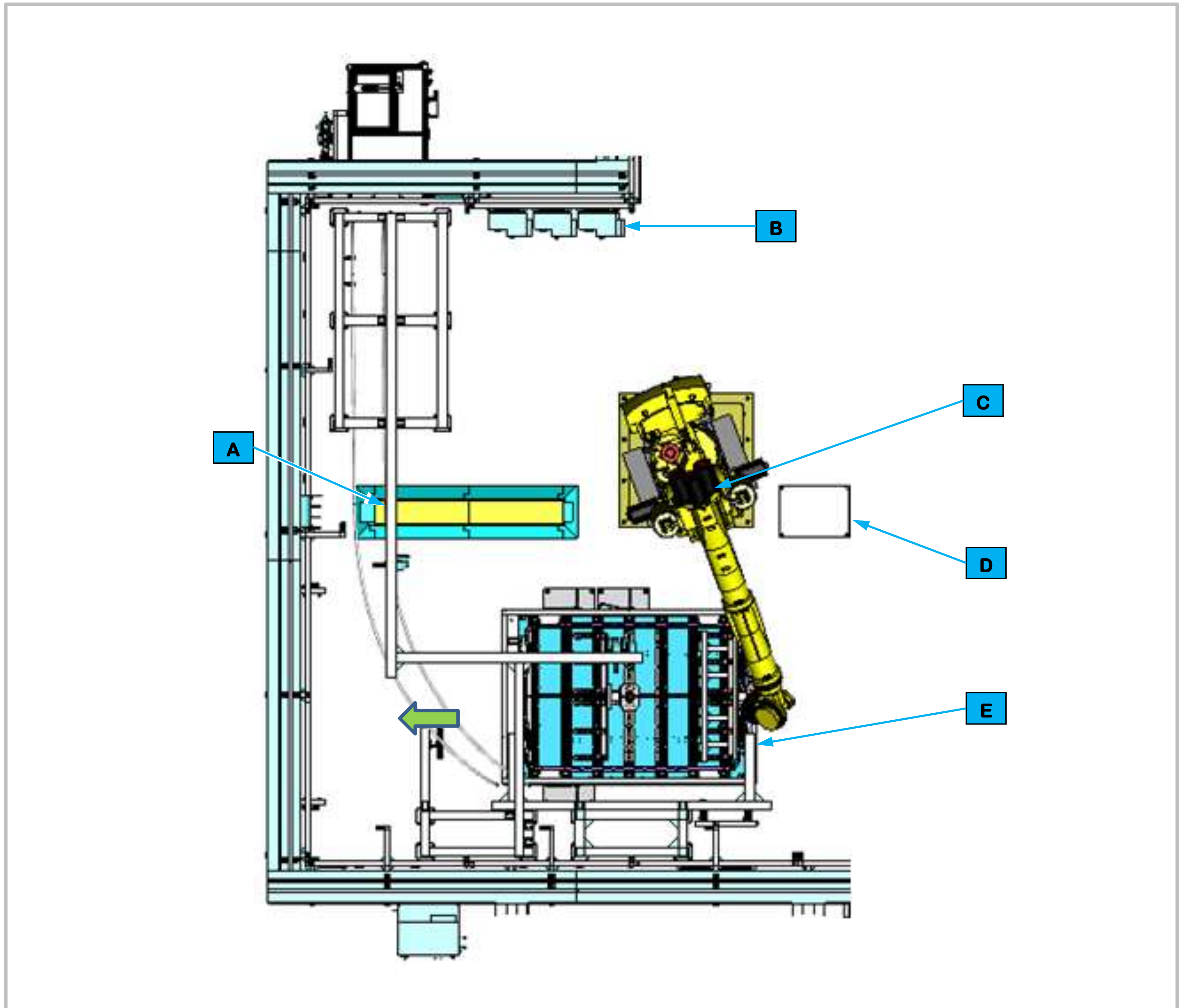
3.6.18.5. Conveyor Equipment

The Conveyor Equipment (EP300T01B01, refer to callout **B** in ***Figure 3-63***) transfers dunnage carrying Midplates into the cell and empty dunnage out of the cell.

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

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 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 personnel 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 conveyor equipment, refer to the equipment supplier documentation (Omni Metalcraft Technical Handbook).***



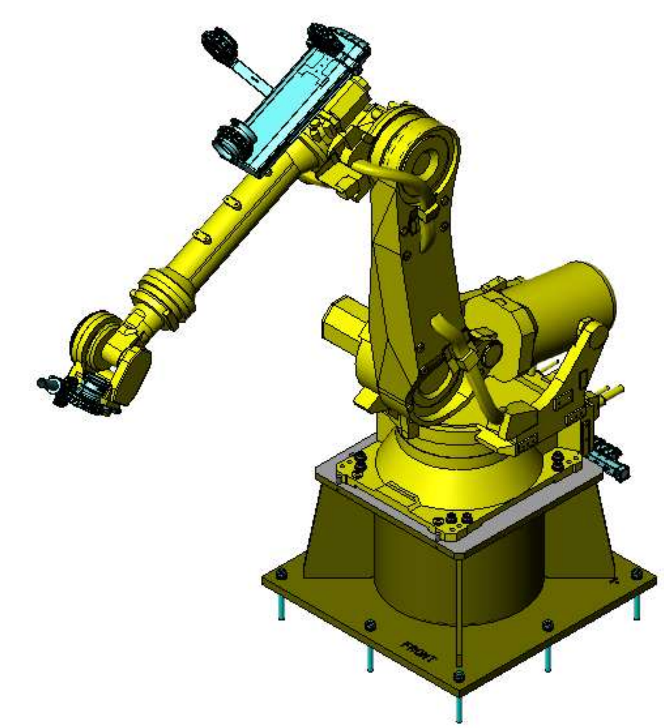
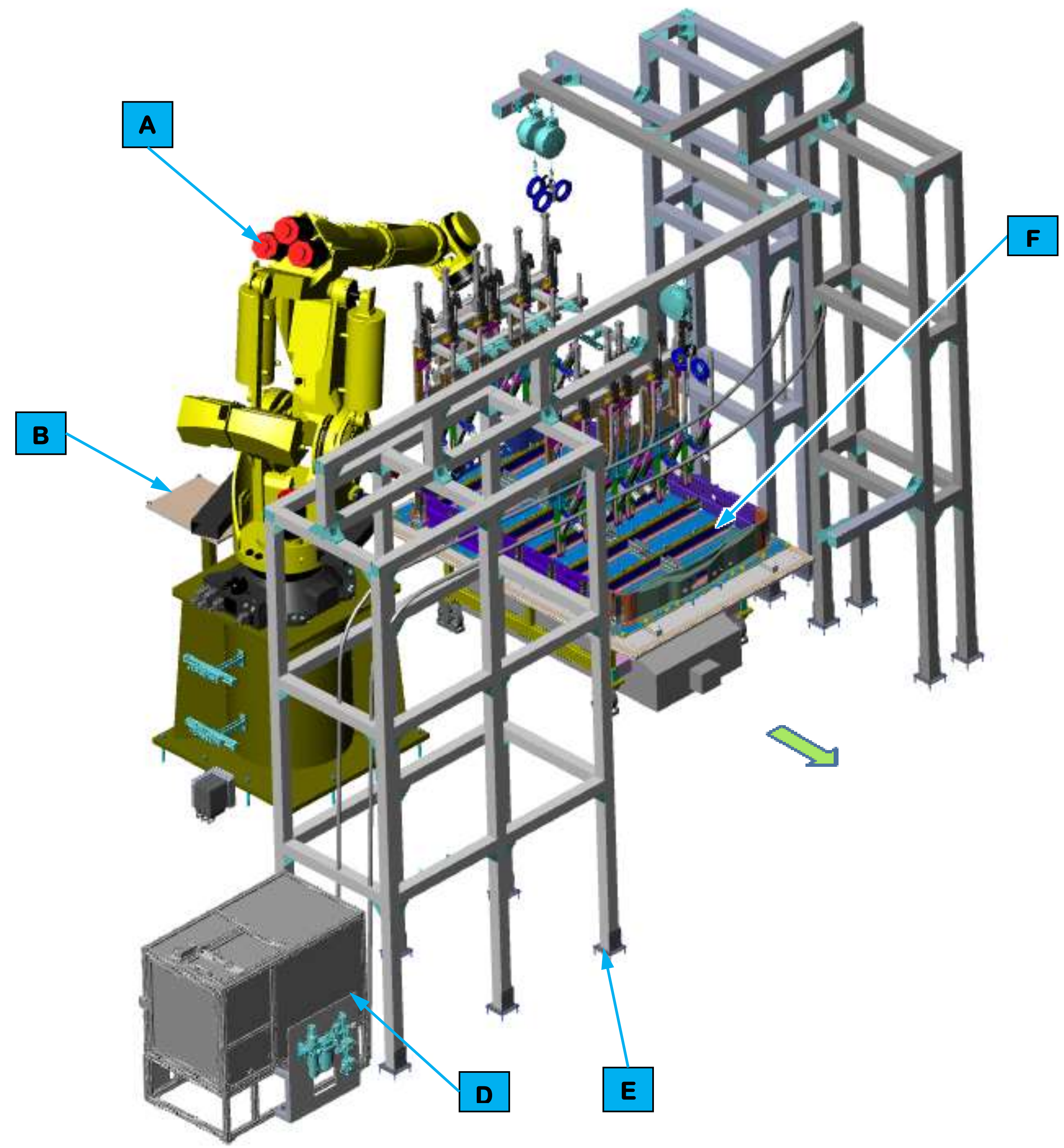


Figure 3-64. Midplate Fasten Robot

Equipment Callouts in Station EP320 Top View		
A	N/A	Cable Protector
B	IDC1 - 11	ArmorStart
C	EP320R01	Midplate Fasten Robot
D	N/A	Robot and Vision Calibration Stand
E	N/A	Automated Guided Cart

Figure 3-65. EP320 Midplate Secure Station Top View



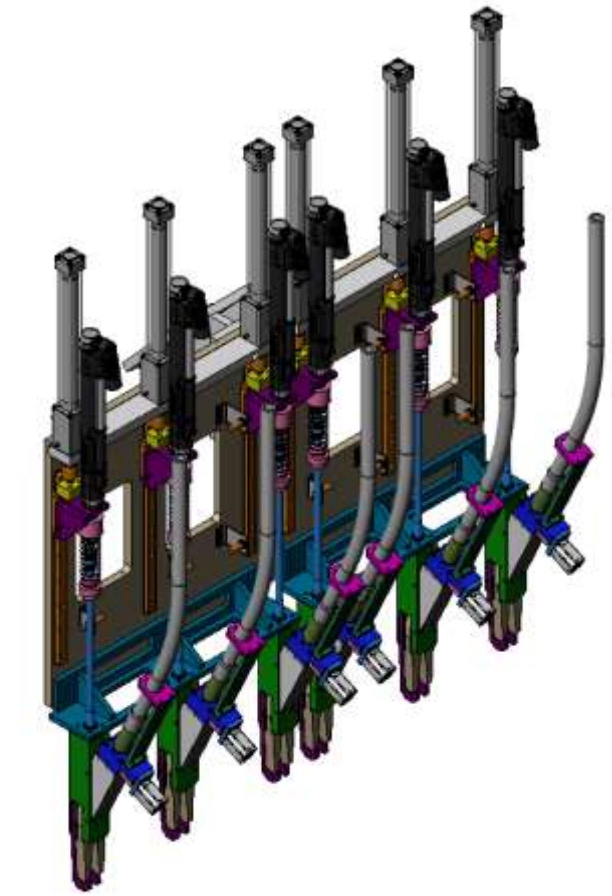


Figure 3-66. Midplate Fasten EOAT

Equipment Callouts in Station EP320 Isometric View		
A	EP320R01	Midplate Fasten Robot
B	N/A	Robot and Vision Calibration Stand
C	IDC1 - 11	ArmorStart
D	EP320BF1	Fastener Feed System
E	N/A	Cable Protector
F	N/A	Automated Guided Cart

Figure 3-67. EP320 Midplate Secure Station Isometric View

3.6.18.6. Station EP320 Sequence of Operation for BET

The Midplate Fasten station equipment completes the following operations during a normal cycle:

1. The AGC enters Station EP320 from adjoined Station EP300 carrying a battery assembly.
2. The Midplate Fasten Robot (refer to callout **A** in ***Figure 3-67***) rotates and lowers to the battery assembly.
3. The Midplate Fasten Robot manipulates vision aligned End of Arm Tooling (EOAT) to the Midplate.
4. The Midplate Fasten Robot EOAT fastens the areas of the midplate that were not secured in Station EP320 to the battery assembly with bolts.
5. The Midplate Fasten Robot raises to clear the battery assembly.
6. The AGC moves forward to exit Station EP320.

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

3.6.18.7. Midplate Fasten Robot and EOAT

Station EP320 contains one Midplate Fasten Robot (EP320R01). The FANUC R2000IC-210F (refer to ***Figure 3-64***) is a 6-axis robot with a load capacity of 462 lbs. Attached to the Midplate Fasten Robot is End of Arm Tooling (EOAT) used to fasten the midplate to the battery assembly. The robot rotates and lowers the vision aligned EOAT to the battery assembly, receives blow-fed bolts to the EOAT and then fastens the bolts six (6) at a time using drivers. Having completed this operation, the Midplate Fasten Robot raises to clear the battery assembly allowing the AGC to move forward and exit the cell.

The Midplate Fasten EOAT (refer to ***Figure 3-66***) consists of six (6) pneumatic drivers each with blow fed attachments that supply bolts. The drivers are configured beside each other allowing for six (6) bolts to secured at the same time. When the EOAT is lowered into the battery assembly the drivers are fed bolts that are vision aligned and torqued to a consistent value.

REFERENCE	***For more information about the robot equipment, refer to the equipment supplier documentation (FANUC Robot R-2000 iC Operator's Manual).***

3.6.18.8. Robot and Vision Calibration Stand

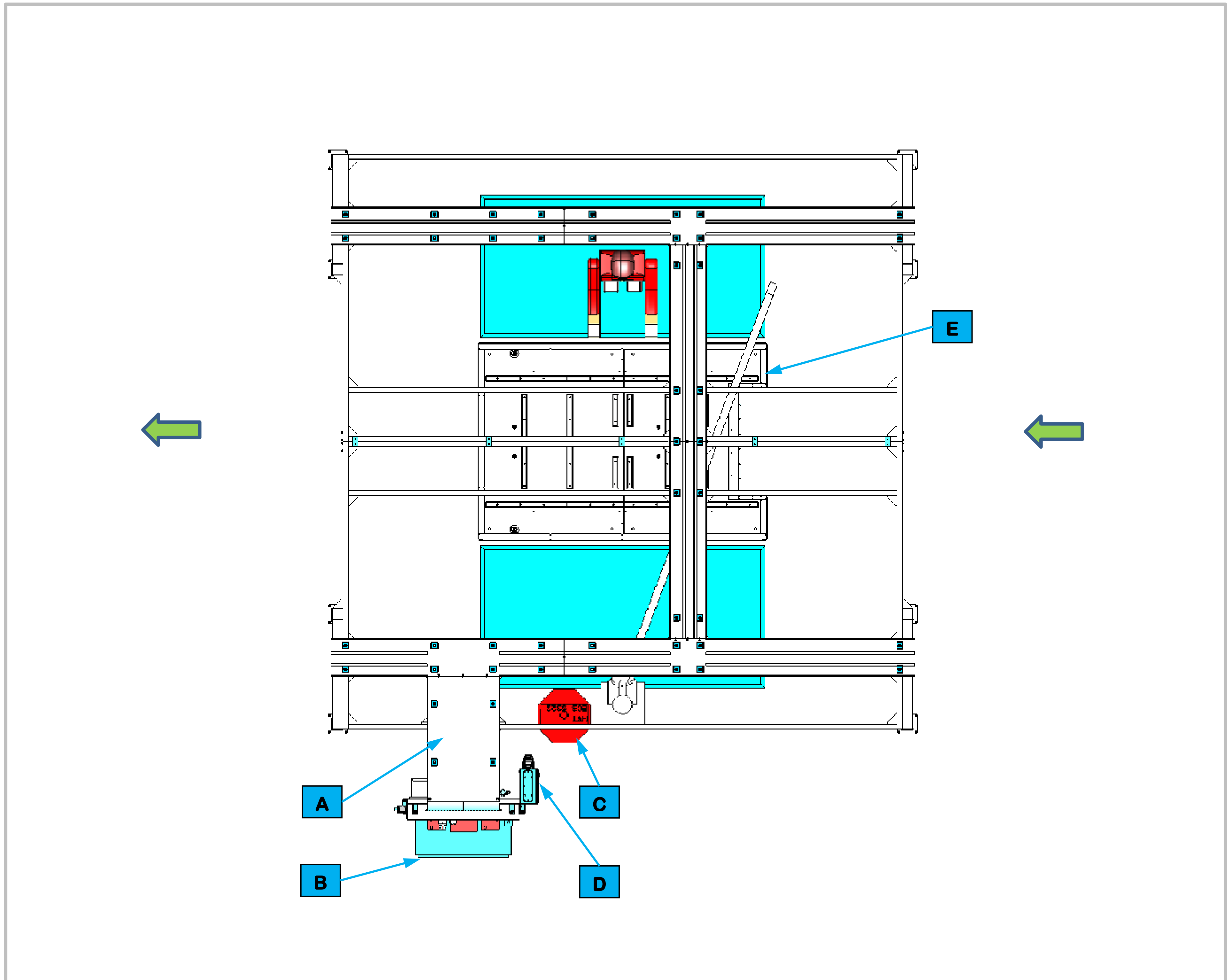
The Robot and Vision Calibration Stand (refer to callout **B** in ***Figure 3-67***) provides a calibration grid that is used as a reference when calibrating the robot and robot vision equipment. Calibration of the robot and robot vision equipment is documented in the associated FANUC documentation.

3.6.18.9. Fastener Feed System

The Carlson S12 Fastener Feed System (EP320BF1, refer to callout **D** in ***Figure 3-67***) is an electrically motorized fastener assembly that sorts and aligns bolts into an inline track that are then blow fed into an air hose to the Midplate Fasten Robot EOAT.

REFERENCE	***For more information about fastener feed system equipment, refer to the equipment supplier documentation (Carlson S12 Technical Manual).***

3.6.19. EP325 Midplate Load and Secure Manual Repair Station Description



3.6.19.1. Station Description

Cell EP325 is a manual cell that adjoins automated Cell 300. An Operator makes required repairs to the mid plate installation operation performed on BET batteries in Cell 300.

Equipment Callouts in Station EP325 Top View		
A	N/A	Wireway
B	EP325P1	Power Cabinet
C	EP325D1	Operator Console HMI
D	EP325BC1	Barcode Scanner
E	N/A	Automated Guided Cart (AGC)

Figure 3-68. EP325 Midplate Load and Secure Manual Repair Station Top View.

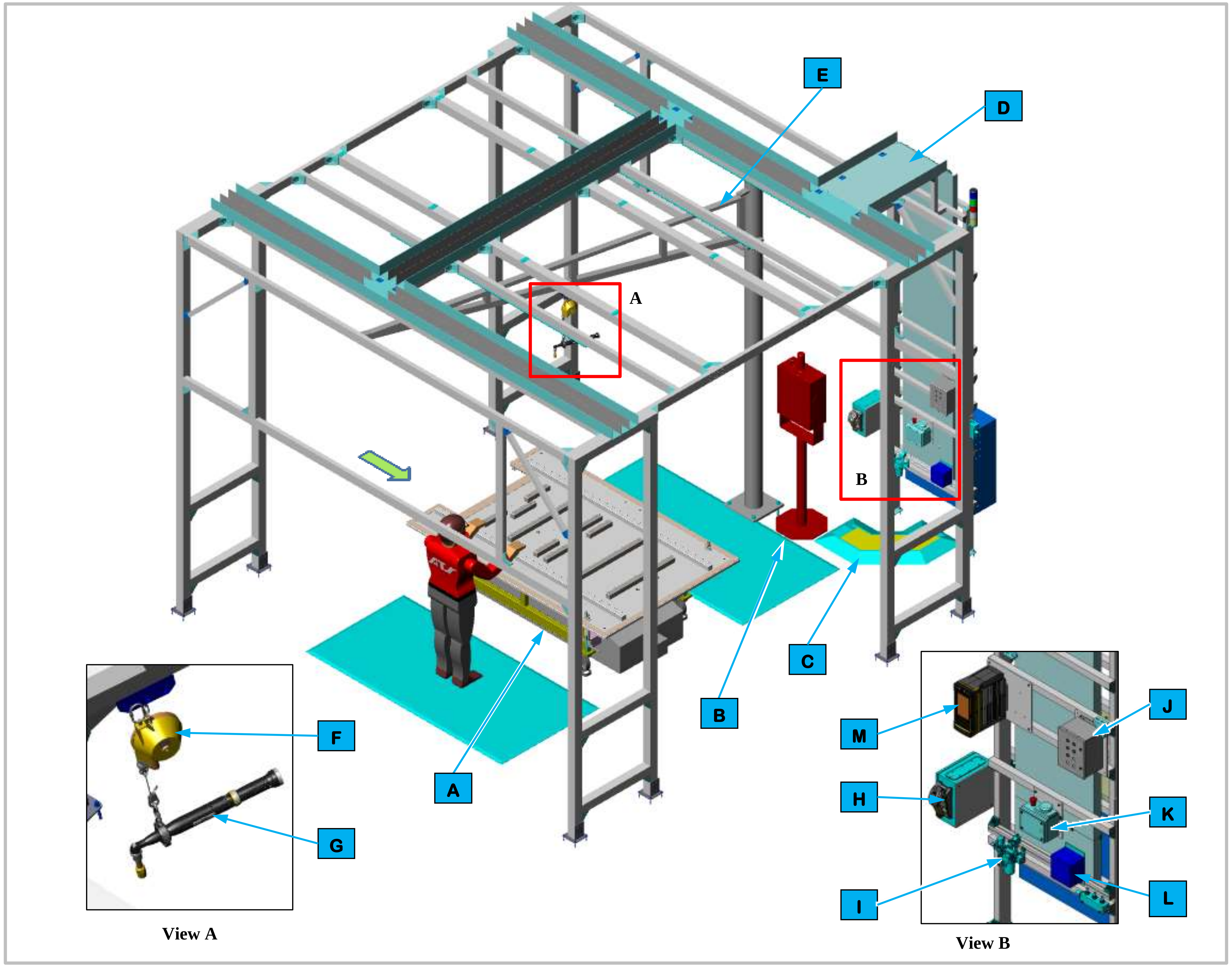


Figure 3-69. EP325 Midplate Load and Secure Manual Repair Station Isometric View.

3.6.19.2. Sequence of Operation for BET

Step	Process
1	Follow repair procedure

3.6.19.3. Sequence of Operation for BEV3

Step	Process
1	N/A

Equipment Callouts in Station EP325 Isometric View		
A	N/A	Automated Guided Cart (AGC)
B	EP325D1	Operator Console HMI
C	N/A	Cable Protector
D	N/A	Wireway
E	N/A	Jib Crane
F	N/A	Tool Balancer
G	EP325TC1	Nutrunner
H	EP325BC1	Barcode Scanner
I	AIRON	Air Preparation Unit
J	EP325E2	Operator Push Button Box
K	EP325E1	Operator Release/E-Stop
L	EP325RCP1	Electrical Outlet Box
M	EP325TC1	Nutrunner Controller

3.6.20. EP340 Midplate To Tray Dimensional Check Station Description

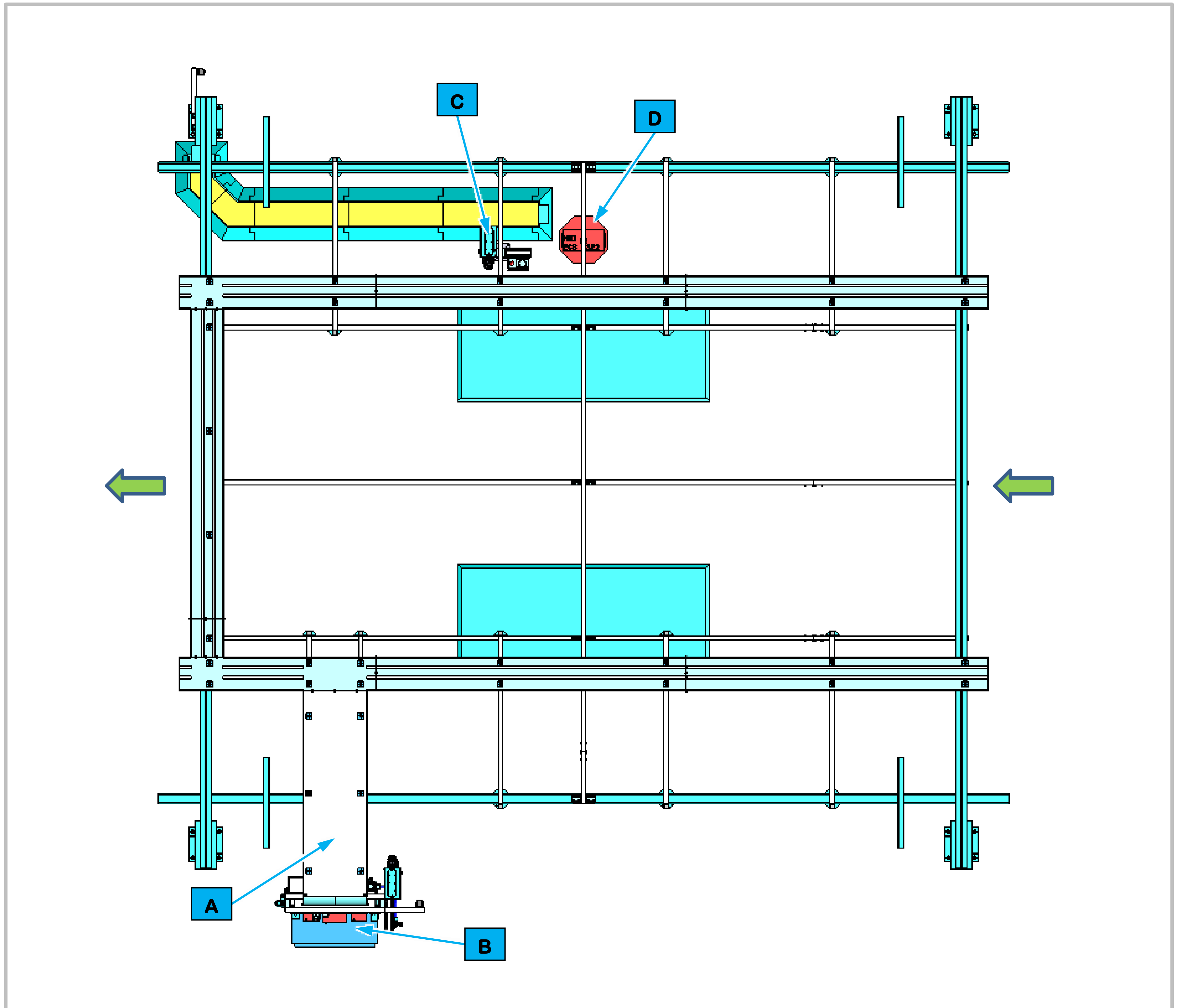


Figure 3-70. EP340 Midplate To Tray Dimensional Check Station Top View.

3.6.20.1. Station Description

Cell EP340 is a manual station for performing a test on the tray datum's and stanchion holes on BET battery packs.

Equipment Callouts in Station EP340 Top View		
A	N/A	Wireway
B	EP340P2	Power Cabinet
C	EP340BC1	Barcode Scanner and E-Stop
D	EP340D1	Operator Console HMI

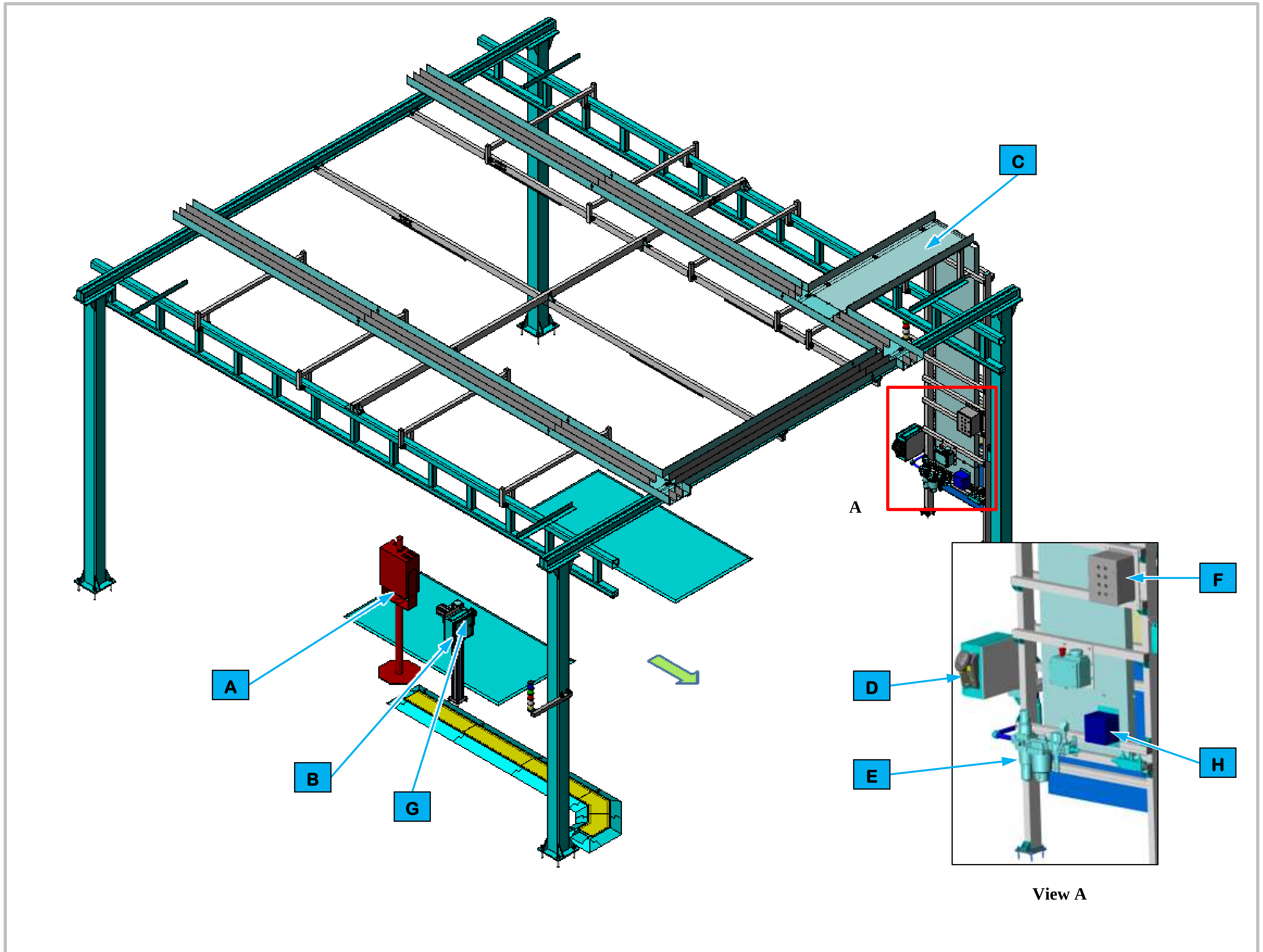


Figure 3-71. EP340 Midplate To Tray Dimensional Check Station Isometric View

3.6.20.2. Sequence of Operation for BET

Step	Process
1	Operator measures tray datum's and stanchion holes

3.6.20.3. Sequence of Operation for BEV3

Step	Process
1	N/A

Equipment Callouts in Station EP340 Isometric View		
A	EP340D1	Operator Console HMI
B	EP340BC1	Barcode Scanner and E-Stop
C	N/A	Wireway
D	N/A	Barcode Scanner
E	AIRON	Air Preparation Unit
F	EP340E2	Operator Push Button Box
G	EP340E1	Operator Release/E-Stop
H	EP340RCP1	Electrical Outlet Box

3.6.21. EP380/EP400 Upper Module Load and Secure Station Description

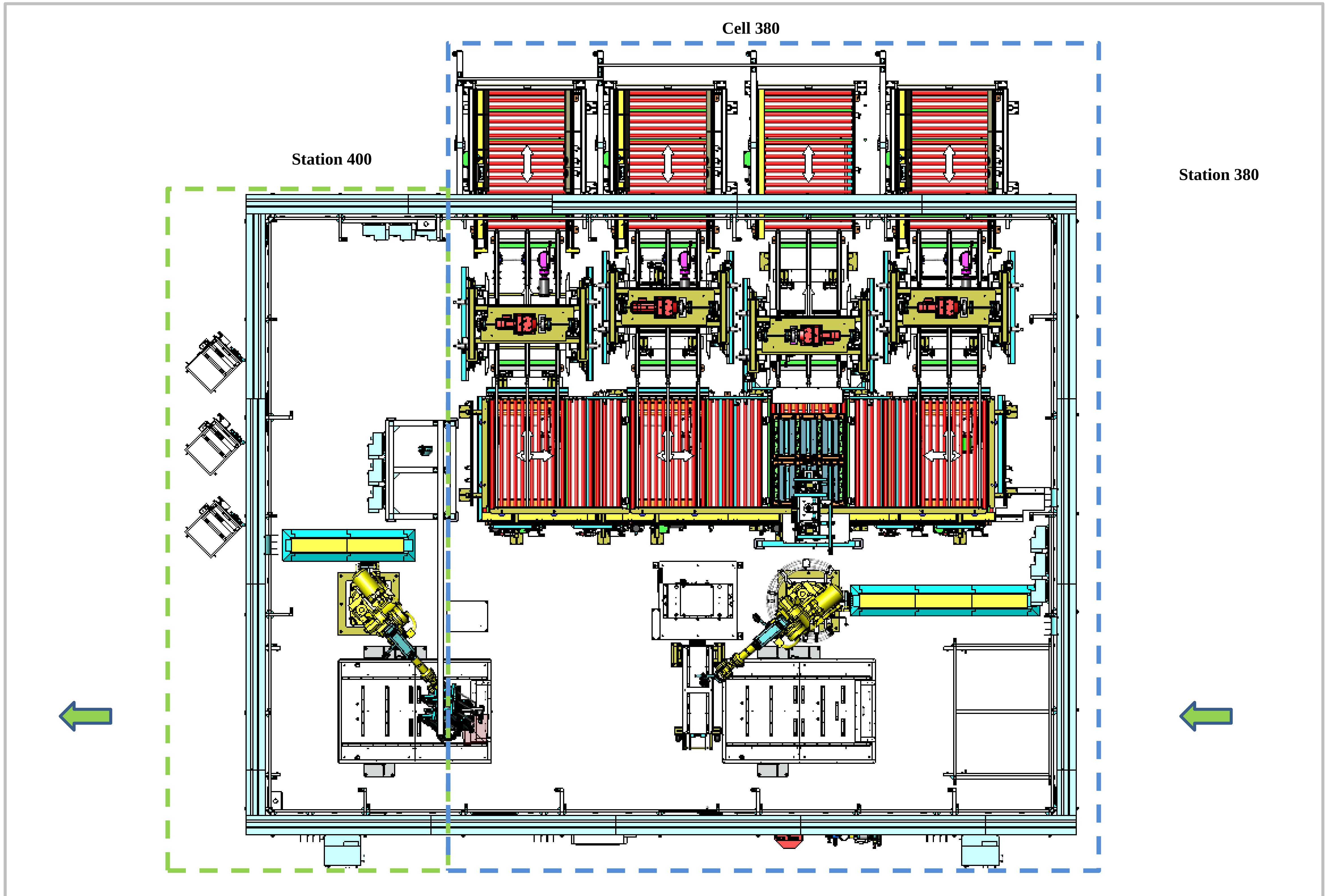


Figure 3-72. EP380/EP400 Upper Module Load and Secure Station Top View.

3.6.21.1. Station Description

Cell EP380/EP400 is a fully automated station used to install and secure modules to the battery assemblies on BET battery assemblies.

The Automated Guided Cart enters the station EP380 where modules in dunnage are delivered into the cell. The Load Modules Robot picks and places modules into the battery assemblies on the AGC. The AGC then moves forward into Station EP400 where the Module Fasten Robot secures the modules to the battery assembly with bolts. The AGC then moves forward and exits the station.

BEV3 battery assemblies do not use this station

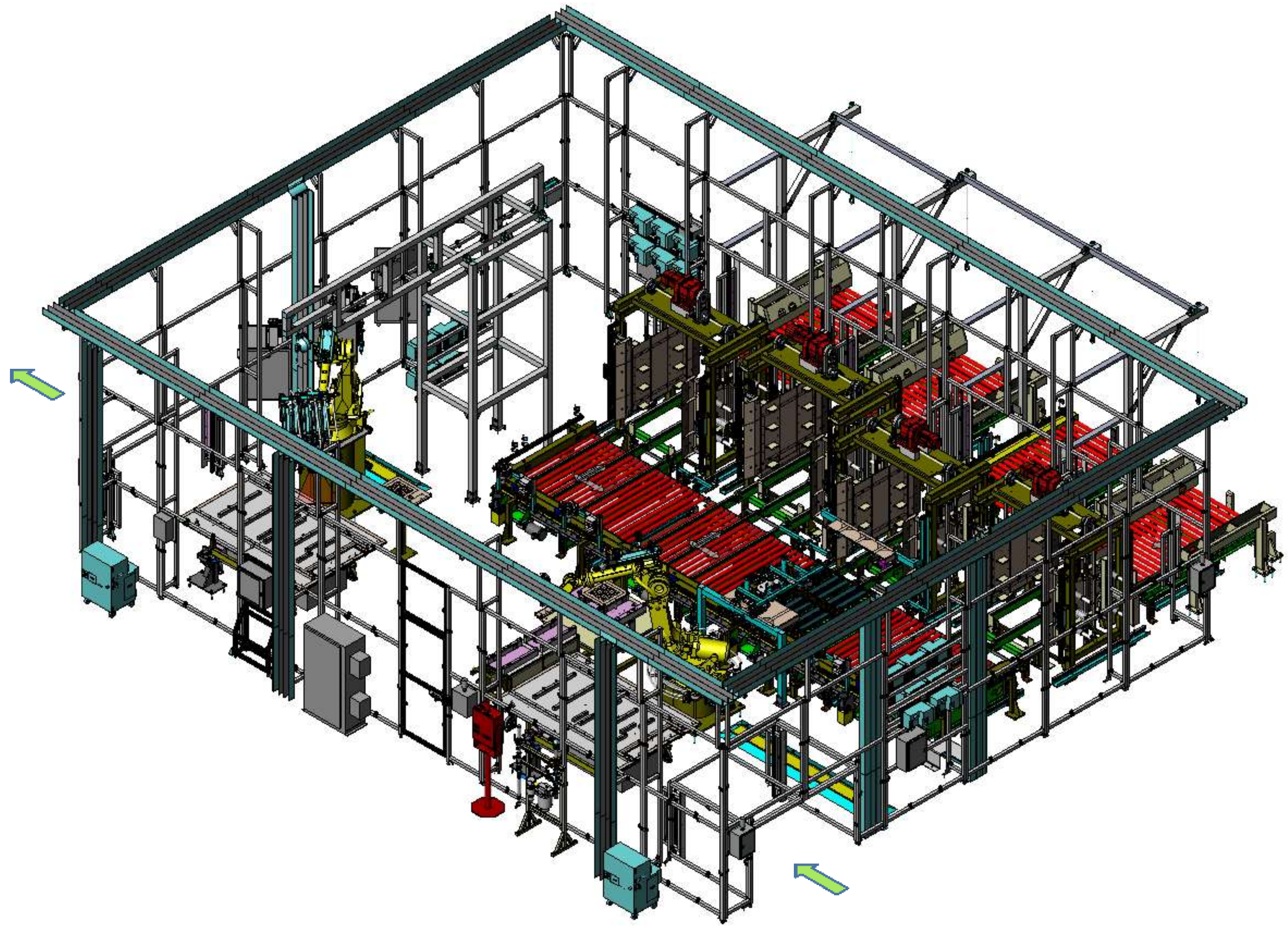
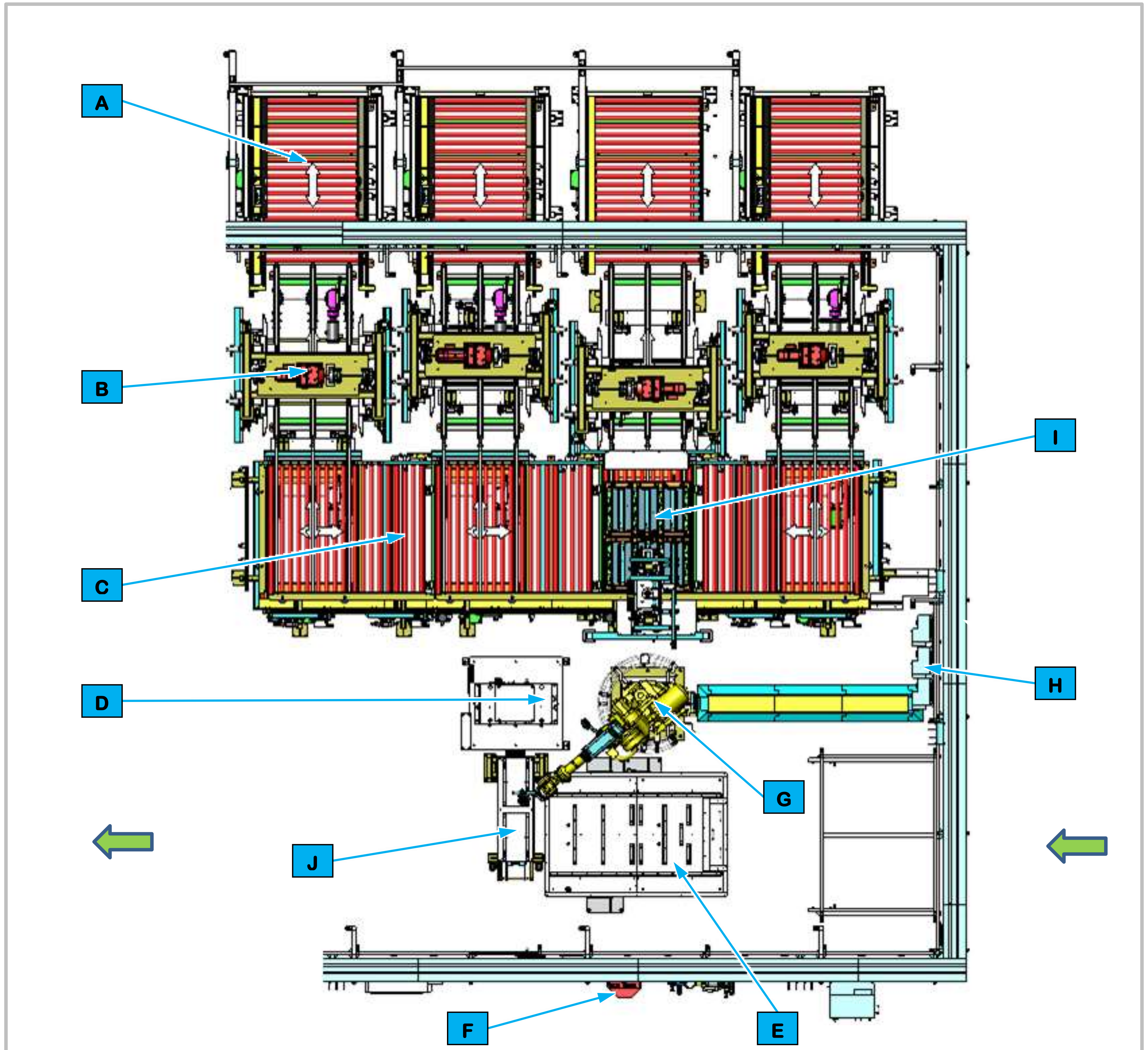


Figure 3-73. EP380/EP400 Upper Module Load and Secure Station Isometric View.



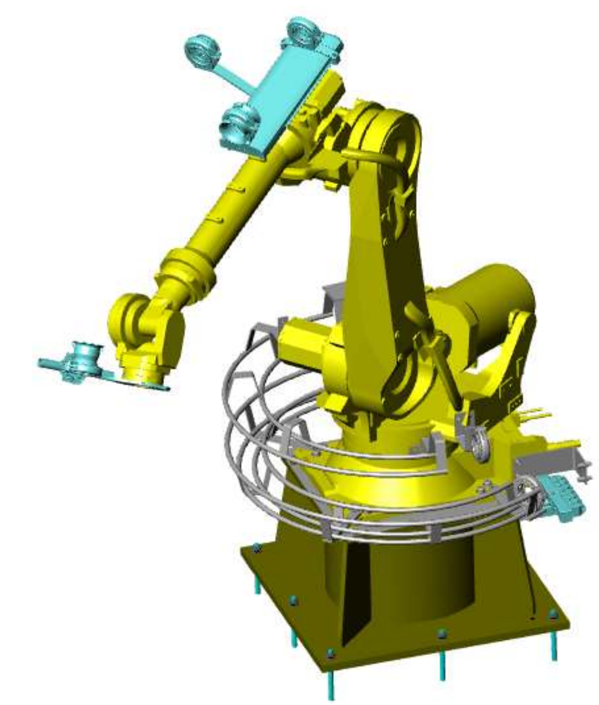


Figure 3-74. Module Load Robot

Equipment Callouts in Station EP380 Top View		
A	EP380T0XB01	Conveyors
B	N/A	Module Tray Stackers
C	EP380T0XB01	Cross Feed Conveyors
D	N/A	Spare Module Dial
E	N/A	Automated Guided Cart
F	EP380D1	Operator Console HMI
G	EP380R01	Module Load Robot
H	IDC01-5	ArmorStart
I	N/A	Module Dunnage
J	N/A	NOK Module Tool Cart

Figure 3-75. EP380 Upper Module Load Station Top View.

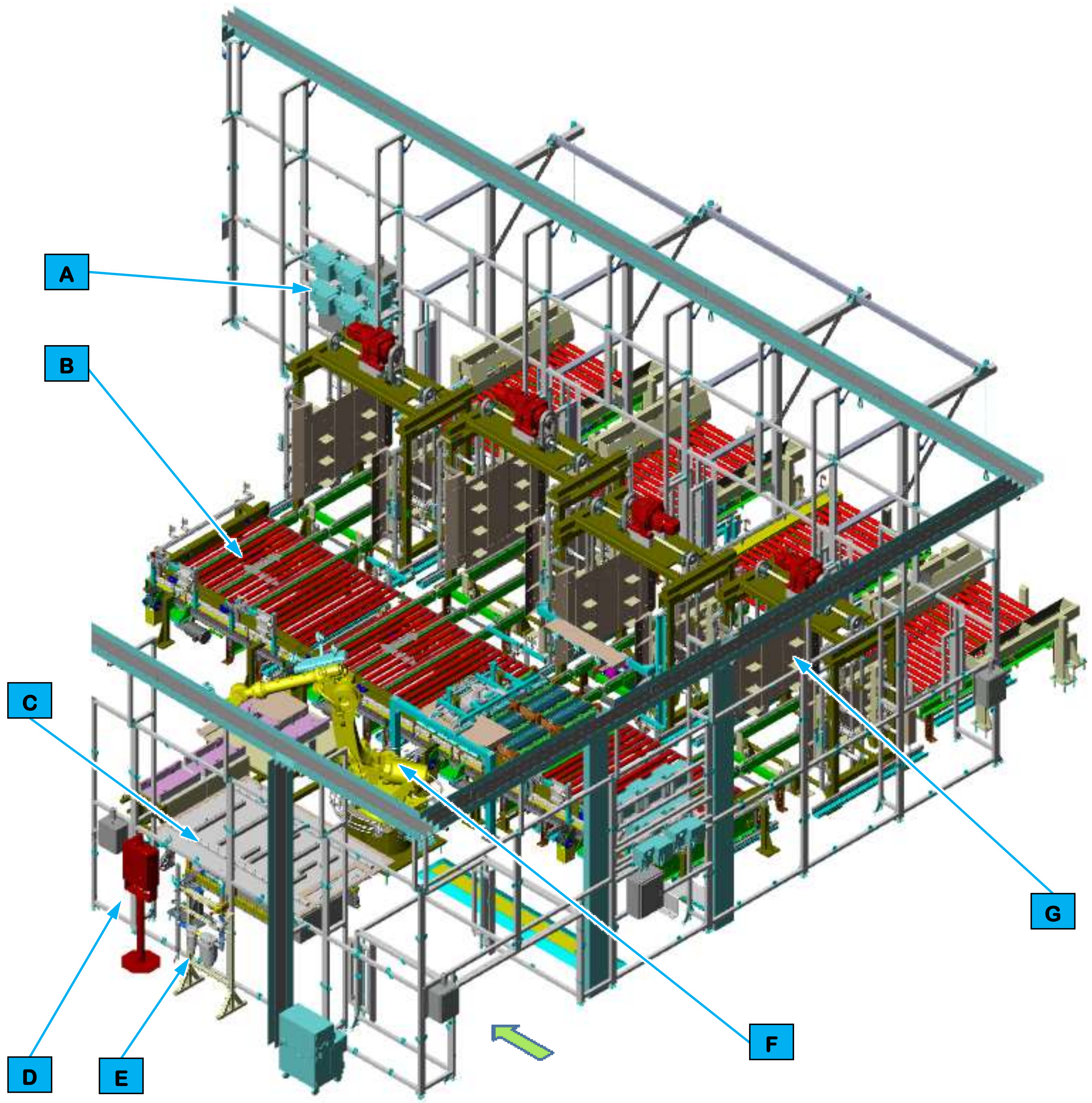


Figure 3-77. EP380 Upper Module Load Station Isometric View.

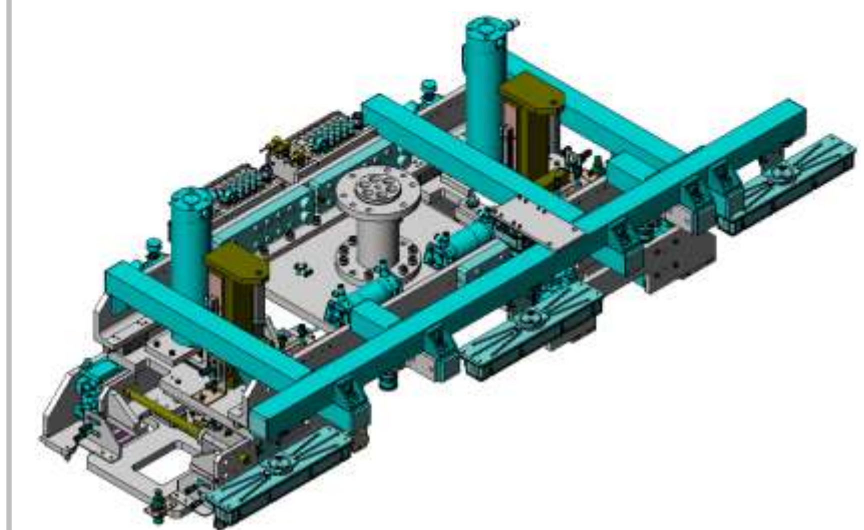


Figure 3-76. Load Module EOAT

Equipment Callouts in Station EP380 Isometric View		
A	IDC01-5	ArmorStart
B	EP380T0XB01	Cross Feed Conveyor
C	N/A	Automated Guided Cart
D	EP380D1	Operator Console HMI
E	AIRON	Air Preparation Unit
F	EP380R01	Module Load Robot
G	EP380T0XB01	Module Tray Stackers

3.6.21.2. Cell EP380 Sequence of Operation

The Upper Module Load Station equipment completes the following operations during a normal cycle:

1. The AGC enters Cell EP380 carrying a battery assembly.
2. The Module Load Robot (refer to callout **F** in ***Figure 3-77***) manipulates End of Arm Tooling (EOAT) to scan and pick two (2) modules from dunnage on Conveyor Equipment.
3. The Module Load Robot rotates to the waiting AGC.
4. The Module Load Robot uses vision cameras to align the EOAT holding the modules with the battery assembly.
5. The Module Load Robot lowers the EOAT to place the modules into the battery assembly.
6. The Module Load Robot raises to clear the battery assembly and rotates to the dunnage.
7. The Module Load Robot repeats steps 2 through 6 until the correct number of modules are placed into the battery assembly depending on the type of battery assembly.
8. The Module Load Robot raises to clear of the battery assembly.
9. The AGC moves forward to Station EP400.

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

3.6.21.3. Module Load Robot and EOAT

Station EP380 contains one Module Load Robot (EP380R01). The FANUC R2000IC-210F (refer to ***Figure 3-74***) is a 6-axis robot with a load capacity of 462 lbs. Attached to the Module Load Robot is End of Arm Tooling (EOAT) used to scan and pick two (2) modules from dunnage, rotate to the waiting AGC, use vision cameras to algin the modules with the battery assembly, and then lowers the modules to the battery assembly. Having completed this operation, the Module Load Robot raises to clear the battery assembly and rotates back to the dunnage to pick another two (2) modules. The Module Load Robot will repeat this process until the appropriate number of modules have been placed into the battery assembly depending on the battery assembly type. Once the appropriate number of modules have been placed the Module Load Robot will raise the EOAT clear of the battery assembly allowing the AGC to move forward.

The Load Module EOAT (refer to ***Figure 3-76***) consists of a frame that holds linear lights, a camera, a scanner, and track mounted subframes holding pneumatic grippers and alignment pins. Three (3) linear lights are mounted on one side of the frame with two (2) FANUC iRVision camera used to vision align the EOAT with modules in dunnage and a barcode scanner used to scan modules are mounted between the linear lights. Attached to the frame are two track mounted subframes consisting of four (4) corner mounted pneumatic grippers and four (4) central mounted pneumatically actuated alignment pins.

When the EOAT is lowered to the modules in dunnage pneumatically actuated alignment pins are lowered to align the EOAT with the module and the grippers are actuated to pick two (2) modules from dunnage. The grippers and alignment pins remain in place while the Module Load Robot rotate from dunnage to the battery assembly on the AGC. The robot then lowers the modules to the battery assembly and the grippers and alignment pins retract releasing the modules.

REFERENCE	***For more information about the robot equipment, refer to the equipment supplier documentation (FANUC Robot R-2000 iC Operator's Manual).***

3.6.21.4. Module Tray Stacker System and Conveyor Equipment

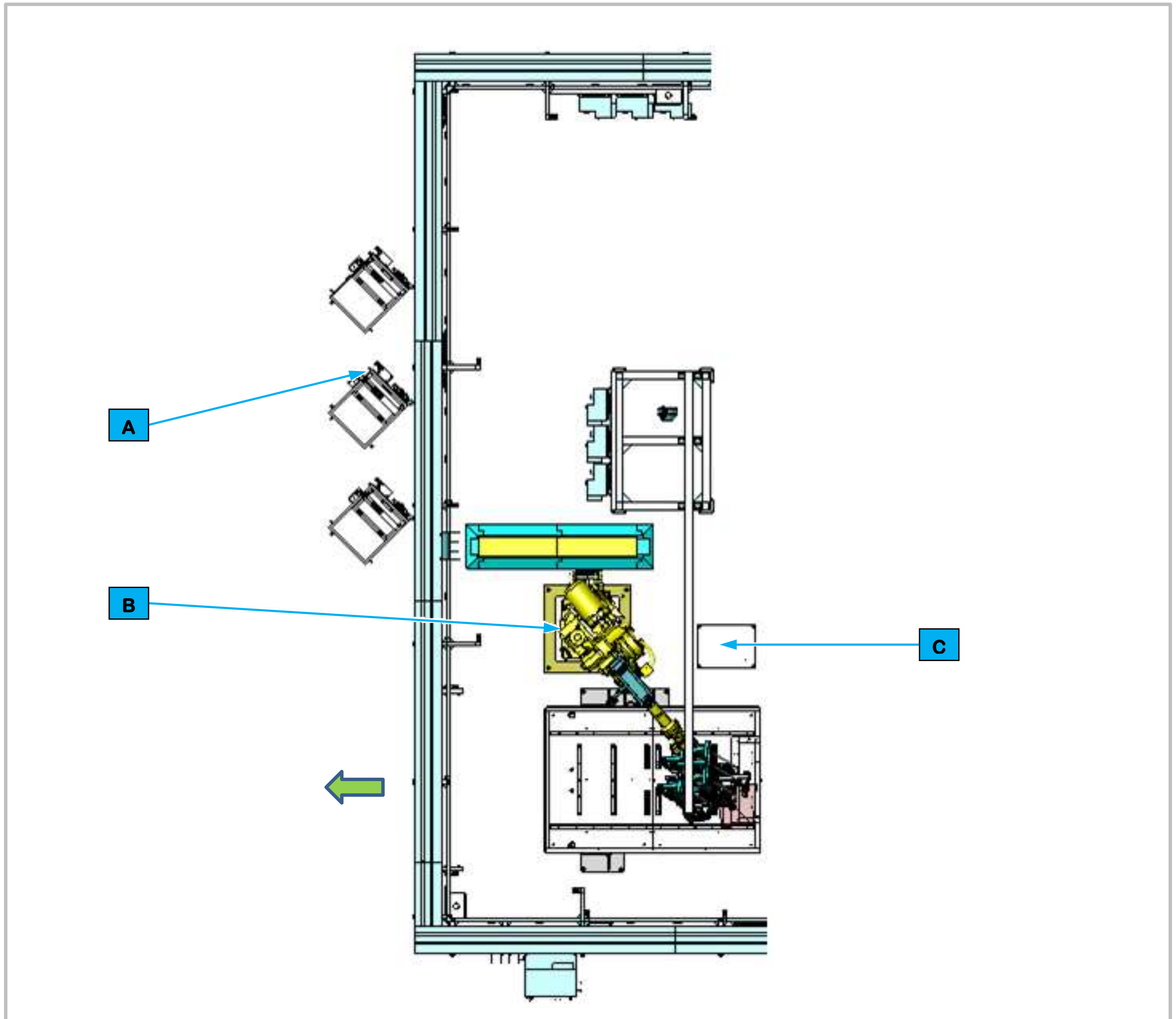
The Module Tray Stacker System (EP380T01, refer to callout **G** in ***Figure 3-77***) consists of four (4) stacker assemblies, three (3) of the stackers are used to lift and hold module dunnage trays and deliver the trays one at a time into the cell and the fourth stacker is used to stack empty trays into a stack. Inside the cell a perpendicular conveyor (refer to callout **B** in ***Figure 3-77***) is used to transfer empty trays to the unload stacker.

Module dunnage trays are place onto the conveyor system outside of the cell in stacks of four (4) and are moved by power rollers into one (1) of the three (3) Module Tray Stackers. A module dunnage tray stack is moved by power rollers into the Module Tray Stacker and three (3) sets of lifting forks are advanced forward to grip and lift the top three (3) trays allowing the bottom fourth tray to be pulled into the cell. The Module Tray Stacker then lowers the stack of three (3) trays to the conveyor and retracts the lifting forks holding the bottom third tray allowing the third tray to be pulled into the cell. The Module Tray Stacker repeats this process for the remaining trays in the stack until the last tray of the stack has been released into the cell.

Empty module dunnage trays move along the conveyor system to the middle Module Tray Stacker of the system and the process is performed in reverse on the empty trays. Empty trays are lifted by lifting forks and held until a stack of four (4) trays has been created in the Module Tray Stacker then the lifting forks are withdrawn. The stack of empty trays is then moved out of the Module Tray Stacker and out of the cell.

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 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 personnel 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.

<u>**REFERENCE**</u>	***For more information about the conveyor equipment, refer to the equipment supplier documentation (Omni Metalcraft Technical Handbook).***



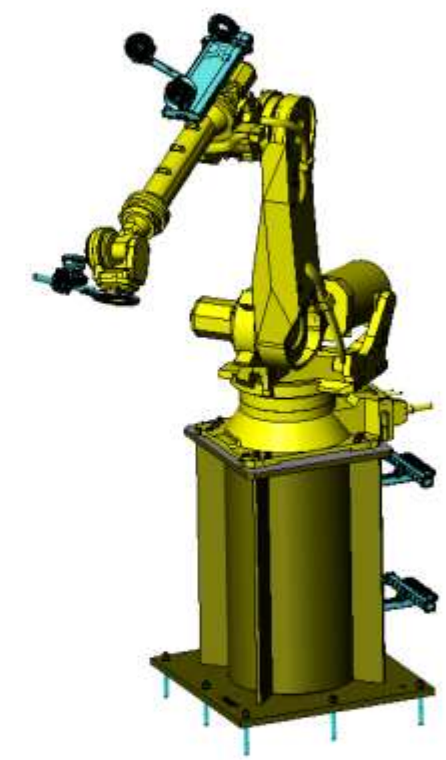
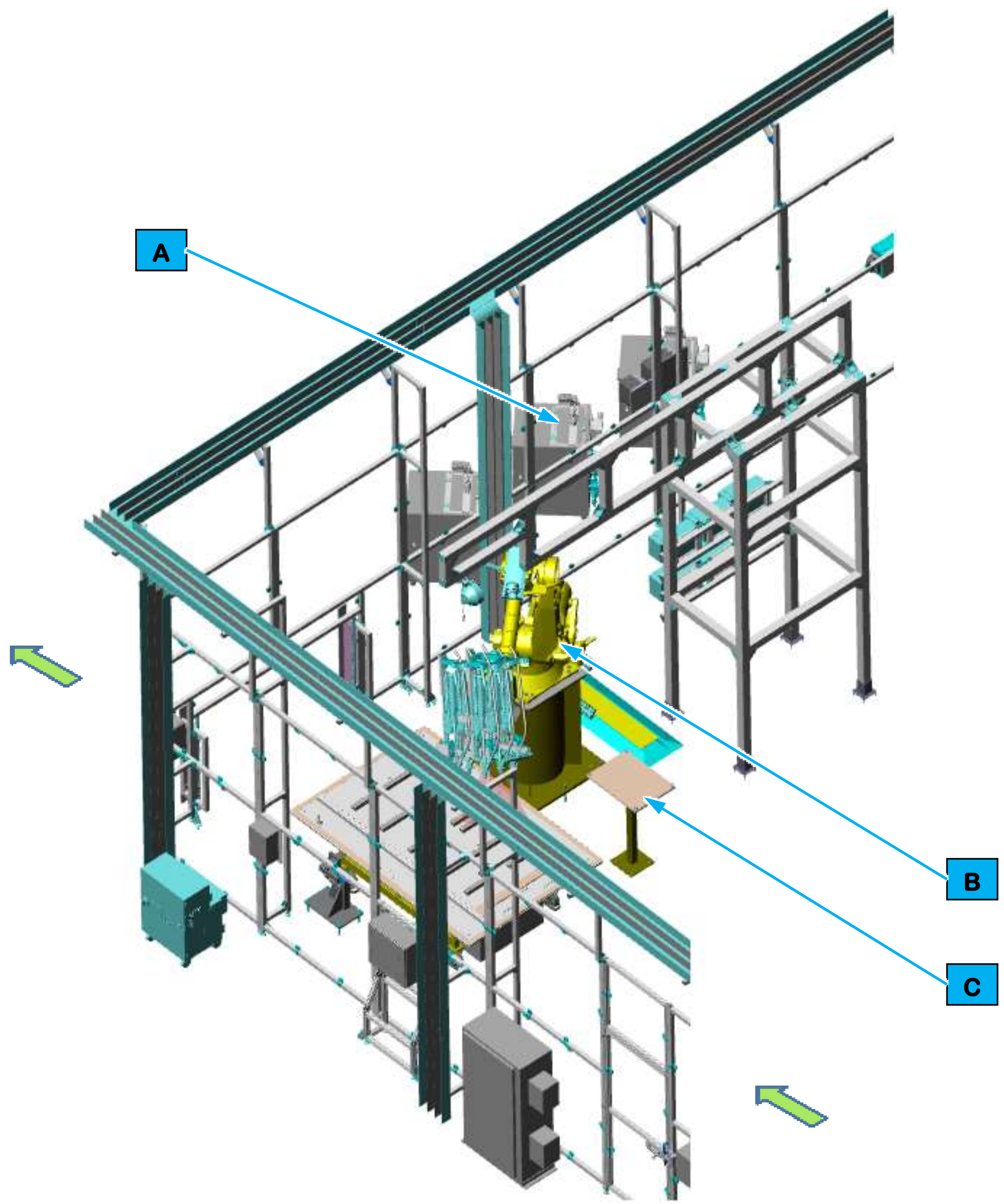


Figure 3-78. Module Secure Robot

Equipment Callouts in Station EP400 Top View		
A	EP400BF1 -3	Feeders
B	EP400R01	Module Secure Robot
C	N/A	Robot and Vision Calibration Stand

Figure 3-79. EP400 Upper Module Secure Station Top View.



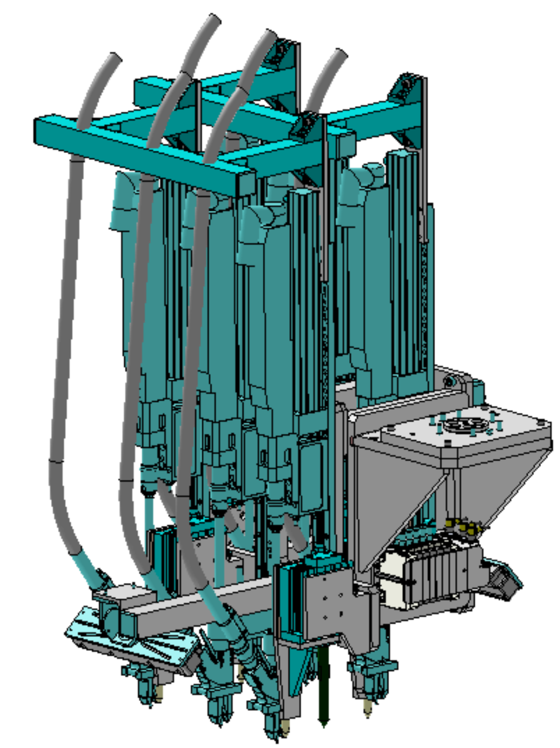


Figure 3-80. Module Secure EOAT

Equipment Callouts in Station EP400 Isometric View		
A	EP120BF1 -3	Fastener Feed System
B	EP120R01	Module Secure Robot
C	N/A	Robot and Vision Calibration Stand

Figure 3-81. EP400 Upper Module Secure Station Isometric View.

3.6.21.5. Station EP400 Sequence of Operation for BET

The Upper Module Secure Station equipment completes the following operations during a normal cycle:

1. The AGC enters Station EP400 from adjoined Cell EP380.
2. The Module Secure Robot (refer to callout **B** in ***Figure 3-81***) rotates and lowers to the battery assembly.
3. The Module Secure Robot manipulates vision aligned End of Arm Tooling (EOAT) to the modules.
4. The Module Secure Robot EOAT fastens the modules to the battery assembly with bolts.\
5. The Module Secure Robot raises to clear the battery assembly.
6. The AGC moves forward to exit Station EP400.

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

3.6.21.6. Module Secure Robot and EOAT

Station EP400 contains one Module Secure Robot (EP400R01). The FANUC R2000IC-210F (refer to ***Figure 3-78***) is a 6-axis robot with a load capacity of 462 lbs. The robot rotates and lowers the vision aligned EOAT to the battery assembly, receives blow-fed bolts to the EOAT and then fastens the bolts 6 at a time using drivers. Having completed this operation, the Module Load Robot raises to clear the battery assembly allowing the AGC to move forward and exit the cell.

The Module Secure EOAT (refer to ***Figure 3-80***) consists of frame that holds two (2) opposing light bars on each side with a center aligned FANUC iRVision camera. Within the frame are 2 rows of 3 drivers aligned beside each other allowing for 2 rows of 3 bolts to be secured at the same time. When the EOAT is lowered into the battery assembly the drivers are fed bolts that are vision aligned and torqued to a consistent value.

REFERENCE	***For more information about the robot equipment, refer to the equipment supplier documentation (FANUC Robot R-2000 iC Operator's Manual).***

3.6.21.7. Robot and Vision Calibration Stand

The Robot and Vision Calibration Stand (refer to callout **C** in ***Figure 3-79***) provides a calibration grid that is used as a reference when calibrating the robot and robot vision equipment. Calibration of the robot and robot vision equipment is documented in the associated FANUC documentation.

3.6.21.8. Fastener Feed System

The Carlson S12 Fastener Feed System (EP400BF1 -3, refer to callout **C** in ***Figure 3-81***) is an electrically motorized fastener assembly that sorts and aligns bolts into an inline track that are then blow fed into an air hose to the Midplate Fasten Robot EOAT.

REFERENCE	***For more information about fastener feed system equipment, refer to the equipment supplier documentation (Carlson S12 Technical Manual).***

3.6.22. EP420 Z-Blocker Install Station Description

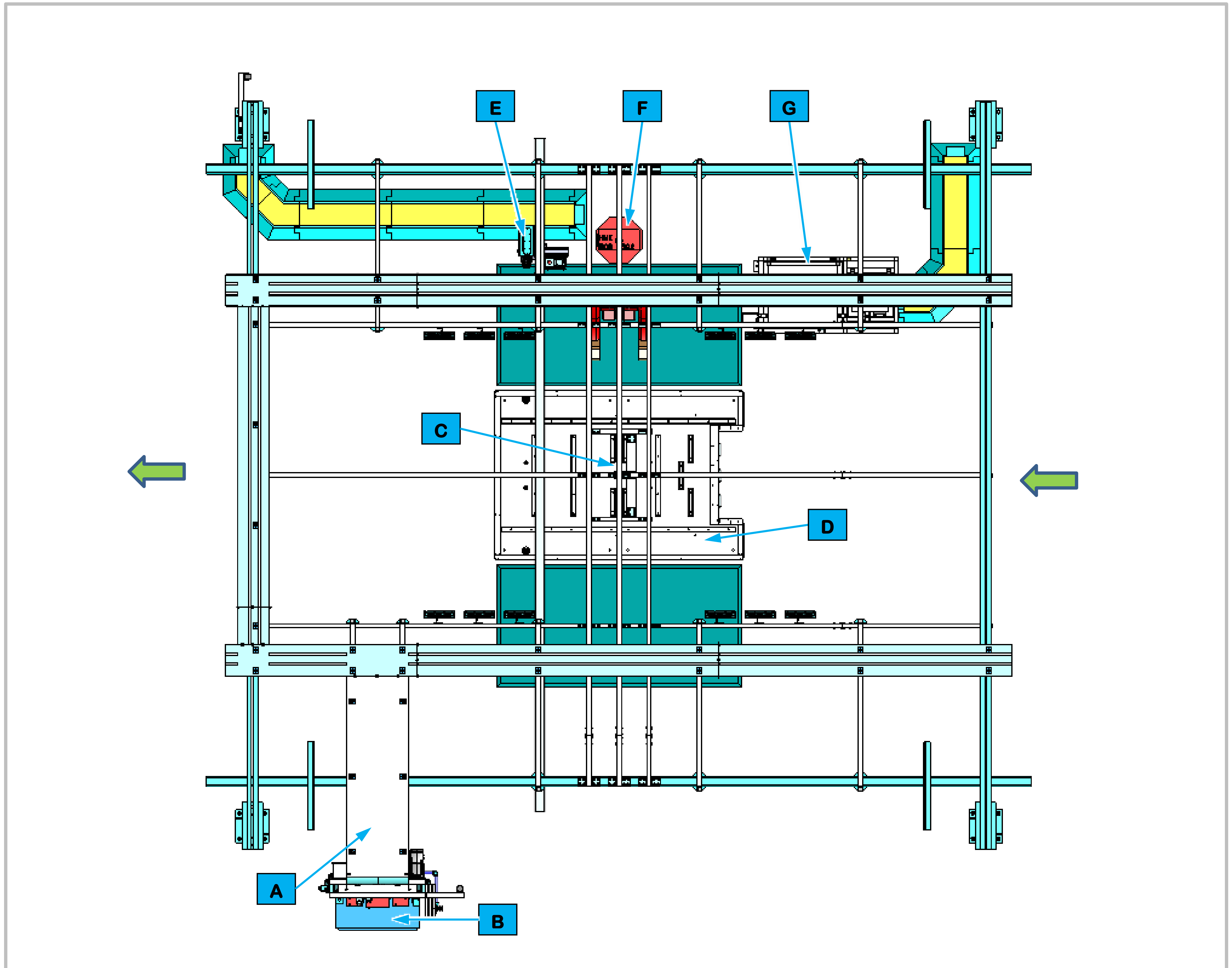
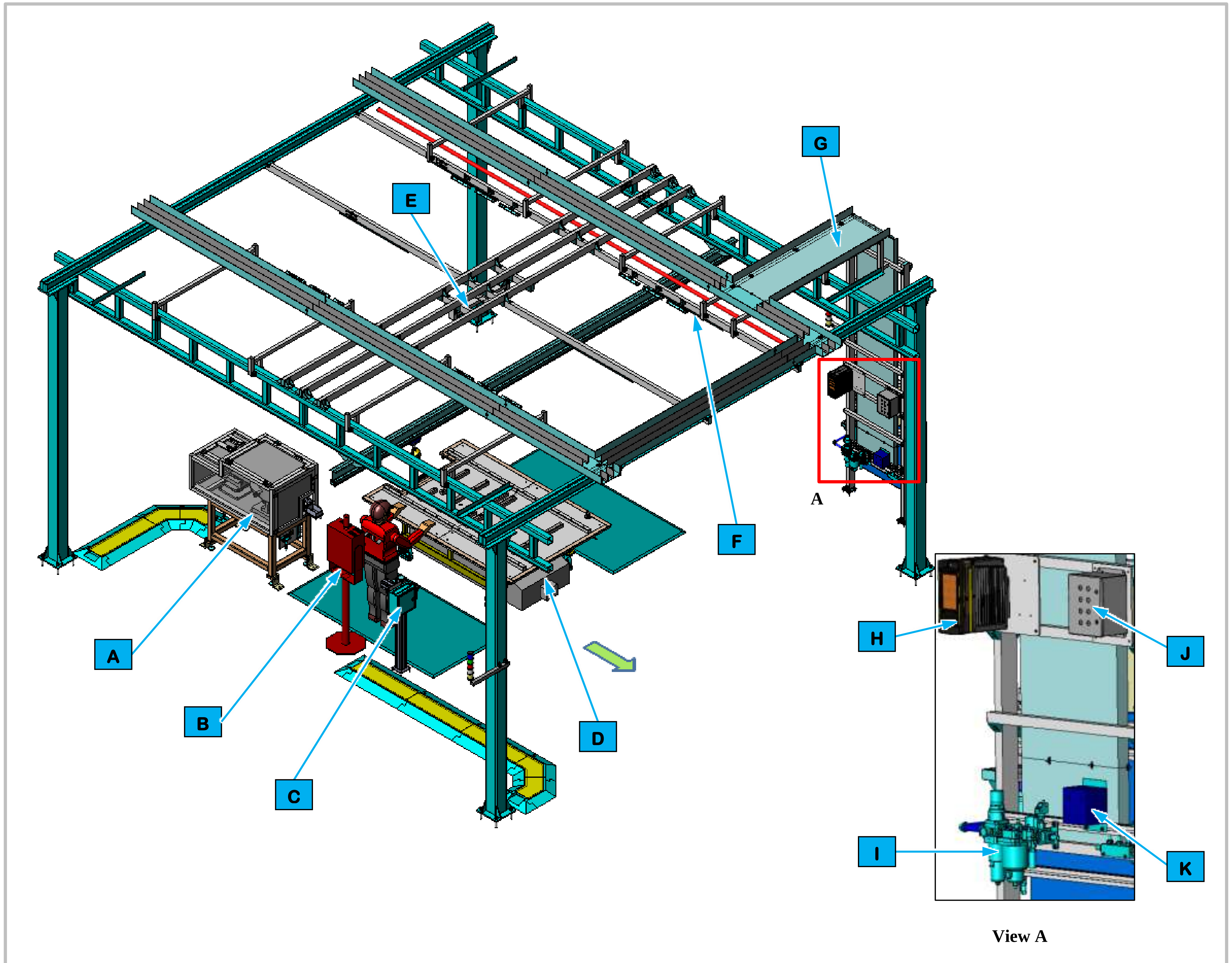


Figure 3-82. EP420 Z-Blocker Install Station Top View.

3.6.22.1. Station Description

Cell EP420 is a manual station for installing the Center Z-Blocker, the String A Bus Bar, the Midpack Bus Bar and the BDU Bracket to the BET Batteries.

Equipment Callouts in Station EP420 Top View		
A	N/A	Wireway
B	EP420P2	Power Cabinet
C	EP420C1	Inspection Camera
D	N/A	Automated Guided Cart (AGC)
E	EP420BC1	Barcode Scanner and E-Stop
F	EP420D1	Operator Console HMI
G	EP420SF1	Feeder



3.6.22.2. Sequence of Operation for BET

Step	Process
1	Get and install Center Z-Blocker
	Vision inspect Center Z-Blocker
2	Get and install String A Bus Bar
3	Get and install the Midpack Bus Bar
4	Get and install the BDU Bracket

3.6.22.3. Sequence of Operation for BEV3

Step	Process
1	N/A

Equipment Callouts in Station EP420 Isometric View		
A	EP420SF1	Feeder
B	EP420D1	Operator Console HMI
C	EP420BC1	Barcode Scanner and E-Stop
D	N/A	Automated Guided Cart (AGC)
E	EP420C1	Inspection Camera
F	N/A	Lights
G	N/A	Wireway
H	EP420TC1	Nutrunner Controller
I	AIRON	Air Preparation Unit
J	EP420E2	Operator Push Button Box
K	EP420RCP1	Electrical Outlet Box

Figure 3-83. EP420 Z-Blocker Install Station Isometric View

3.6.23. EP480 Upper Bus Bar Install and Secure Station Description

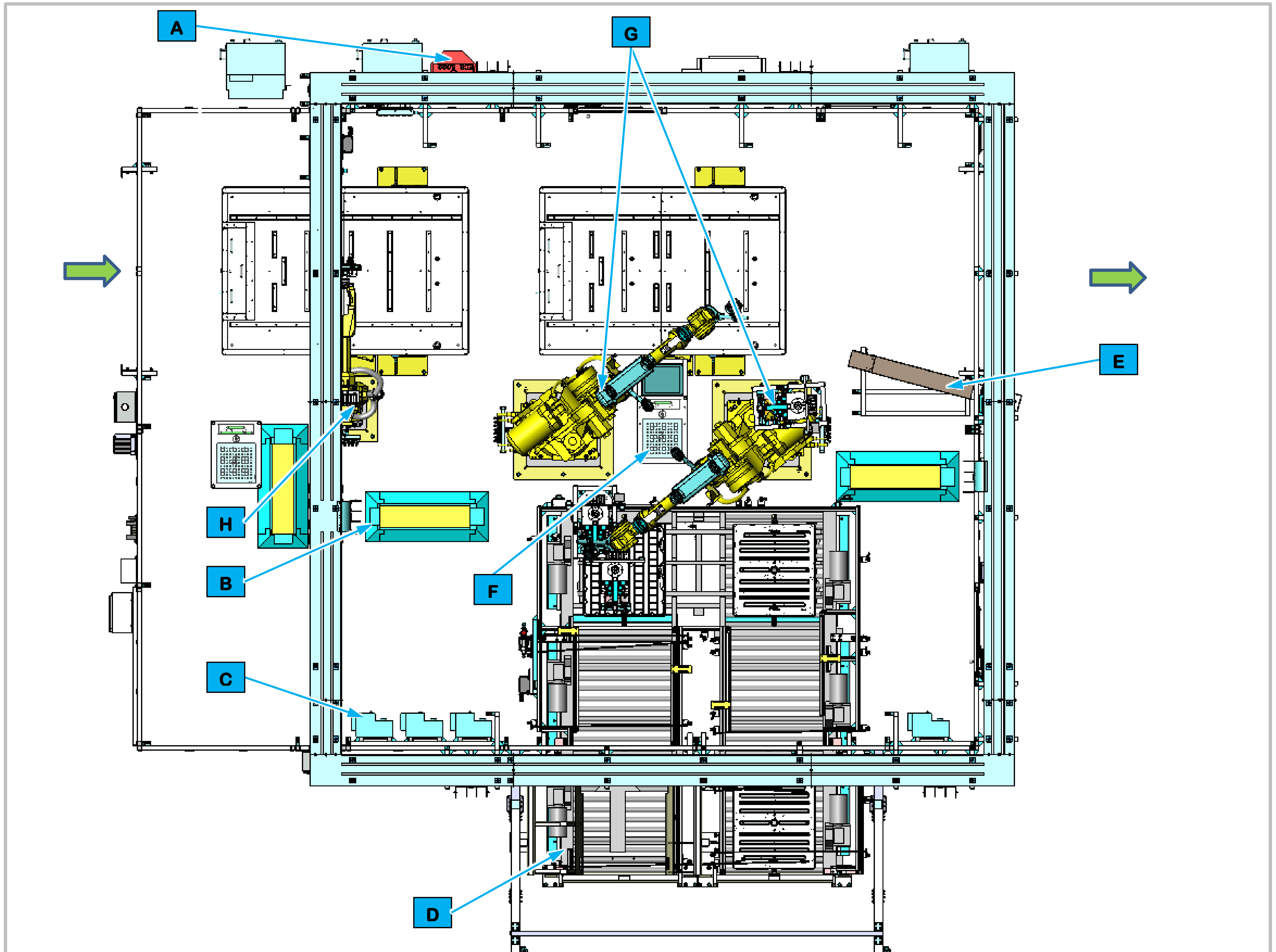


Figure 3-84. EP480 Upper Bus Bar Install and Secure Top View.

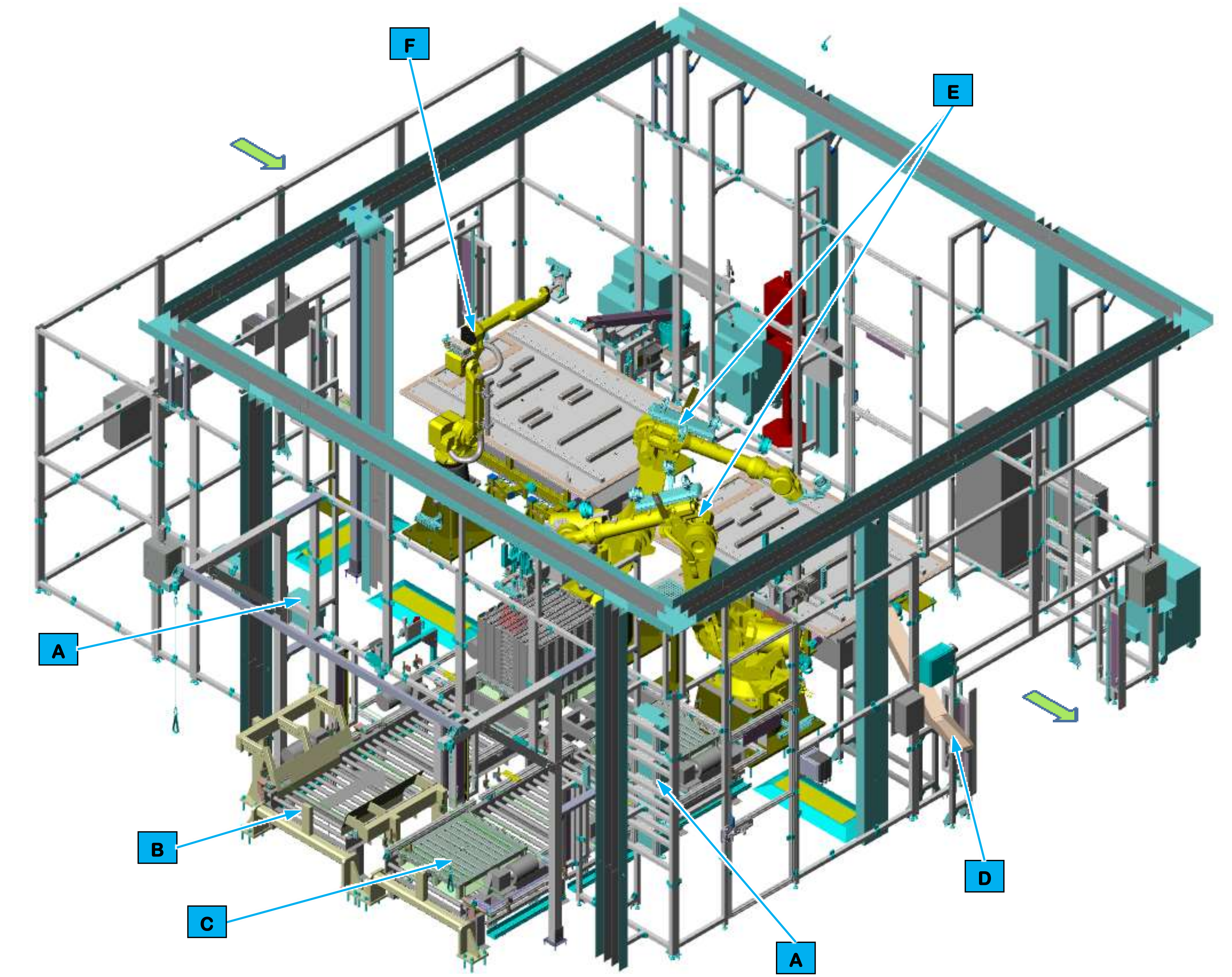
3.6.23.1. Station Description

Cell EP480 is a fully automated station used to install and secure bus bars onto the BET modules.

The Automated Guided Cart enters the station where bus bars in dunnage are delivered into the cell. One Terminal End Cap Robot removes the caps from the modules. Two Bus Bar Load and Secure Robots pick bus bars from dunnage and place them onto the modules of the battery assembly. The Bus Bar and Secure Robots then use EOAT drivers to secure the bus bars. The Robots repeat this process until the appropriate number of bus bars have been placed and secured for the type of battery assembly worked on. The AGC then moves forward and exits the station.

BEV3 battery assemblies do not use this station

Equipment Callouts in Station EP480 Top View		
A	EP480D1	Operator Console HMI
B	N/A	Cable Protector (2)
C	IDC1 -7	ArmorStart
D	EP480T01B01	Conveyors
E	N/A	Bus Bar Repair Chute
F	N/A	Robot and Vision Calibration Stand
G	EP480R01 -02	Bus Bar Load and Secure Robot (2)
H	EP480R03B01	Thermal End Cap Removal Robot



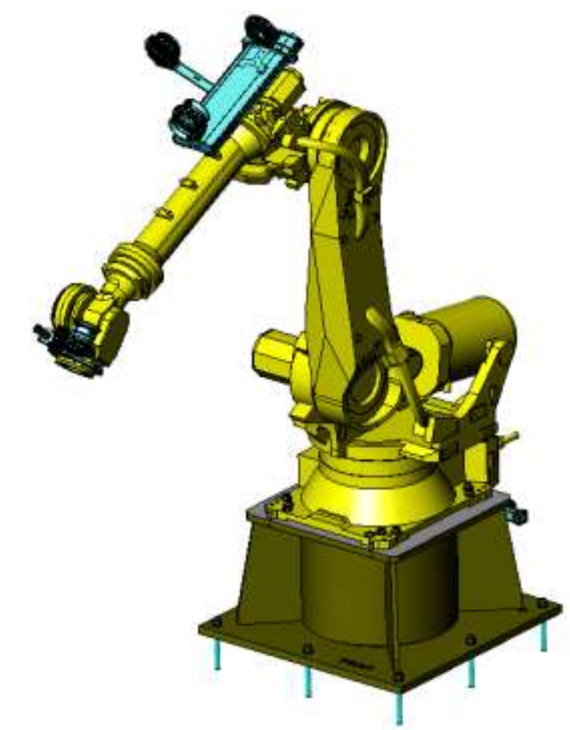
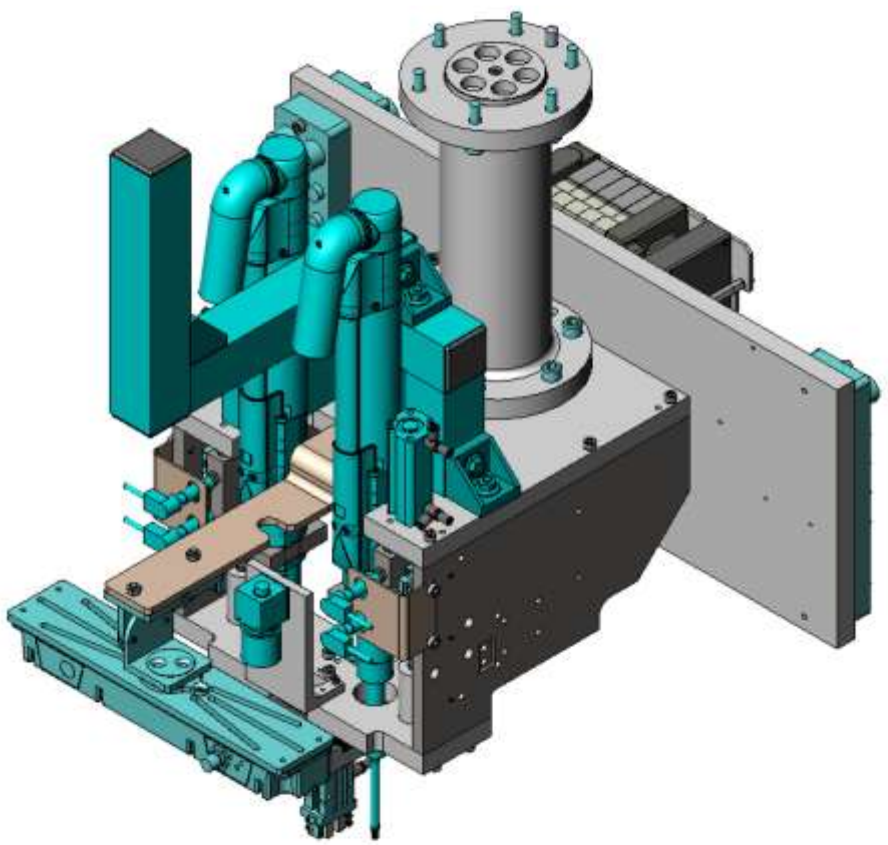


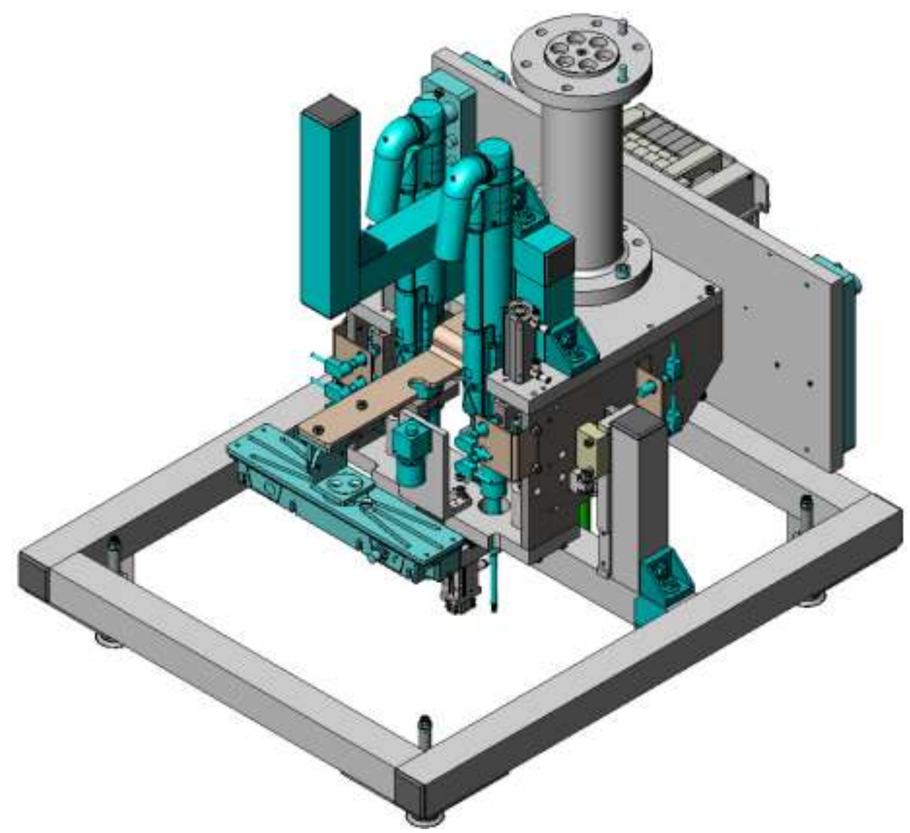
Figure 3-85. Bus Bar Load and Secure Robot

Equipment Callouts in Station EP480 Isometric View		
A	IDC1 -7	ArmorStart
B	EP480T01B01	Conveyors
C	N/A	Bus Bar Dunnage
D	N/A	Bus Bar Repair Chute
E	EP480R01 -02	Bus Bar Load and Secure Robot (2)
F	EP480R03B01	Thermal End Cap Removal Robot

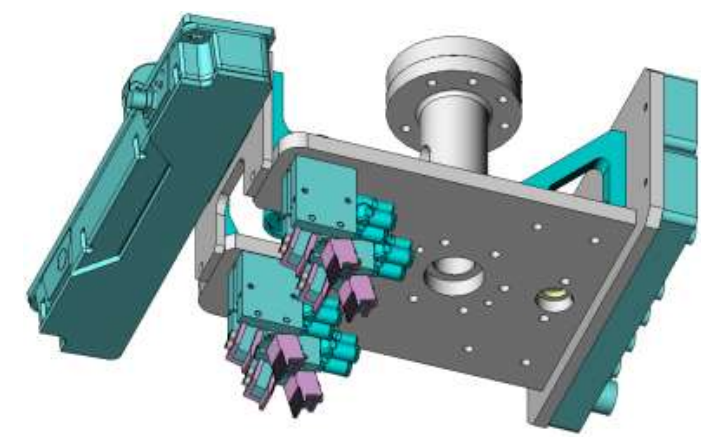
Figure 3-86. EP480 Upper Bus Bar Install and Secure Isometric View



**Bus Bar Load and
Secure EOAT
(Without Tray Gripper)**



**Bus Bar Load and
Secure EOAT
(With Tray Gripper)**



End Cap

EOAT

Figure 3-87. EP480 Upper Bus Bar Install and Secure End of Arm Tool View

3.6.23.2. Cell EP480 Sequence of Operation

The Upper Bus Bar Install and Secure Station equipment completes the following operations during a normal cycle:

Note: Two (2) Bus Bar Load and Secure Robots perform the same actions.

1. The AGC enters Cell EP480 carrying a battery assembly.
2. The End Cap Robot removes the End Cap from the Battery Assembly and places the End Caps on the Cap Chute.
3. The Bus Bar Load and Secure Robot (refer to callout **E** in ***Figure 3-86***) to manipulates End of Arm Tooling (EOAT) to pick bus bars from dunnage on Conveyor Equipment.
4. The Bus Bar Load and Secure Robot rotates to the waiting AGC.
5. The Bus Bar Load and Secure Robot uses a vision camera to align the EOAT holding a bus bar with the battery assembly.
6. The Bus Bar Load and Secure Robot lowers the EOAT to the place a bus bar into the battery assembly.
7. The Bus Bar Load and Secure Robot uses attached drivers to fasten the bus bar to the battery assembly with bolts.
8. The Bus Bar Load and Secure Robot raises to clear the battery assembly and rotates to the dunnage.
9. The Bus Bar Load and Secure Robot repeats steps 2 through 7 until the correct number of bus bars are placed into the battery assembly depending on the type of battery assembly.
10. The Bus Bar Load and Secure Robot raises to clear the battery assembly.
11. The AGC moves forward and exits the Cell.

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

3.6.23.3. Bus Bar Load and Secure Robot and EOAT

Cell EP480 contains two Bus Bar Load and Secure Robots (EP480R01 -02). The FANUC R2000IC-210F (refer to ***Figure 3-85***) is a 6-axis robot with a load capacity of 462 lbs. Attached to a Bus Bar Install and Secure Robot is End of Arm Tooling (EOAT) used to pick a bus bar from dunnage, rotate to the waiting AGC, use a vision camera to algin the bus bar with the battery assembly, and then lowers the bus bar to the battery assembly. Having completed this operation, the Bus Bar Install and Secure Robot raises to clear the battery assembly and rotates back to the dunnage to pick another bus bar. The Bus Bar Install and Secure Robot will repeat this process until the appropriate number of bus bars have been placed into the battery assembly depending on the battery assembly type. Once the appropriate number of bar bars have been placed the Bus Bar Install and Secure Robot raise the EOAT clear of the battery assembly allowing the AGC to move forward.

Two Bus Bar Install and Secure Robots work on the same battery assembly on an AGC at the same time within this Cell with one of the one of the Robot's EOAT equipped with a vacuum pad tray gripper that allows the Robot to transfer an empty tray from the infeed conveyor and places it on the outfeed conveyor allowing for a full dunnage tray to move forward.

The Bus Bar Install and Secure EOAT (refer to ***Figure 3-87***) consists of a frame that holds a center aligned linear light, a FANUC iRVision camera used to scan bus bar and align the bus bars with modules within the battery assembly. A center mounted bus bar gripper uses two (2) pneumatic actuators to close two (2) gripper pads to pick a bus bar from dunnage. Before the bus bar is placed onto modules within the battery assembly, the EOAT scans the modules to find an appropriate location for the bus bar and then places the busbar into the battery assembly. The EOAT will then use two (2) attached drivers located on both sides of the gripper to secure bolts that are attached to the bus bar. The two (2) pneumatic actuators then open the (2) gripper pads to release the bus bar.

If after scanning the modules within the battery assembly the EOAT does not find an appropriate location to place the bus bar, the Bus Bar Install and Secure Robot will rotate to the Repair Chute and place the bus bar into the Repair Chute.

Attached to one of the Bus Bar Install and Secure EOATs is an outer square frame that consists of five (5) vacuum pads attached to a vacuum generator with four (4) vacuum pads located at each corner of the frame and a center mounted pad. When a bus bar dunnage tray on the infeed conveyor has been emptied of bus bars, this robot will rotate to the empty tray and manipulate attached EOAT to the empty tray. When the EOAT is lowered to the empty tray the vacuum pads are activated by the vacuum generator to apply suction again the empty tray to pick the tray. The robot then raises and rotates to the outfeed conveyor and lowers the tray to the conveyor. The EOAT then stops the vacuum generator releasing the empty tray from the vacuum pads.

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

REFERENCE ***For more information about the robot equipment, refer to the equipment supplier documentation (FANUC Robot R-2000 iC Operator's Manual).***

3.6.23.4. Robot and Vision Calibration Stand

The Robot and Vision Calibration Stand (refer to callout **F** in ***Figure 3-84***) provides a calibration grid that is used as a reference when calibrating the robot and robot vision equipment. Calibration of the robot and robot vision equipment is documented in the associated FANUC documentation.

3.6.23.5. Bus Bar Repair Chute

The Bus Bar Repair Chute (refer to callout **E** in ***Figure 3-84***) is a sloped channel where unusable bus bars are placed by both Bus Bar Load and Secure Robots after the robots attempt to place the bus bar on battery assembly but cannot find an appropriate module.

3.6.23.6. Conveyor Equipment

The Conveyor Equipment (EP480T01B01, refer to callout **B** in ***Figure 3-86***) transfers dunnage carrying bus bars into the cell and empty dunnage out of the cell.

The Conveyor Equipment utilizes third-party OTP conveyance devices. Powered roller conveyor sections are used to pull full bus bar dunnage trays into the cell and to push empty bus bar dunnage trays out of the cell. Each powered roller conveyor section has its own motor and motor starter. At the Bus Bar Load and Secure Robots, one of the Robot's EOAT is equipped with a vacuum pad tray gripper that allows the Robot to transfer an empty tray from the infeed conveyor and places it on the outfeed conveyor allowing for a full dunnage tray to move forward.

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 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 personnel 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 conveyor equipment, refer to the equipment supplier documentation (Omni Metalcraft Technical Handbook).***

3.6.24. EP485 Bus Bar Install and Secure, Upper Deck Manual Repair Station Description

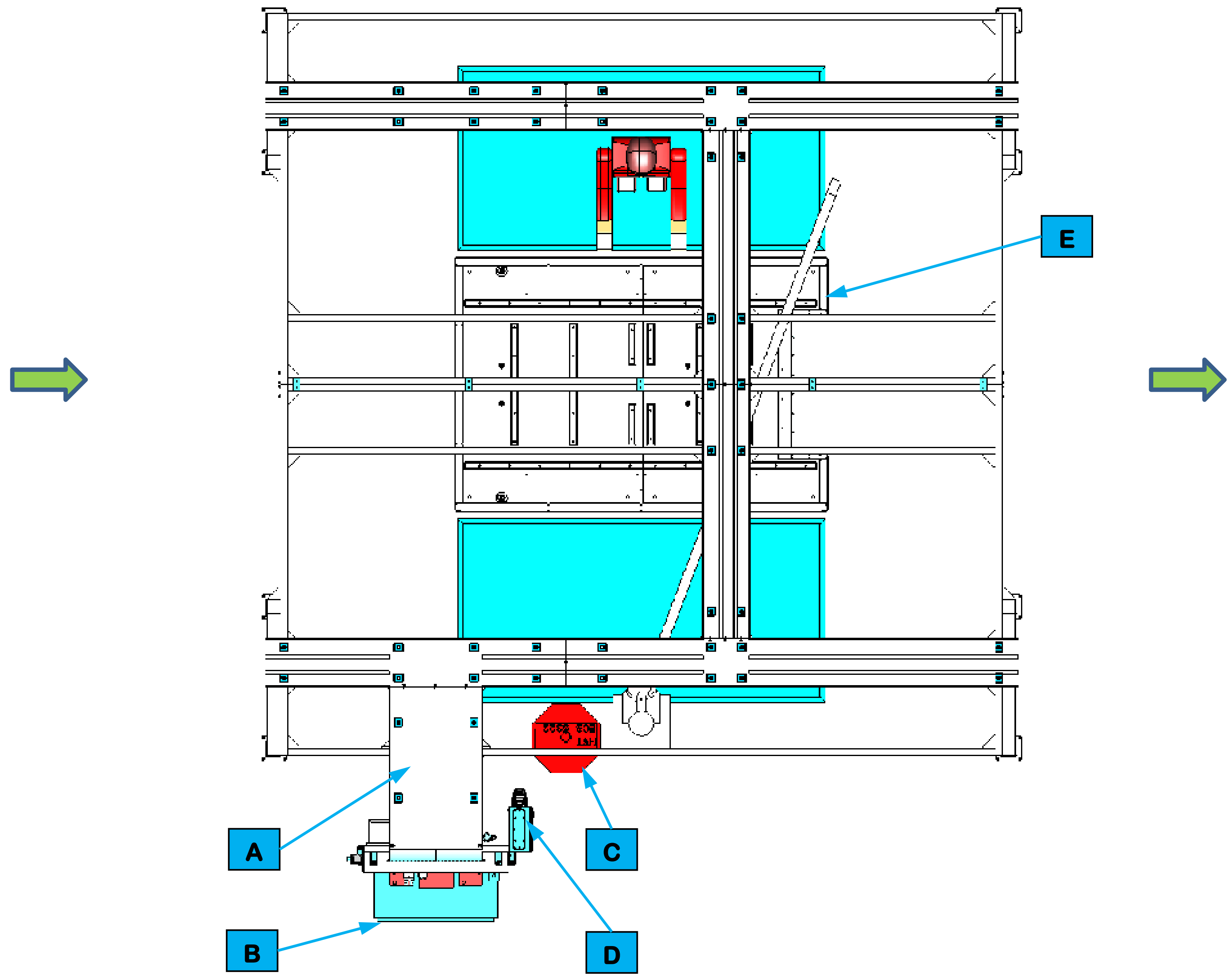


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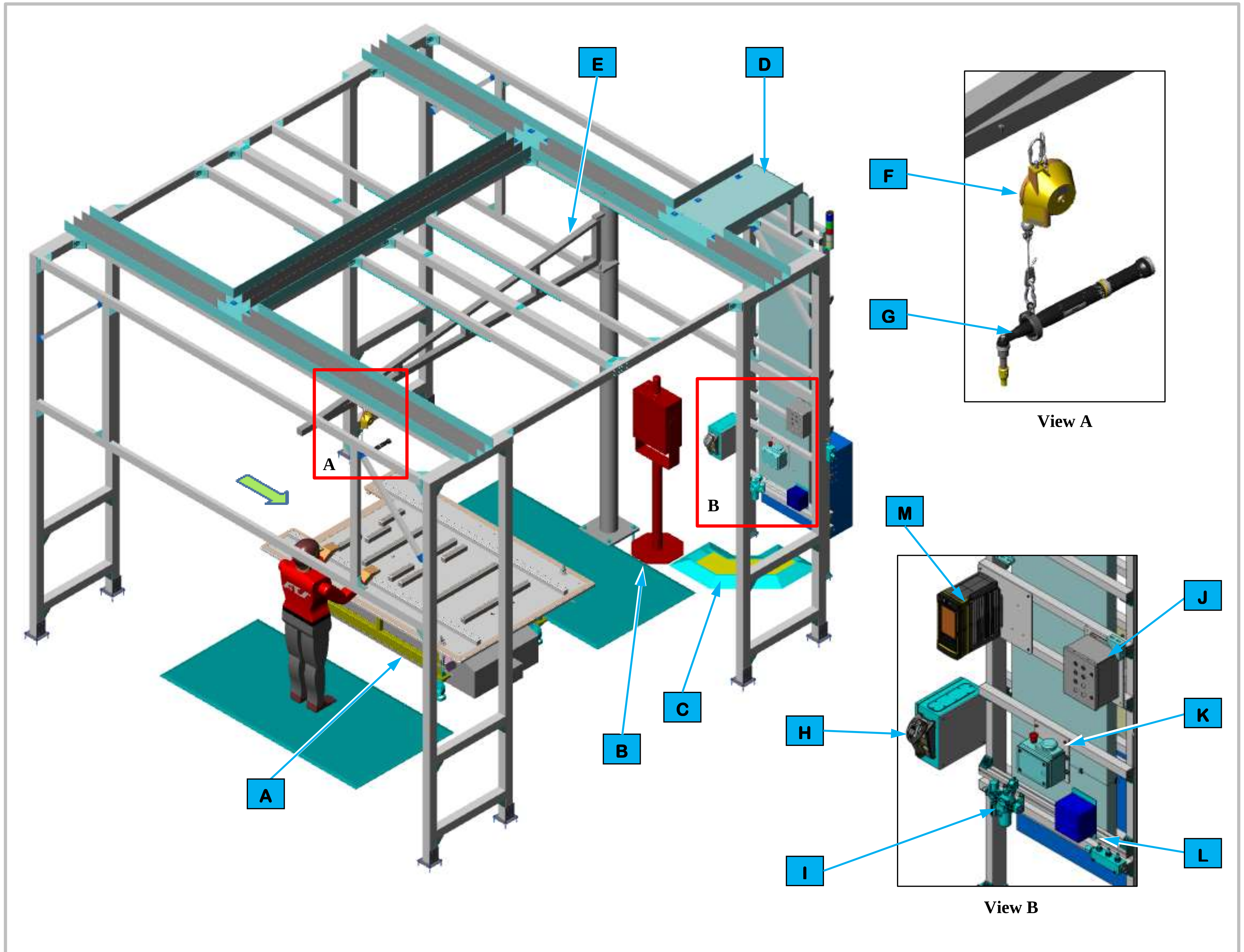
Figure 3-88. EP485 Bus Bar Install and Secure, Upper Deck Manual Repair Station Top View

3.6.24.1. Station Description

Cell EP485 is a manual cell that adjoins automated Cell 480. An Operator makes required repairs to the upper bus bar installation operation performed for BET modules in Cell 480.

Equipment Callouts in Station 485 Top View		
A	N/A	Wireway
B	EP485P2	Power Cabinet
C	EP485D1	Operator Console HMI
D	EP485BC1	Barcode Scanner
E	N/A	Automated Guided Cart (AGC)



3.6.24.2. Sequence of Operation for BET

Step	Process
1	Follow repair procedure

3.6.24.3. Sequence of Operation for BEV3

Step	Process
1	N/A

Equipment Callouts in Station EP485 Isometric View		
A	N/A	Automated Guided Cart (AGC)
B	EP485D1	Operator Console HMI
C	N/A	Cable Protector
D	N/A	Wireway
E	N/A	Jib Crane
F	N/A	Tool Balancer
G	EP485TC1	Nutrunner
H	EP485BC1	Barcode Scanner
I	AIRON	Air Preparation Unit
J	EP485E2	Operator Push Button Box
K	EP485E1	Operator Release/E-Stop
L	EP485RCP1	Electrical Outlet Box
M	EP485TC1	Nutrunner Controller

Figure 3-89. EP485 Bus Bar Install and Secure, Upper Deck Manual Repair Station Isometric View

3.6.25. EP500 BET RH and LH Outboard Hose Install Station Description

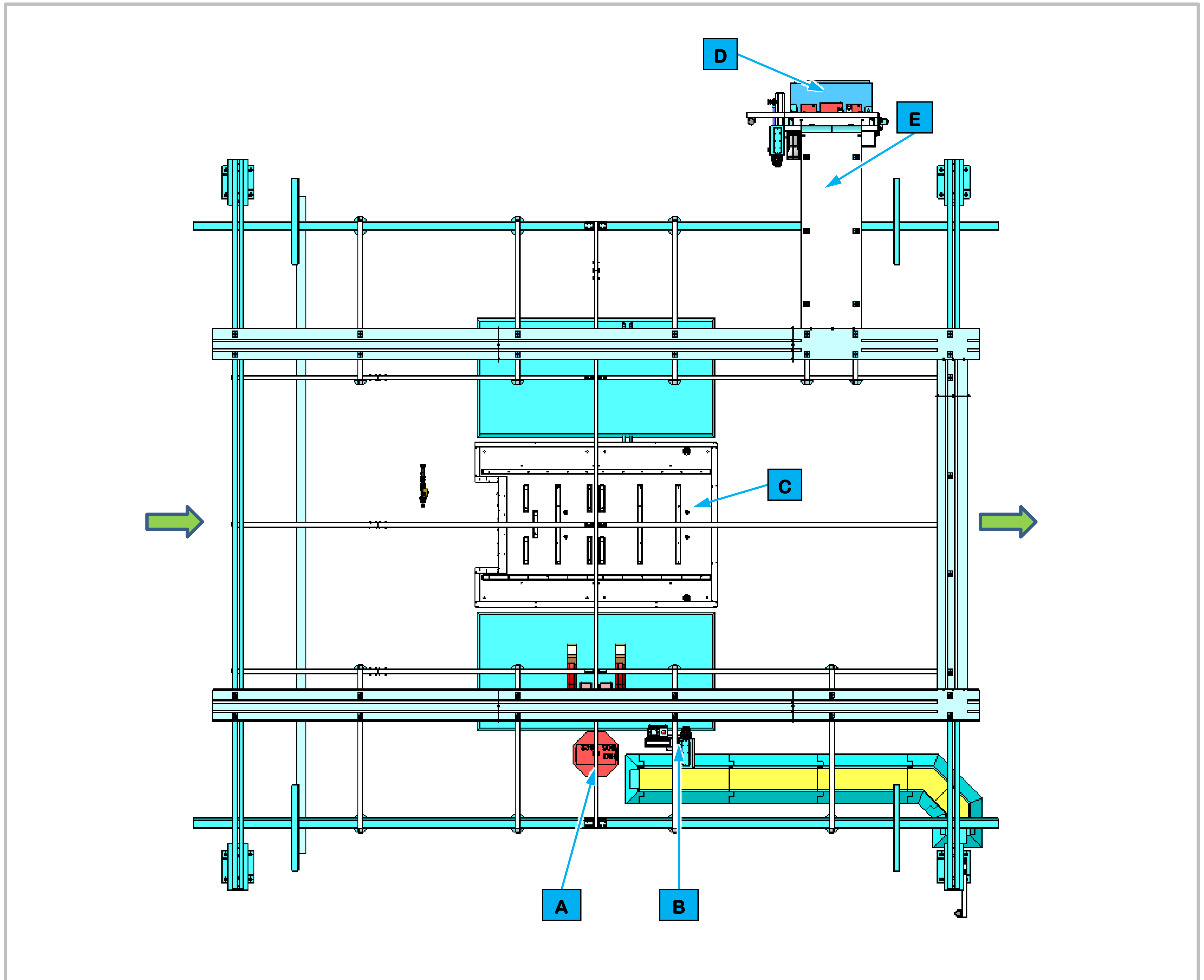
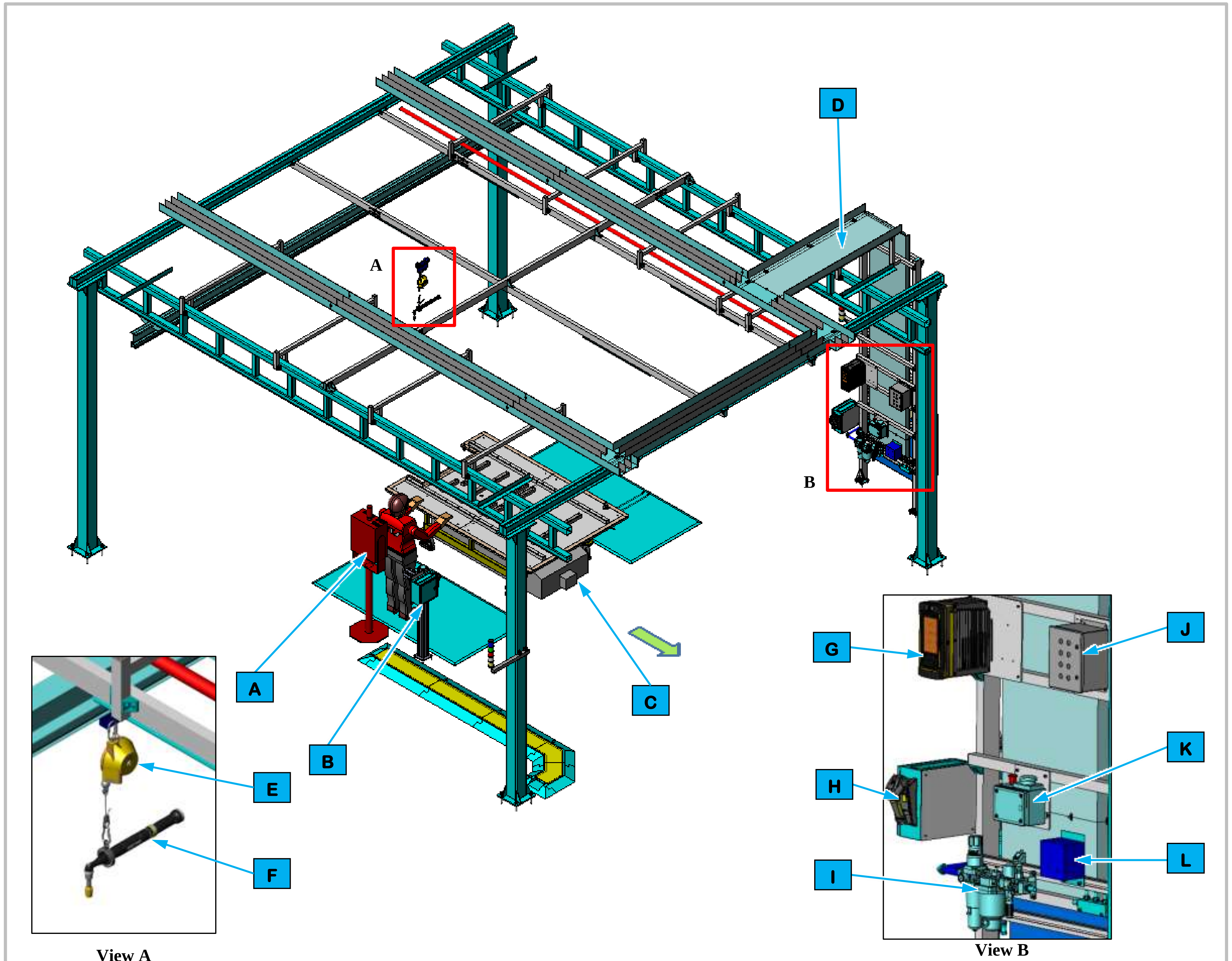


Figure 3-90. EP500 BET RH and LH Outboard Hose Install Station Top View

3.6.25.1. Station Description

Cell EP500 is a manual station for installing the RH and LH Outboard Hose for BET Batteries.

Equipment Callouts in Station EP500 Top View		
A	EP500D1	Operator Console HMI
B	EP500BC1	Barcode Scanner and E-Stop
C	N/A	Automated Guided Cart (AGC)
D	EP500P2	Power Cabinet
E	N/A	Wireway



3.6.25.2. Sequence of Operation for BET

Step	Process
1	Get and error-proof the RH Outboard Hose.
2	Install the RH Outboard Hose
3	Get and error-proof the LH Outboard Hose.
4	Install the LH Outboard Hose

Equipment Callouts in Station EP500 Isometric View		
A	EP500D1	Operator Console HMI
B	EP500BC1	Barcode Scanner and E-Stop
C	N/A	Automated Guided Cart (AGC)
D	N/A	Wireway
E	N/A	Tool Balancer
F	EP500TC1	Nutrunner
G	EP500TC1	Nutrunner Controller
H	EP500BC1	Barcode Scanner
I	AIRON	Air Preparation Unit
J	EP500E2	Operator Push Button Box
K	EP500E1	Operator E-Stop
L	EP500RCP1	Electrical Outlet Box

Figure 3-91. EP500 BET RH and LH Outboard Hose Install Station Isometric View

3.6.26. EP520 LH & RH Outer Z-Blocker Install Station Description

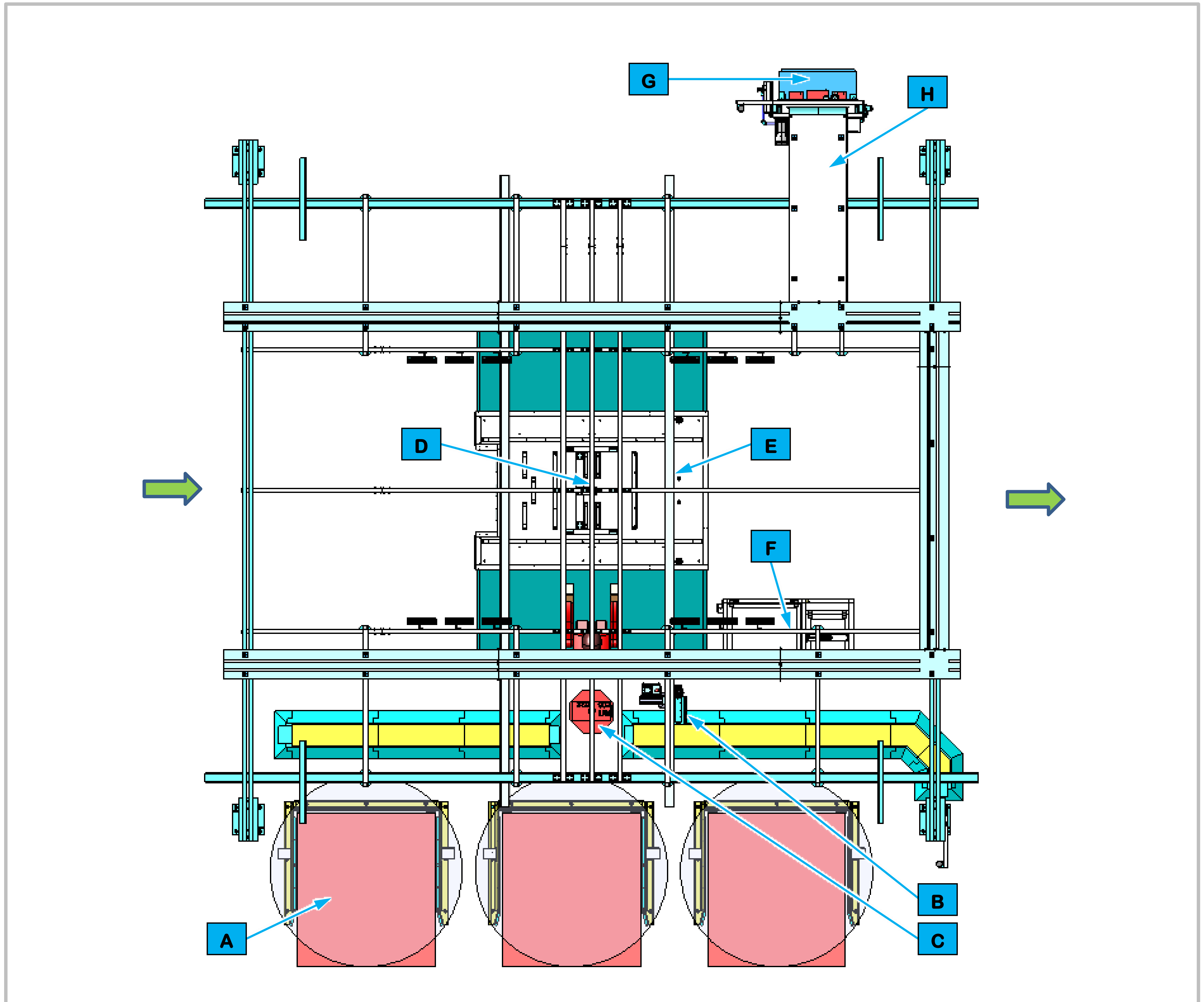


Figure 3-92. EP520 LH & RH Outer Z-Blocker Install Station Top View

3.6.26.1. Station Description

Cell EP520 is a manual station for installing the Bus Bar Z-Blocker, the LH Outer Z-Blocker and the RH Outer Z-Blocker for BET batteries.

Equipment Callouts in Station EP520 Top View		
A	N/A	Dunnage
B	EP520BC1	Barcode Scanner and E-Stop
C	EP520D1	Operator Console HMI
D	EP520C1	Inspection Camera
E	N/A	Automated Guided Cart (AGC)
F	EP520SF1	Feeder
G	EP520P2	Power Cabinet
H	N/A	Wireway

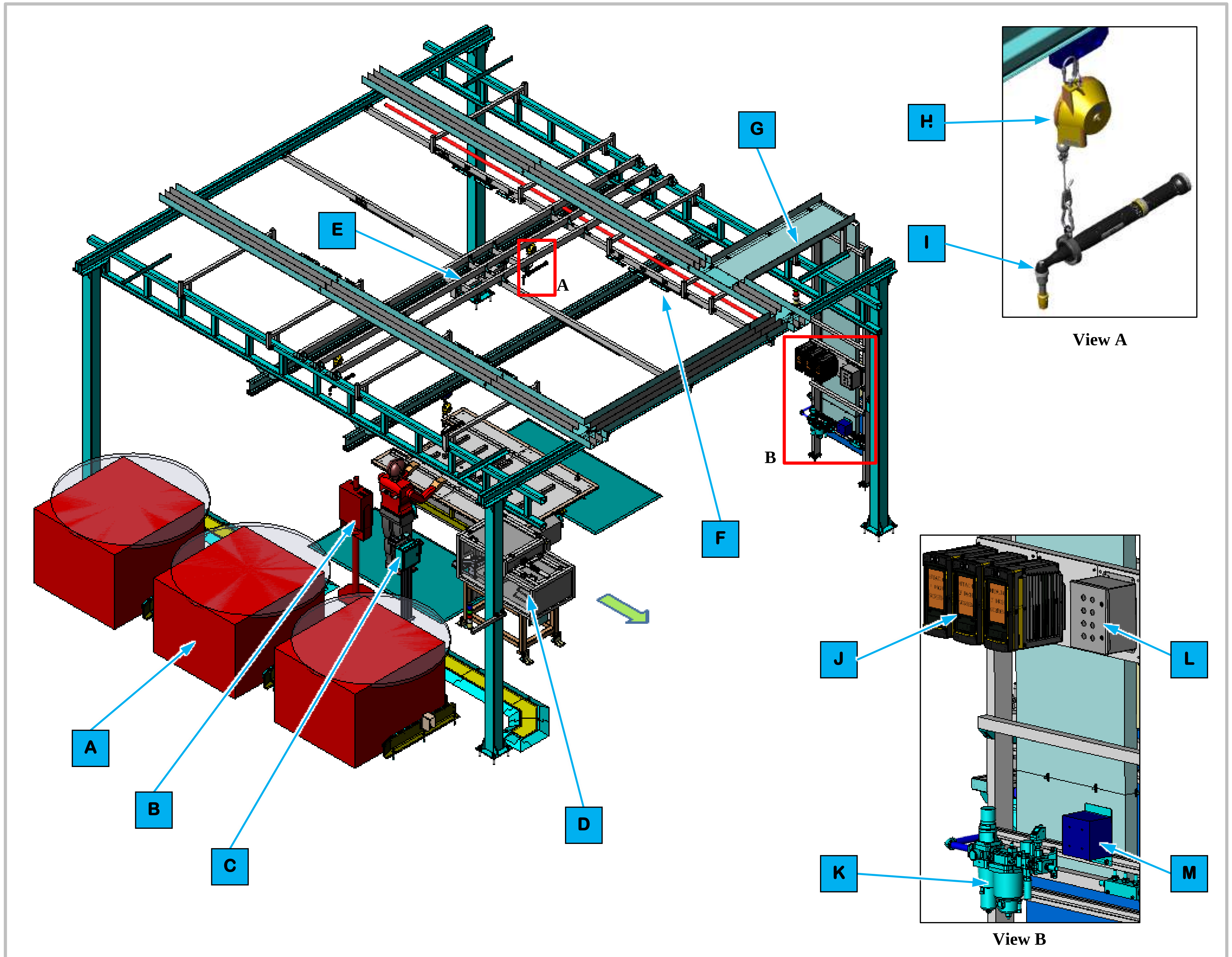


Figure 3-93. EP520 LH & RH Outer Z-Blocker Install Station Isometric View

3.6.26.2. Sequence of Operation for BET

Step	Process
1	Get and install the Bus Bar Z-Blocker
2	Get and install the LH Outer Z-Blocker
	Get and install the RH Outer Z-Blocker

3.6.26.3. Sequence of Operation for BEV3

Step	Process
1	N/A

Equipment Callouts in Station EP520 Isometric View		
A	N/A	Dunnage
B	EP520D1	Operation Console HMI
C	EP520BC1	Barcode Scanner and E-Stop
D	EP520SF1	Feeder
E	EP520C1	Inspection Camera
F	N/A	Lights
G	N/A	Wireway
H	N/A	Tool Balancer
I	EP520TC1 -3	Nutrunner
J	EP520TC1 -3	Nutrunner Controller
K	AIRON	Air Preparation Unit
L	EP520E2	Operator Push Button Box
M	EP520RCP1	Electrical Outlet Box

3.6.27. EP540 MCP1, Thermal Barrier Install Station Description

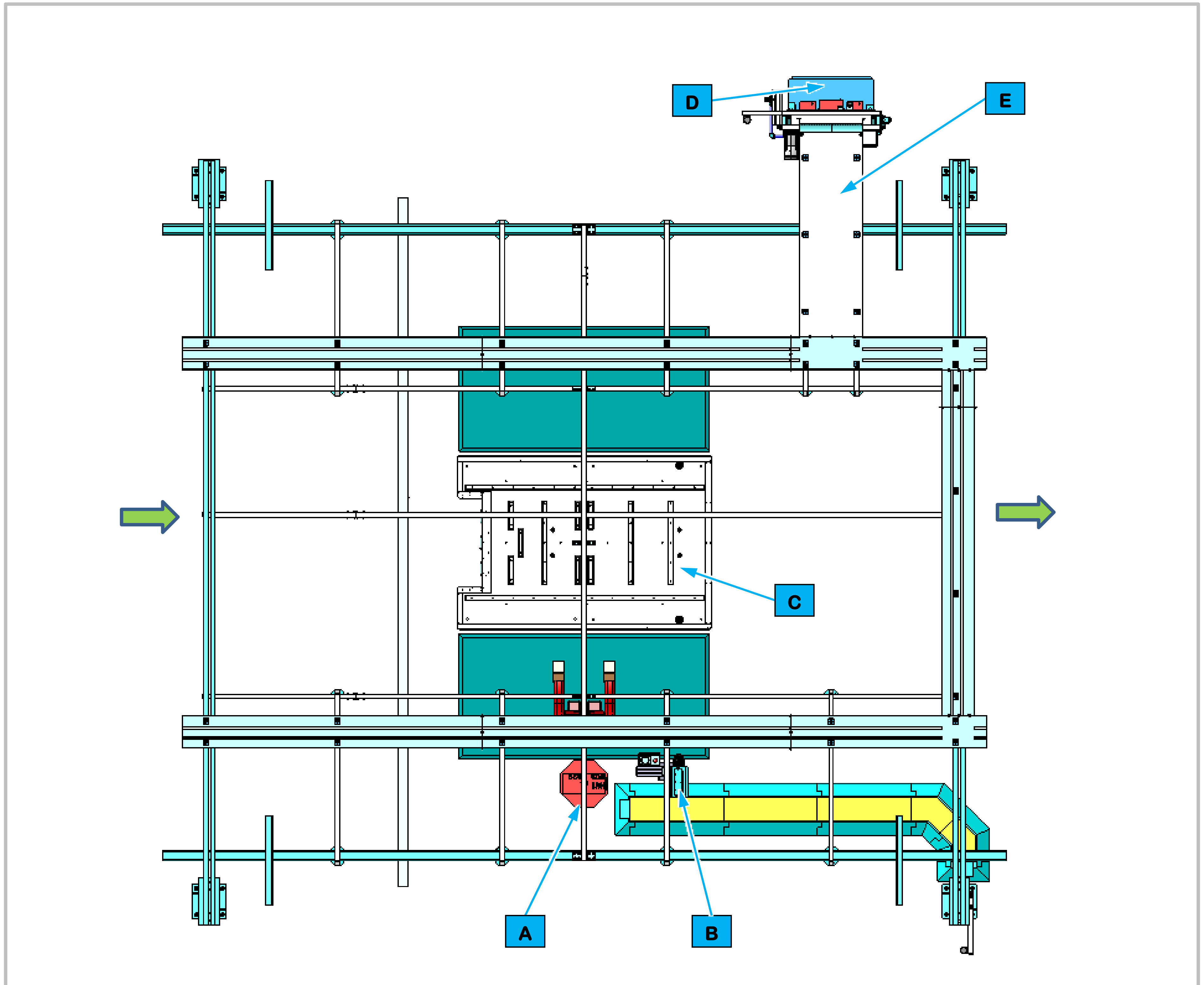


Figure 3-94. EP540 MCP1, Thermal Barrier Install Station Top View

3.6.27.1. Station Description

Cell EP540 is a manual station for installing the MCP1 Module Bracket, the LH & RH Thermal Barrier, the Front to Back Hose and the BDU Bracket for the BET batteries.

Equipment Callouts in Station EP540 Top View		
A	EP540D1	Operator Console HMI
B	EP540BC1	Barcode Scanner and E-Stop
C	N/A	Automated Guided Cart (AGC)
D	EP540P2	Power Cabinet
E	N/A	Wireway

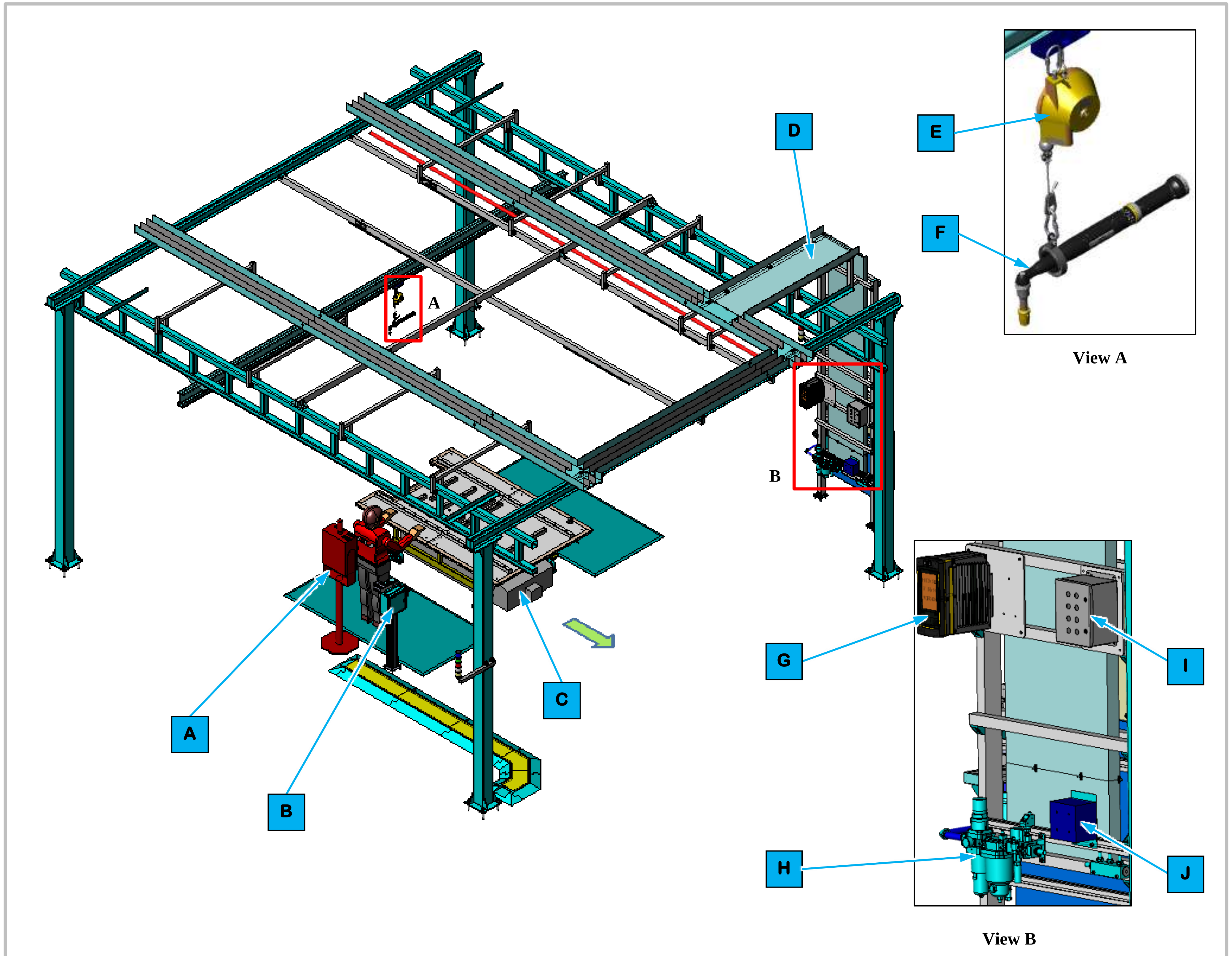


Figure 3-95. EP540 MCP1, Thermal Barrier Install Station Isometric View

3.6.27.2. Sequence of Operation for BET

Step	Process
1	Get and install the MCP1 Bracket
2	Get and install the Thermal Barrier
3	Vision inspect Thermal Barrier
4	Get and error-proof the Front-to-Back Hose
5	Install the Front-to-Back Hose
6	Get and install the BDU Bracket

3.6.27.3. Sequence of Operation for BEV3

Step	Process
1	N/A

Equipment Callouts in Station EP540 Isometric View		
A	EP540D1	Operator Console HMI
B	EP540BC1	Barcode Scanner and E-Stop
C	N/A	Automated Guided Cart (AGC)
D	N/A	Wireway
E	N/A	Tool Balancer
F	EP540TC1	Nutrunner
G	EP540TC1	Nutrunner Controllers
H	AIRON	Air Preparation Unit
I	EP540E2	Operator Push Button Box
J	EP540RCP1	Electrical Outlet Box

3.6.28. EP560 Front to Rear Bus Bar Install Station Description

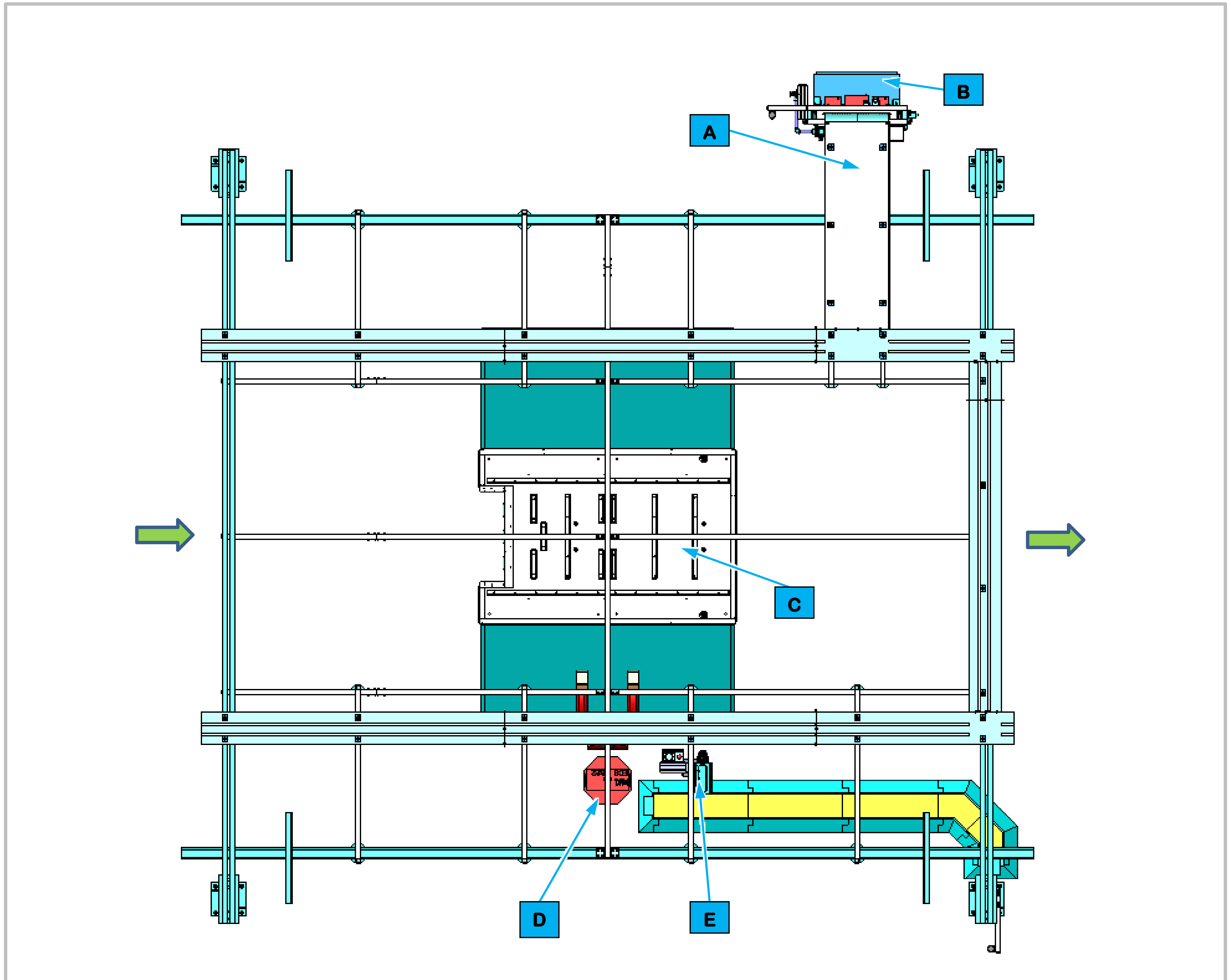


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Figure 3-96. EP560 Front to Rear Bus Bar Install Station Top View

3.6.28.1. Station Description

Cell EP560 is a manual station to install the BDU Hose, and the SWB or LWB Front to Rear Bus Bar for BET batteries.

Equipment Callouts in Station EP560 Top View		
A	N/A	Wireway
B	EP560P2	Power Cabinet
C	N/A	Automated Guided Cart (AGC)
D	EP560BC1	Barcode Scanner and E-Stop
E	EP560D1	Operator Console HMI

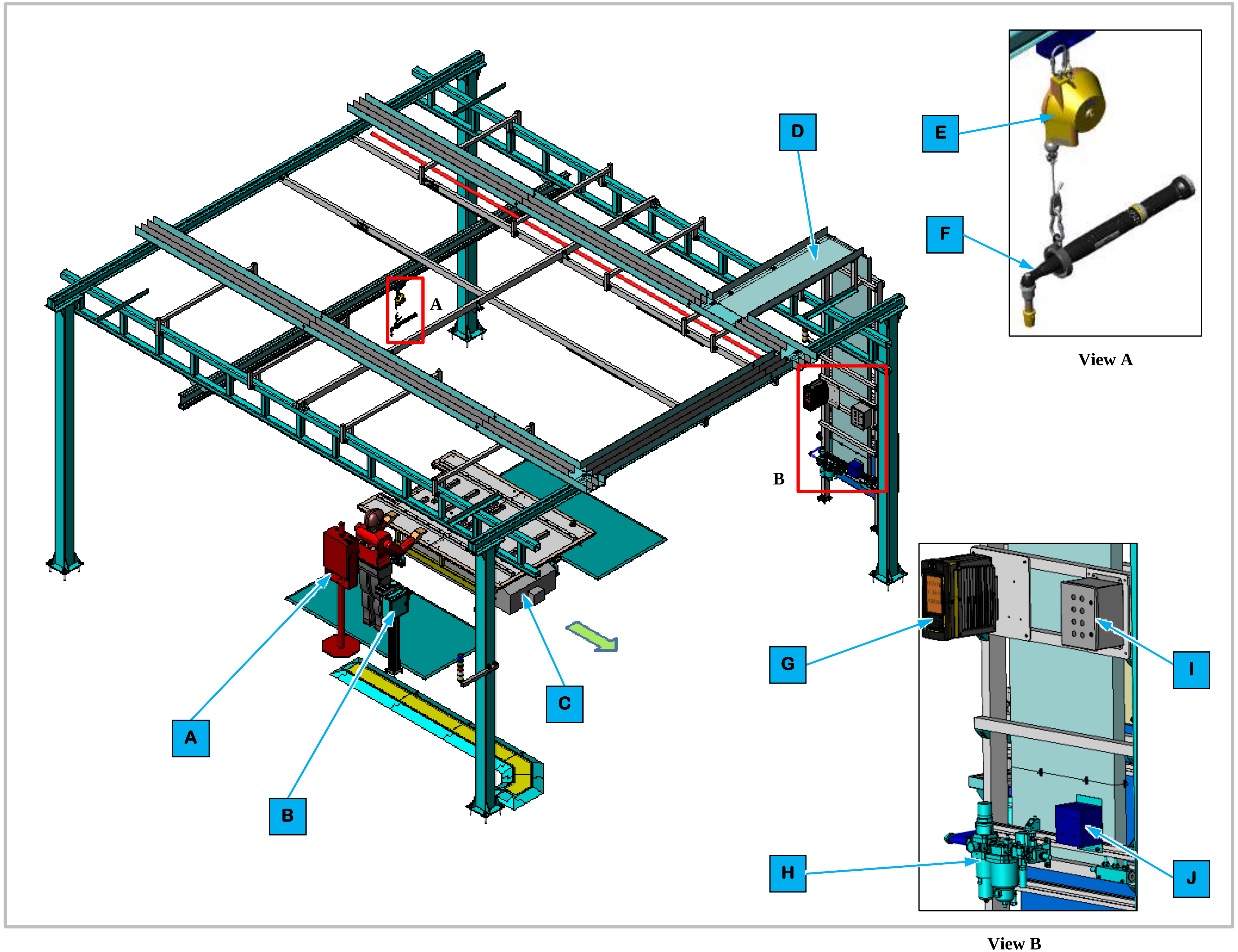


Figure 3-97. EP560 Front to Rear Bus Bar Install Station Isometric View

3.6.28.2. Sequence of Operation for BET

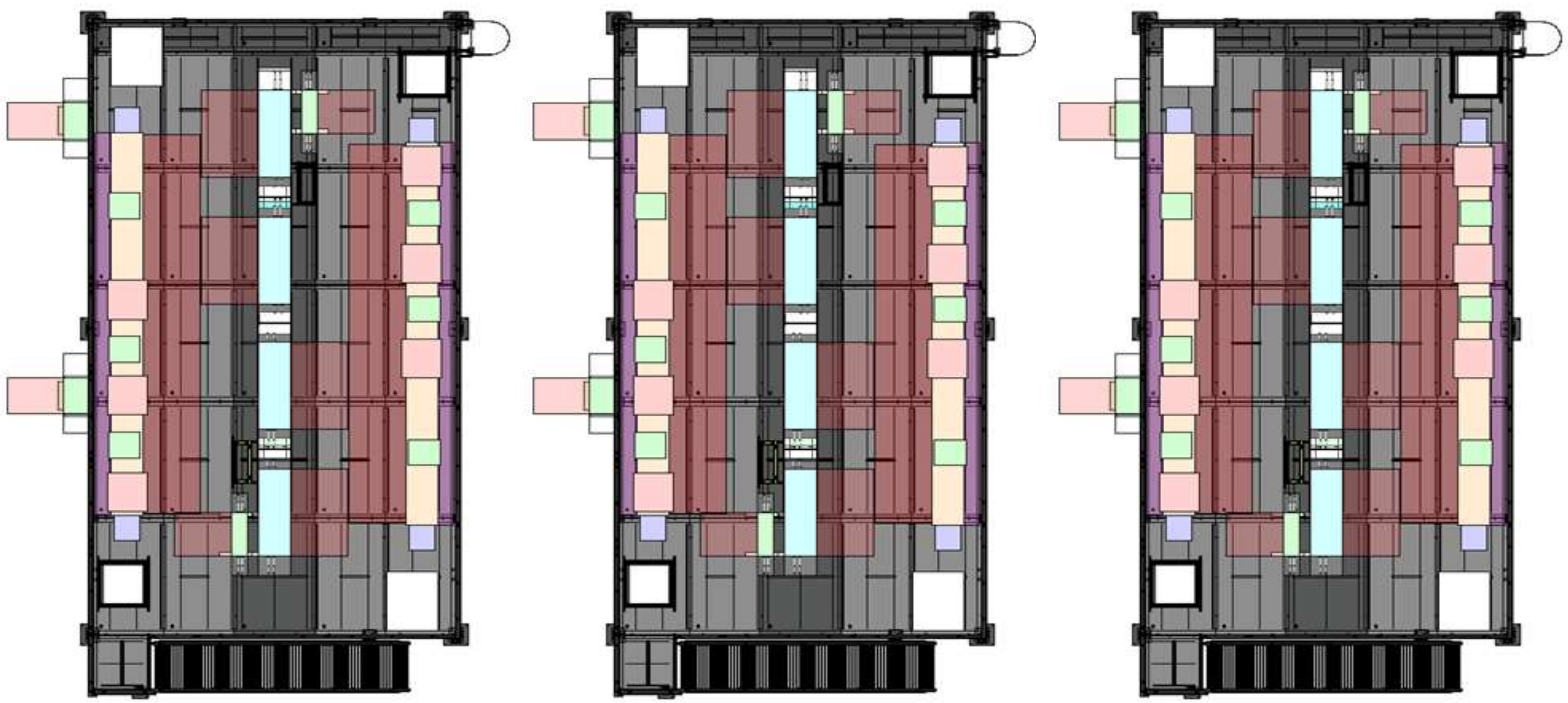
Step	Process
1	Get and install the BDU Hose
	Get and install the SWB or LWB Front to Rear Bus Bar

3.6.28.3. Sequence of Operation for BEV

Step	Process
1	N/A

Equipment Callouts in Station EP560 Isometric View		
A	EP560D1	Operator Console HMI
B	EP560BC1	Barcode Scanner and E-Stop
C	N/A	Automated Guided Cart (AGC)
D	N/A	Wireway
E	N/A	Tool Balancer
F	EP560TC1	Nutrunner
G	EP560TC1	Nutrunner Controllers
H	AIRON	Air Preparation Unit
I	EP560E2	Operator Push Button Box
J	EP560RCP1	Electrical Outlet Box

3.6.29. EP580 Upper Deck Electrical Leak Test Station Description



For information regarding equipment located in Cell EP580, refer to *Battery Pack Test and Cover Leak Test Operation and Maintenance Manual.*

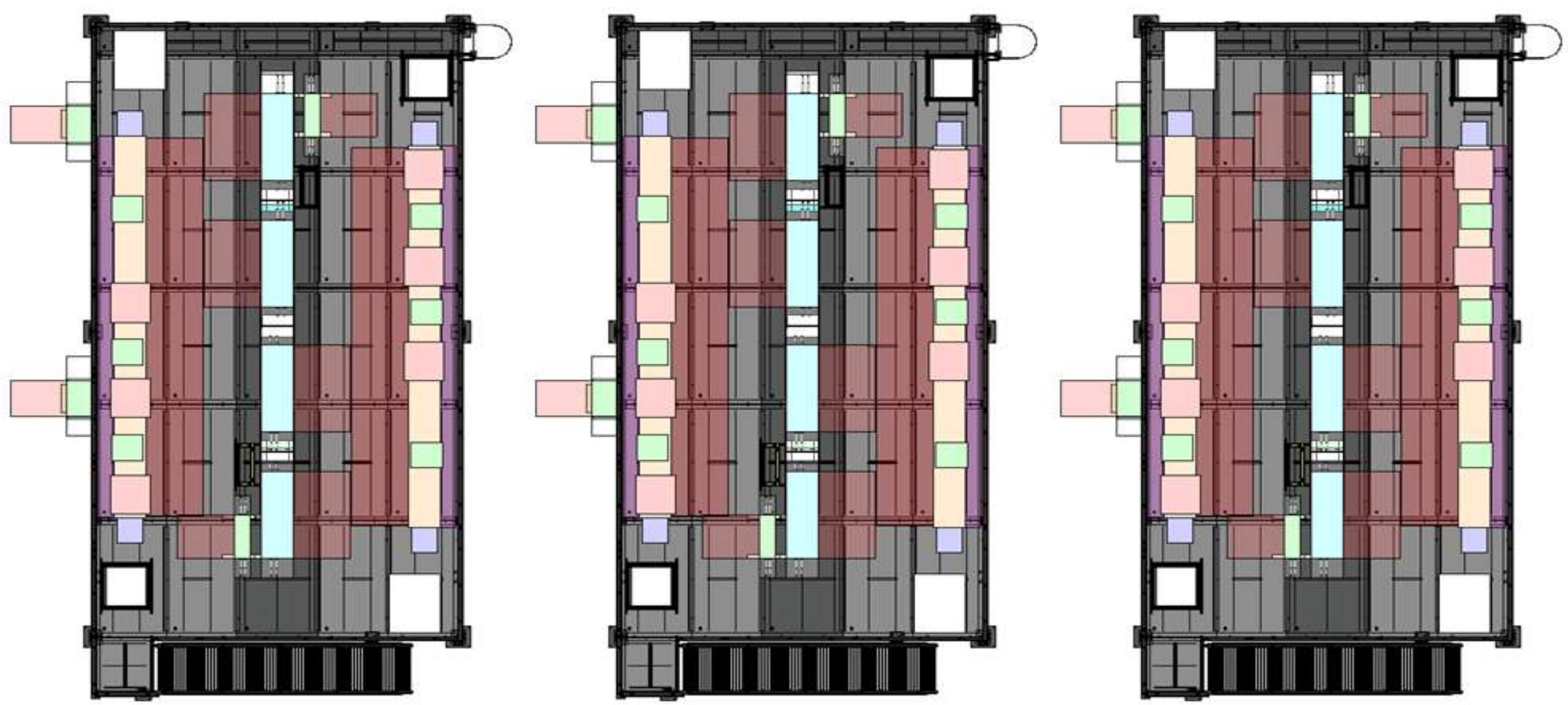
Figure 3-98. EP580 Upper Deck Electrical Leak Test Station Top View

3.6.29.1. Station Description

Cell EP580 is a test station for performing an electrical test on BET and BEV3 battery assemblies.

An AGC enters this station where an Operator performs a quality check and an electrical leak test on the battery assembly.

For more detailed information about Cell 580, refer to *Battery Pack Test and Cover Leak Test Operation and Maintenance Manual.*



For information regarding equipment located in Cell EP580, refer to *Battery Pack Test and Cover Leak Test Operation and Maintenance Manual.*

Figure 3-99. EP580 Upper Deck Electrical Leak Test Station Isometric View

3.6.29.2. Sequence of Operation for BET

Step	Process
1	Operator performs a quality check on battery assembly
2	Operator performs an electrical leak test on battery assembly
	For more detailed information about Cell 580, refer to *Battery Pack Test and Cover Leak Test Operation and Maintenance Manual.*

3.6.29.3. Sequence of Operation for BEV

Step	Process
1	N/A

3.6.30. EP600 O-Ring Install Station Description

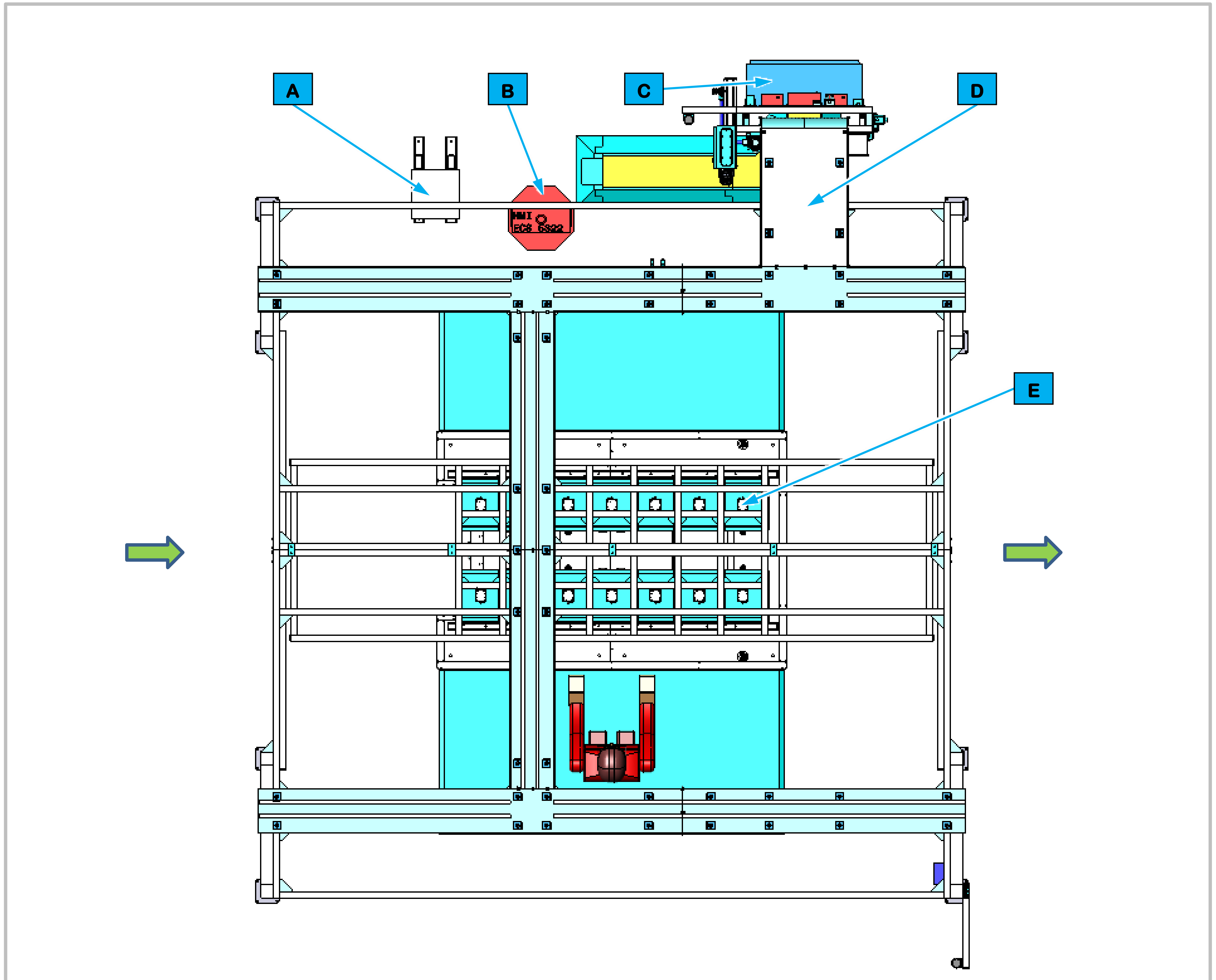


Figure 3-100. EP600 O-Ring Install Station Top View

3.6.30.1. Station Description

Cell EP600 is a manual station for installing O-rings to BET and BEV3 batteries packs.

For BET batteries an Operator gets and installs O-rings to battery pack.

For BEV3 batteries the Operator gets and installs O-rings to battery pack.

Equipment Callouts in Station EP600 Top View		
A	N/A	Charger Stand
B	EP600D1	Operator Console HMI
C	EP600E2	Power Cabinet
D	N/A	Wireway
E	N/A	Inspection Camera Frame

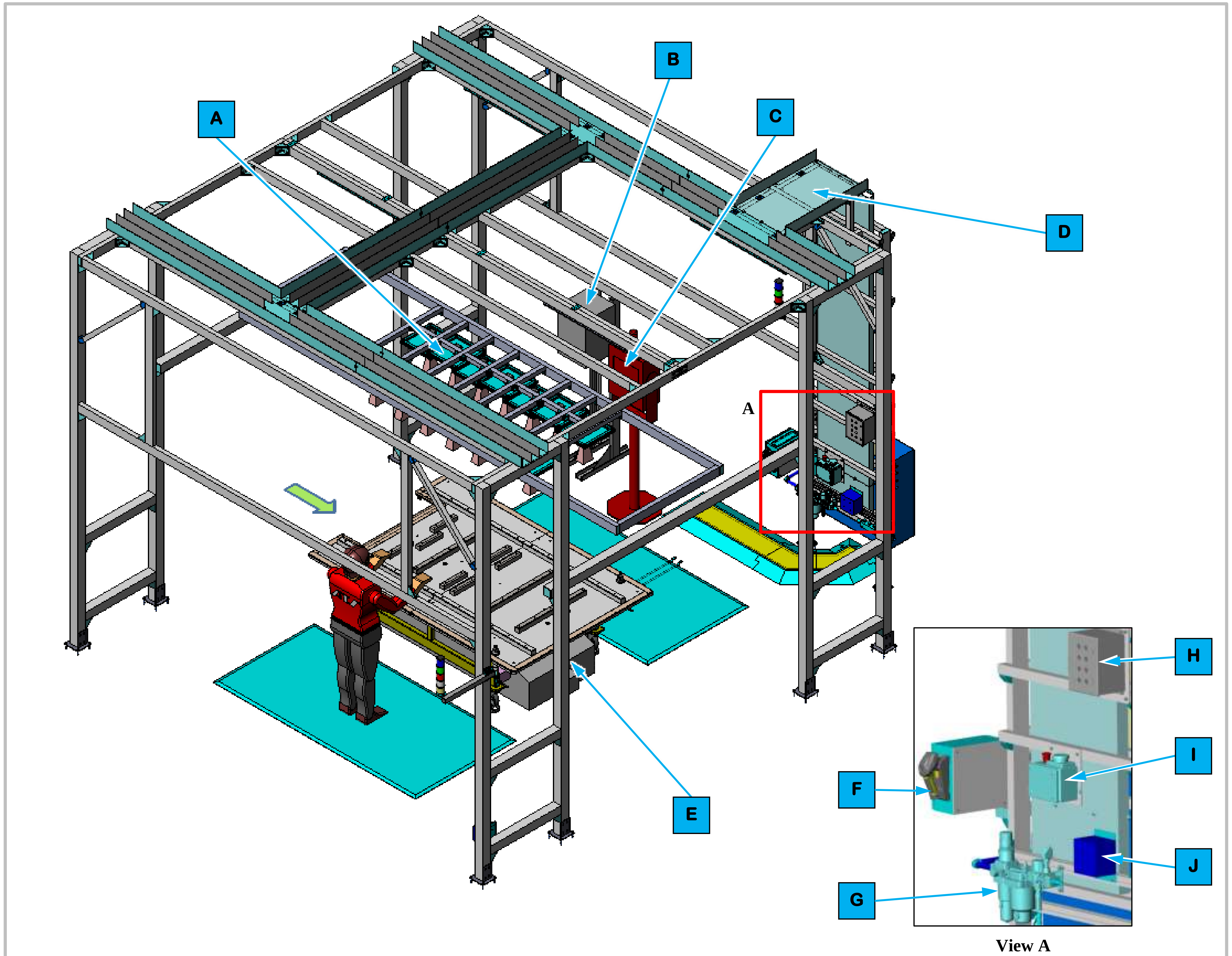


Figure 3-101. EP600 O-Ring Install Station Isometric View

3.6.30.2. Sequence of Operation for BET

Step	Process
1	Get and install O-rings

3.6.30.3. Sequence of Operation for BEV3

Step	Process
1	Get and install O-rings

Equipment Callouts in Station EP600 Isometric View		
A	N/A	Inspection Camera Frame
B	N/A	Charger Stand
C	EP600D1	Operator Console HMI
D	N/A	Wireway
E	N/A	Automated Guided Cart (AGC)
F	EP600BC1	Barcode Scanner
G	AIRON	Air Preparation Unit
H	EP600E2	Operator Push Button Box
I	EP600E1	E-Stop
J	EP600RCP1	Electrical Outlet Box

3.6.31. EP610 Idle Station Description

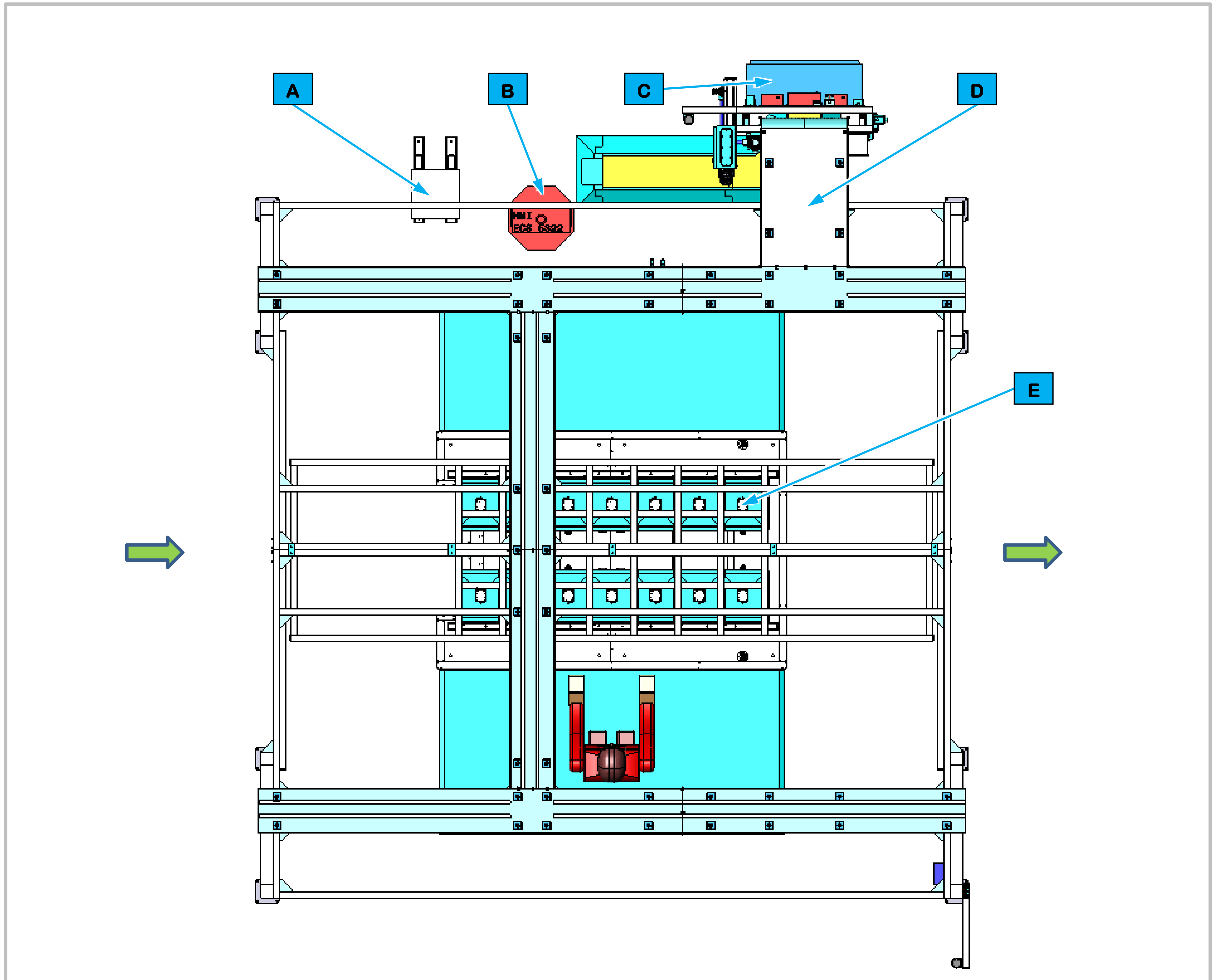


Figure 3-102. EP610 Idle Station Top View

3.6.31.1. Station Description

Cell EP610 is a manual idle station.

Equipment Callouts in Station EP600 Top View		
A	N/A	Charger Stand
B	EP610D1	Operator Console HMI
C	EP610E2	Power Cabinet
D	N/A	Wireway
E	N/A	Inspection Camera Frame

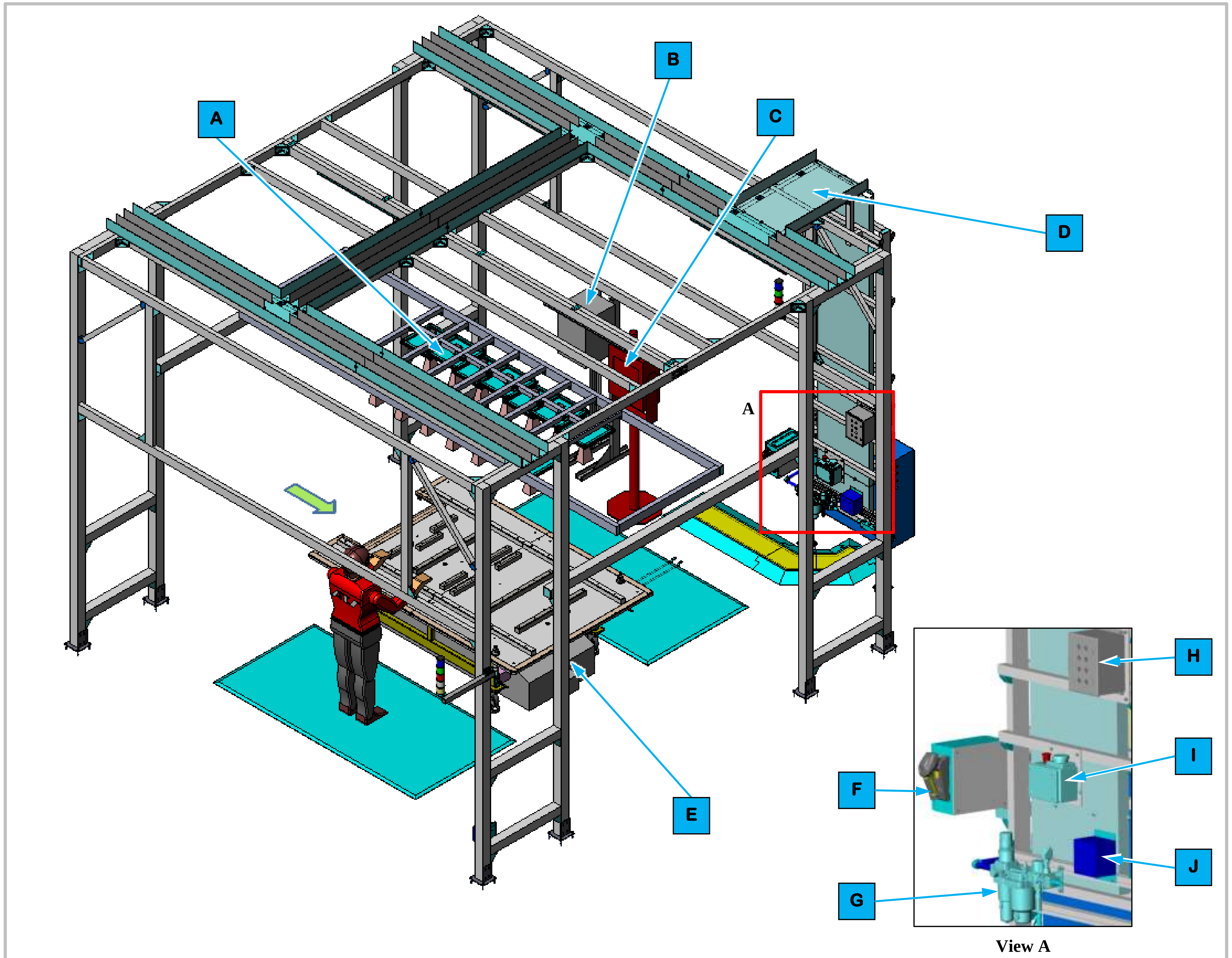


Figure 3-103. EP610 Idle Station Isometric View

3.6.31.2. Sequence of Operation for BET

Step	Process

3.6.31.3. Sequence of Operation for BEV3

Step	Process

Equipment Callouts in Station EP600 Isometric View		
A	N/A	Inspection Camera Frame
B	N/A	Charger Stand
C	EP610D1	Operator Console HMI
D	N/A	Wireway
E	N/A	Automated Guided Cart (AGC)
F	EP610BC1	Barcode Scanner
G	AIRON	Air Preparation Unit
H	EP610E2	Operator Push Button Box
I	EP610E1	E-Stop
J	EP610RCP1	Electrical Outlet Box

3.6.32. EP620/EP630/EP640 RTV and Cover Load Station Description

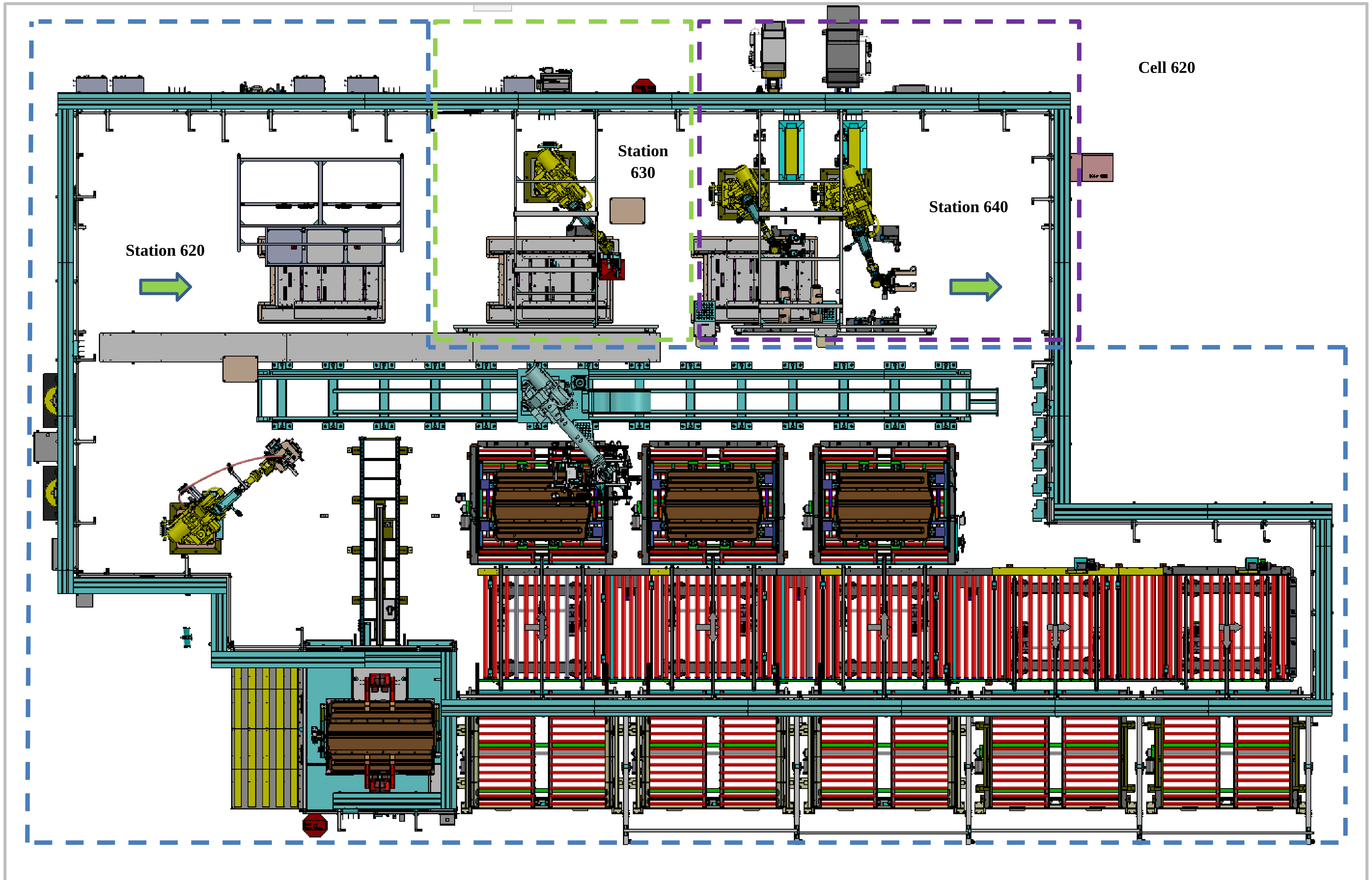


Figure 3-104. EP620/EP630/EP640 RTV and Cover Load Station Top View

3.6.32.1. Station Description

Cell EP620/EP630/EP640 is an automated station with an incorporated Repair Cell. In this station a cover is selected based on the type of battery assembly and then a RTV dispense system is used to apply RTV to the cover. The cover is then place on the battery assembly and secured to the battery assembly on both BET and BEV3 battery assemblies.

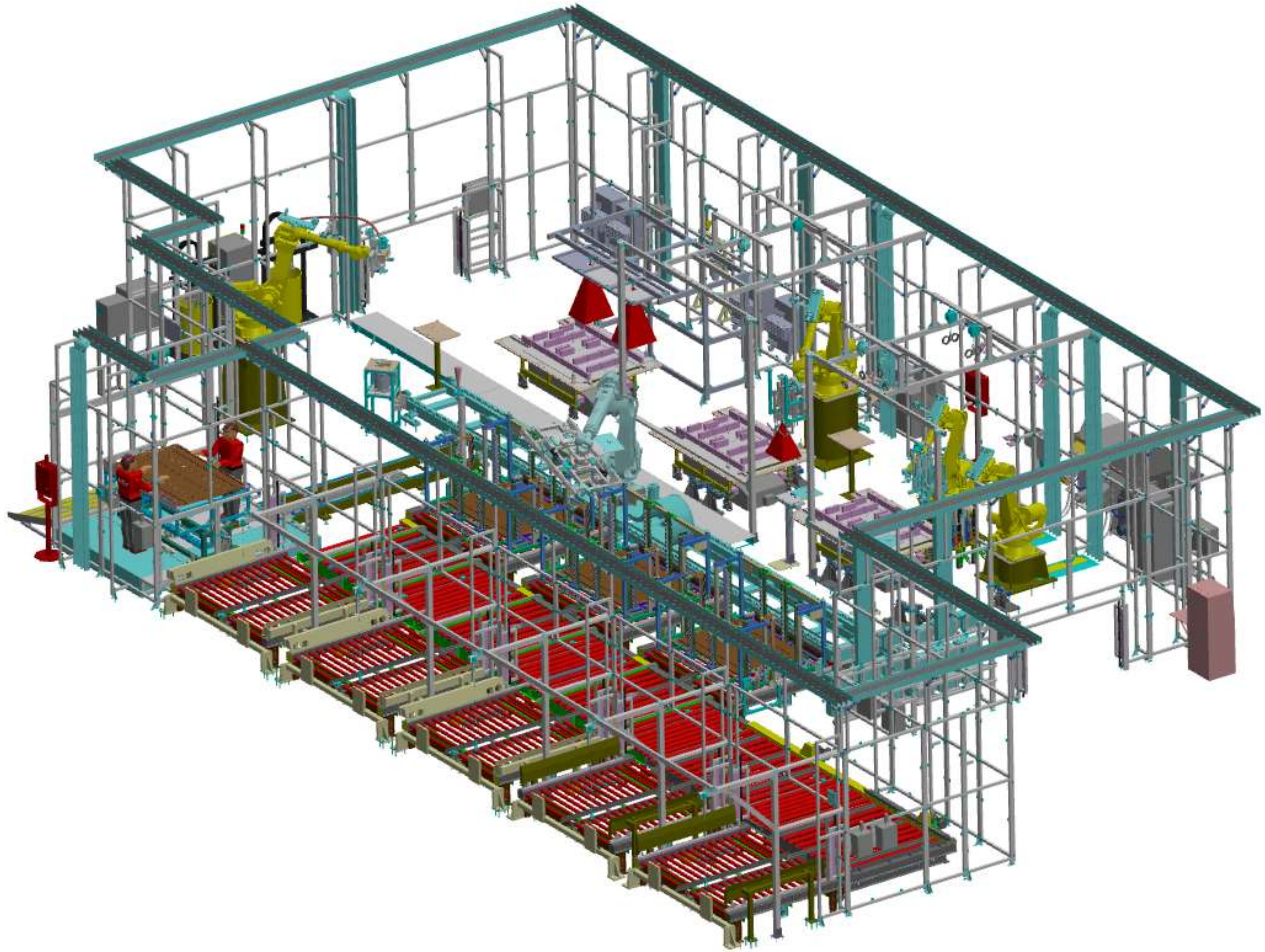
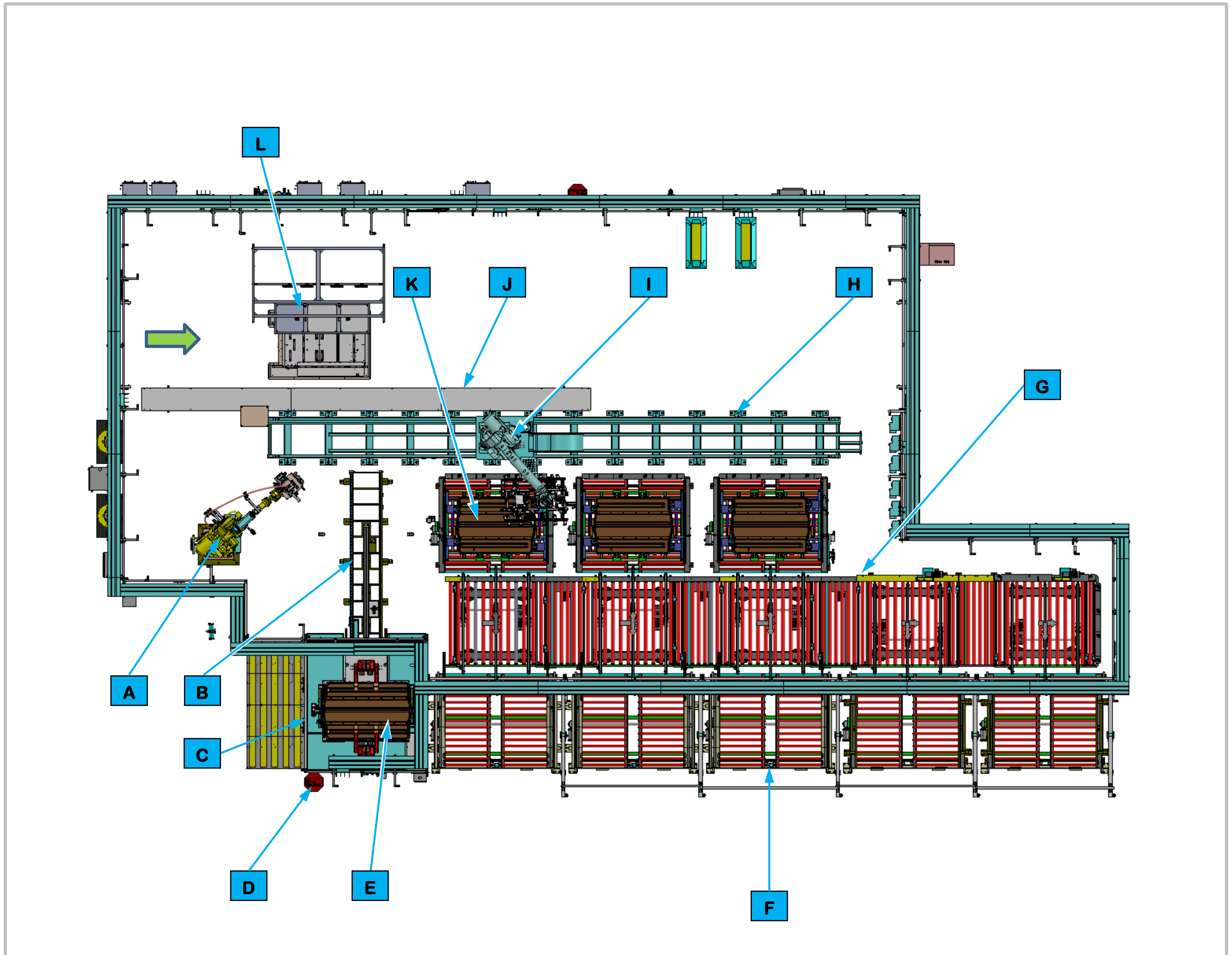


Figure 3-105. EP620/EP630/EP640 RTV and Cover Load Station Isometric View



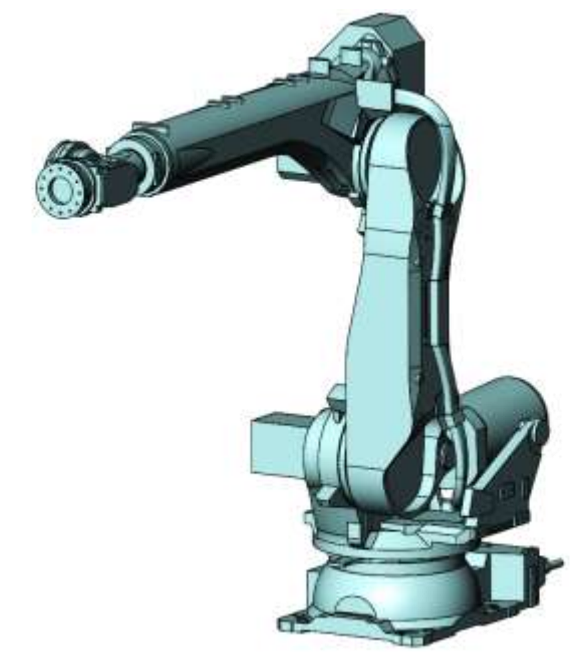
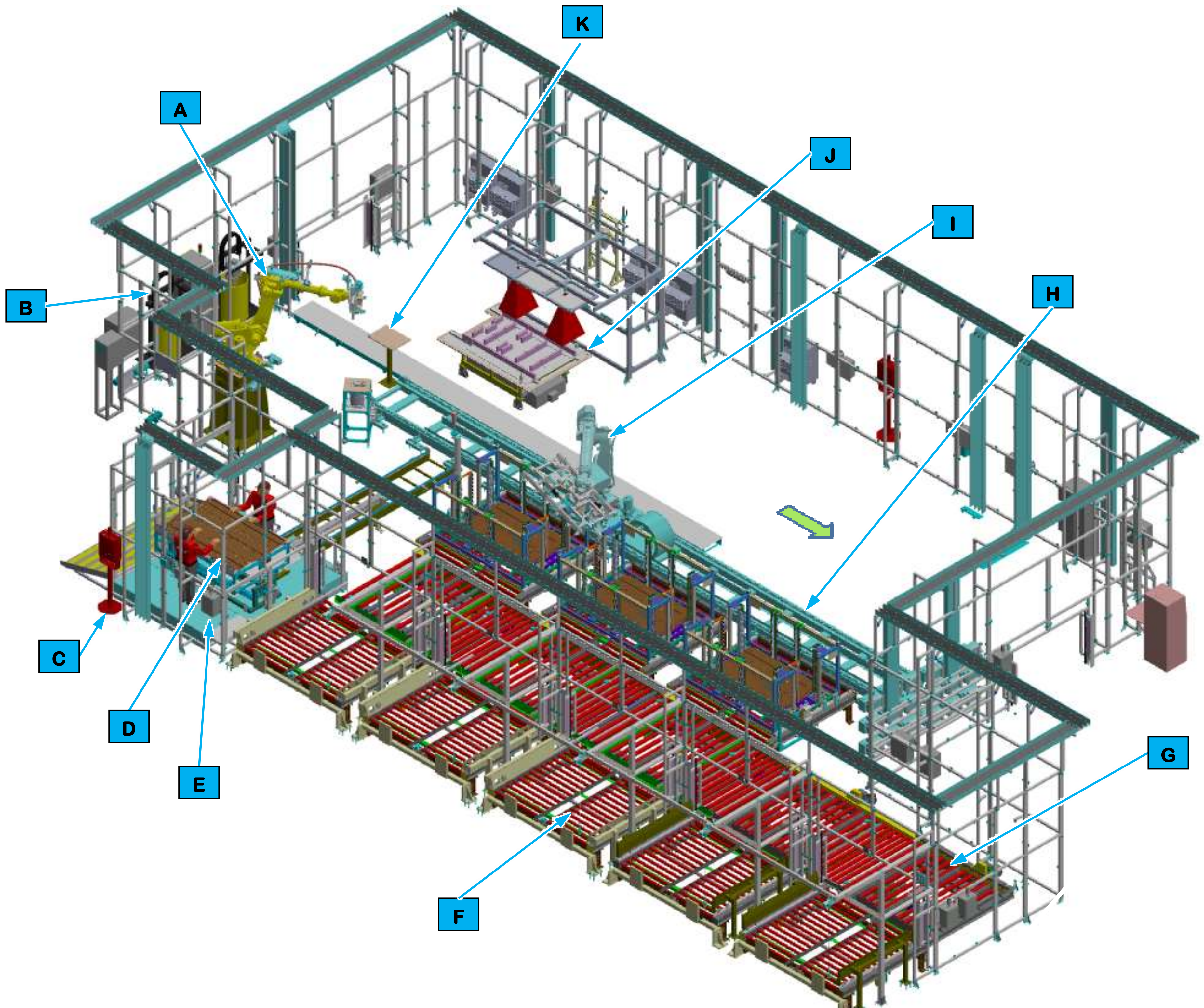


Figure 3-106. Cover Load Robot

Equipment Callouts in Station EP620 Top View		
A	EP620R01B01	RTV Dispense System
B	N/A	Repair Shuttle
C	EP625B01	Repair Cell
D	EP620D2	Operator Console HMI
E	N/A	Cover Reject Table
F	EP620T01B01	Conveyors
G	EP620T01B01	Cross Feed Conveyors
H	N/A	FANUC Robot Track Unit
I	EP620R01	Cover Load Robot
J	N/A	Cable Protector
K	N/A	Battery Assembly Cover
L	N/A	Automated Guided Cart (AGC)

Figure 3-107. EP620 RTV and Cover Load Station Top View.



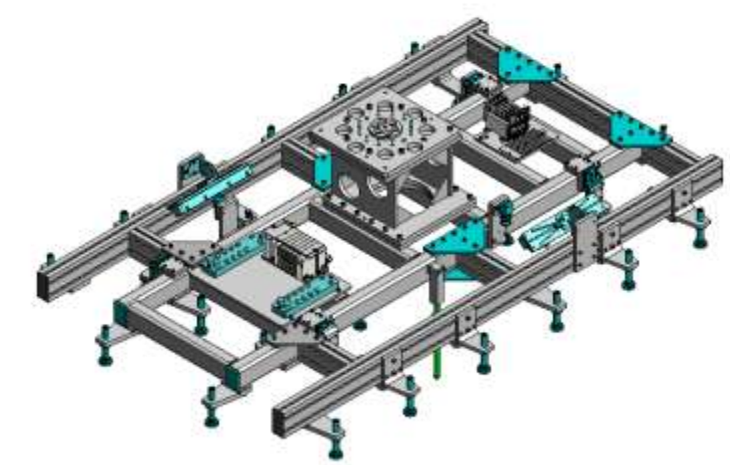


Figure 3-108. Cover Load EOAT

Equipment Callouts in Station EP620 Isometric View		
A	RTV Dispense System	EP620R02
B	RTV Dispense System Storage	EP620R01B01
C	Operator Console HMI	EP620D2
D	Cover Reject Table	N/A
E	Repair Cell	EP625B01
F	Conveyors	EP620T01B01
G	Cross Feed Conveyors	EP620T01B01
H	FANUC Robot Track	N/A
I	Cover Load Robot	EP620R01
J	Automated Guided Cart (AGC)	N/A
K	Robot and Vision Calibration Stand	N/A

Figure 3-109. EP620 RTV and Cover Load Station Isometric View.

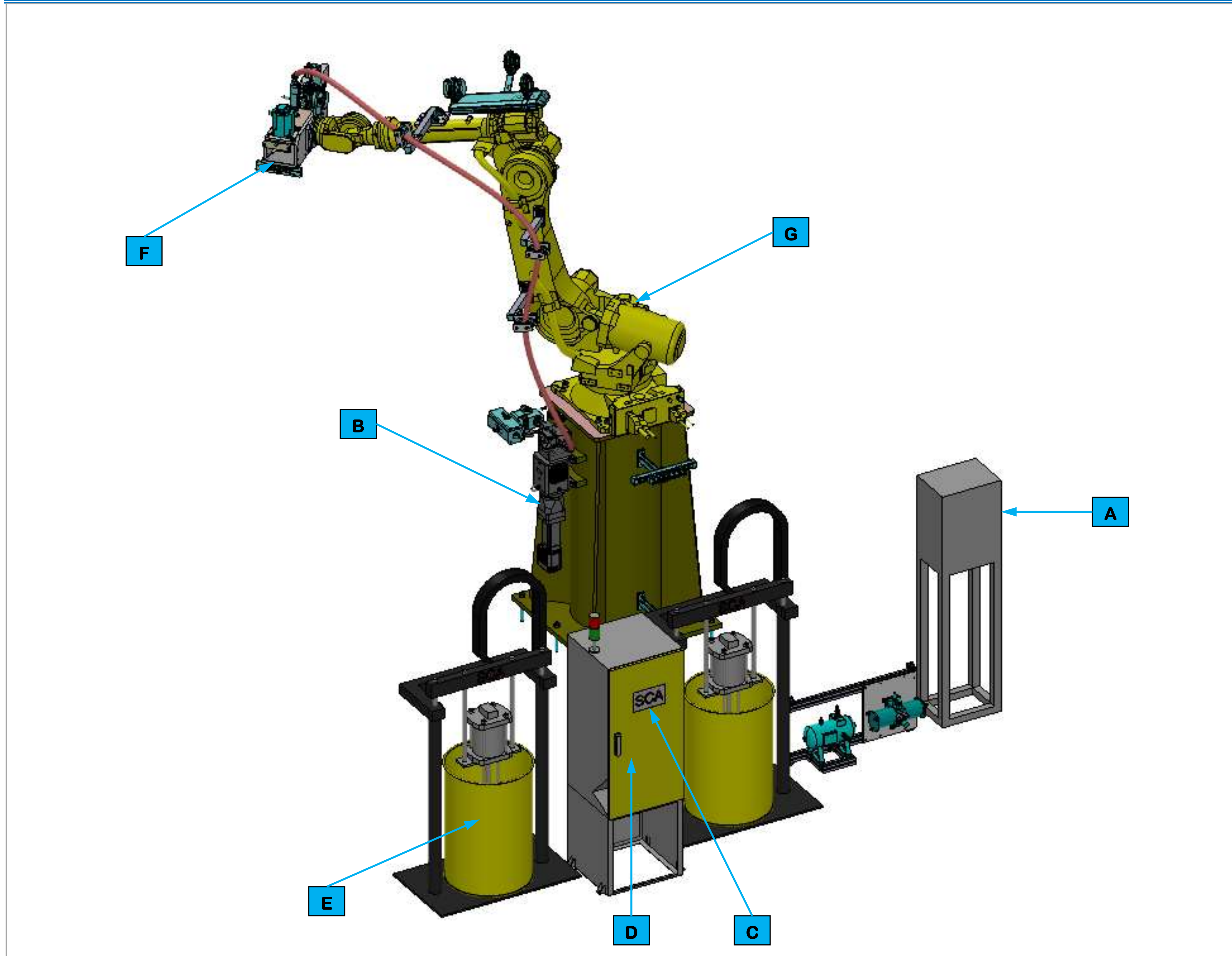


Figure 3-110. EP620 RTV Dispense System

3.6.32.2. RTV Dispense System

RTV sealant is pumped from one of two barrels by the heated pump system and then fed into Station EP620 to the metering pump and then to the dispense nozzle mounted on the dispense Robot.

Control of the pumps and heat is performed by the pump controller. Control of the dispensing is controlled by the dispense controller.

Device Callouts for Figure 3-110	
A	Dispense Controller
B	Metering Pump
C	Pump Controller
D	Pump Cabinet
E	RTV Barrels
F	Dispense Nozzle
G	Dispense Robot

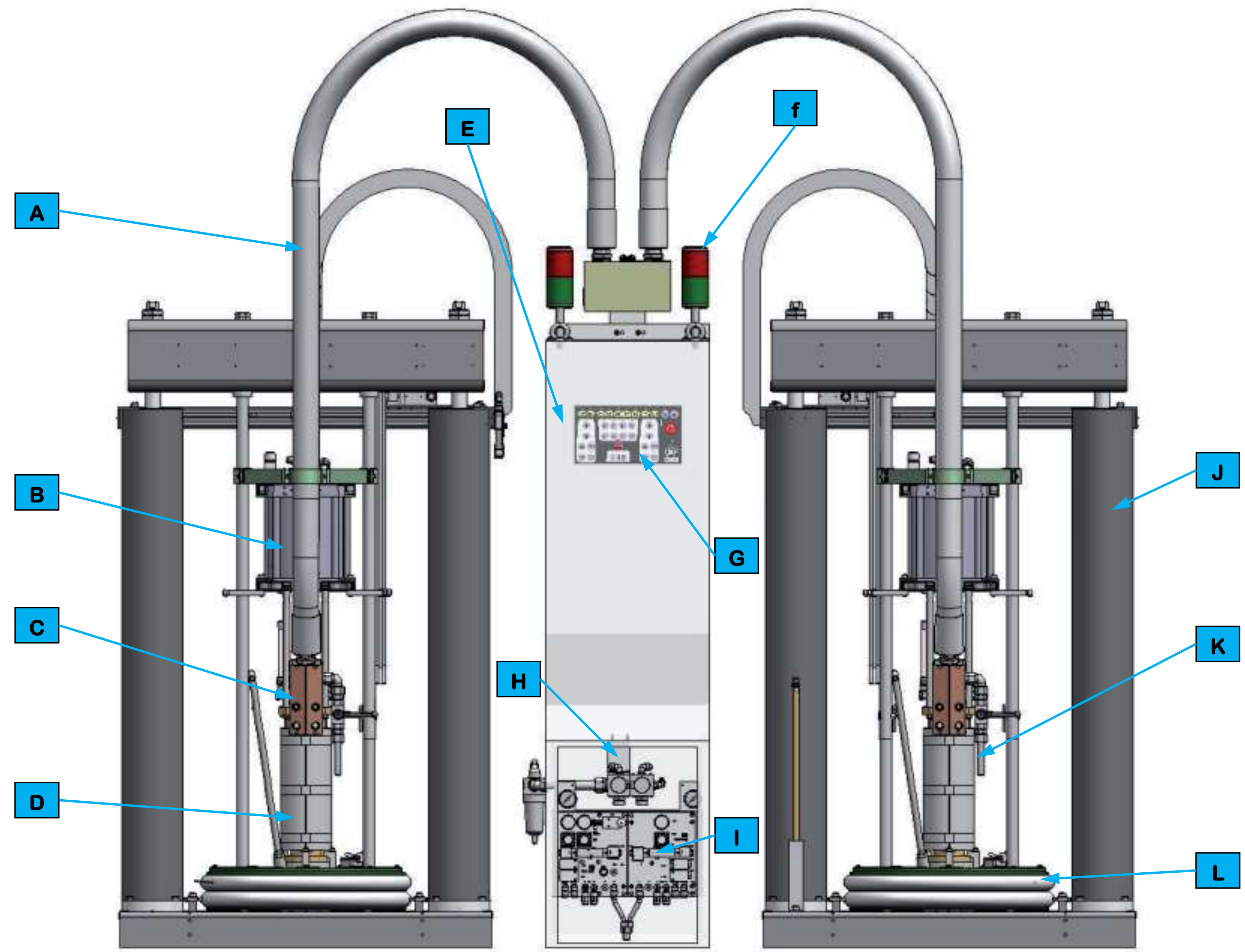


Figure 3-111. EP620 RTV Dispense Pump System

3.6.32.3. RTV Dispense Pump Operation

RTV sealant is pumped from one of two barrels by the lower pump into the material hose that feeds into the pump cabinet. Inside the pump cabinet the RTV is heated and measured by a metering device. The RTV is then fed to the RTV Dispense Stand inside Station EP620.

Control of the RTV Dispense Pump System is controlled by the control panel.

Device Callouts for Figure 3-111	
A	Feed Hose
B	Pump Drive
C	Material Outlet Pump
D	Lower Pump
E	Pump Cabinet
F	Status Light
G	Pump Control Panel
H	Air Connection
I	Pneumatic Control Unit
J	Pump Lifter
K	Barrel Ventilation
L	Follower Plate

3.6.32.4. Cell EP620 Sequence of Operation

The RTV and Load Cover Station equipment completes the following operations during a normal cycle:

1. The AGC enters Cell EP620 carrying a battery assembly.
2. The Cover Load Robot (refer to callout **I** in ***Figure 3-109***) manipulates End of Arm Tooling (EOAT) to scan and pick a cover from dunnage on Conveyor Equipment.
3. The Cover Load Robot moves along its rail system to the RTV Dispense System
4. The Cover Load Robot inverts the cover and articulates the cover to apply a bead of RTV seal along the periphery of the cover.
5. If the bead of sealant is not in the proper location and size the cover is rejected by the system and the Cover Load Robot manipulates EOAT to place the rejected cover on the Repair Shuttle (refer to callout **B** in ***Figure 3-107***) allowing the cover to move to the Repair Cell to be repaired.
6. The Cover Load Robot Rotates to the waiting AGC.
7. The Cover Load Robot uses vision cameras to align the EOAT holding the cover with the battery assembly.
8. The Cover Load Robot lowers the EOAT to place the cover onto the battery assembly.
9. The Cover Load Robot raises to clear the battery assembly.
10. The AGC moves forward to Station EP630.

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

3.6.32.5. Cover Load Robot and EOAT

Station EP620 contains one Cover Load Robot (EP620R01). The FANUC R-2000IC/210L (refer to ***Figure 3-106***) is a 6-axis robot with a load capacity of 462 lbs. attached to a track rail system. Attached to the Cover Load Robot is End of Arm Tooling (EOAT) used to pick a cover from dunnage and then moves along the track rail system to the RTV Dispense System. At the RTV Dispense System the Cover Load Robot inverts the cover and articulates the cover to apply a bead of RTV seal along the periphery of the cover. After the RTV seal has been applied the Cover Load Robot inverts the cover and rotates to the waiting AGC where the Robot uses vision cameras to align the EOAT holding the cover to the battery assembly and then lowers the cover onto the battery assembly. The Cover Load Robot then raises to clear the battery assembly allowing the AGC to move forward.

An inspection sensor is incorporated into the RTV Dispense System that confirms a proper bead of sealant has been applied. If the bead of sealant is not in the proper location and size the cover is automated rejected by the system and the Cover Load Robot will manipulate the EOAT to place the rejected cover on the Repair Shuttle (refer to callout **B** in ***Figure 3-107***) allowing the cover to move to the Repair Cell to be repaired.

The Cover Load EOAT (refer to ***Figure 3-108***) consists of a rectangular frame with linear lights, cameras, a vacuum generator, vacuum pads, and pneumatic actuated grippers. Two (2) opposing light bars and two (2) opposing FANUC iRVision cameras are located on the outer section of the frame facing inwards and are used to align the EOAT with the battery assembly cover. Eight (8) vacuum pads are located on the outer section of the frame configured in two (2) rows of four (4) connected to the vacuum generator. 4 pneumatically powered grippers are located on the inner section of the frame at each corner. When the EOAT is lowered to the cover, the vacuum pads are activated to apply suction against the cover to hold the cover and the grippers are actuated to align the EOAT. The vacuum generator remains on and the grippers in place while the Cover Load Robot moves to the RTV Dispense Station and moves to place the cover on the battery assembly on the AGC. Once the robot lowers the cover to the battery assembly on the AGC the grippers actuate and the vacuum generator stops, releasing the cover.

REFERENCE ***For more information about the robot equipment, refer to the equipment supplier documentation (FANUC Robot R-2000 iC Operator's Manual).***

3.6.32.6. Robot and Vision Calibration Stand

The Robot and Vision Calibration Stand (refer to callout **K** in ***Figure 3-109***)) provides a calibration grid that is used as a reference when calibrating the robot and robot vision equipment. Calibration of the robot and robot vision equipment is documented in the associated FANUC documentation.

3.6.32.7. RTV Dispense System in Cell EP620

The RTV Dispense System (EP620R01B01), refer to callouts **A** and **B** in ***Figure 3-109***) is used to hold and dispense RTV sealant in a bead along the periphery of the cover of battery assemblies. The RTV Dispense System consists of a pump station with attached receptacles for two (2) RTV containers placed beside Cell 620. The pump feeds into a material hose that feeds into a pump mounted at the middle of a Dispense Robot (EP620R02) located inside the cell. The pump maintains a constant pressure and flow feeding into a hose that connects to an EOAT dispense nozzle assembly mounted to the Robot. The dispense nozzle assembly consists of a dispensing nozzle that applies a bead of RTV along the periphery of the cover of battery assemblies and a RTV bead spin top sensor that scans the RTV bead after it is applied for proper location, height, and width.

3.6.32.8. Repair Shuttle and Repair Cell

The Repair Shuttle (refer to callout **B** in ***Figure 3-109***) is a track system that moves the Cover Reject Table from Cell 620 into the Repair Cell (EP625B01, refer to callout **C** in ***Figure 3-109***) so that an Operator can perform repairs on the cover before the cover is returned to Cell 620.

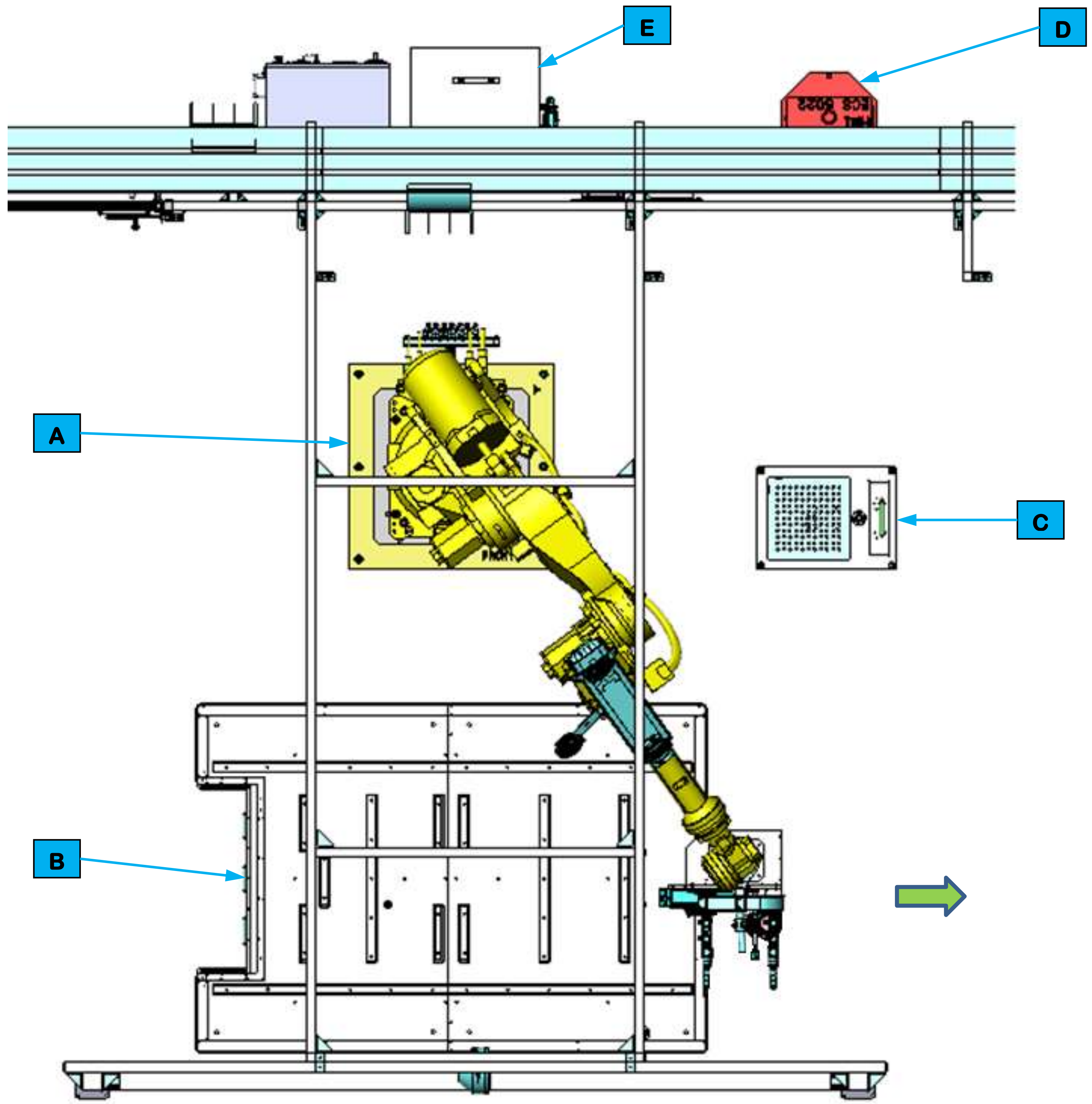
3.6.32.9. Conveyor Equipment

The Conveyor Equipment (EP620T01B01, refer to callouts **F** and **G** in ***Figure 3-109***) transfers dunnage carrying covers into the cell and empty dunnage out of the cell.

The Conveyor Equipment utilizes third-party OTP conveyance devices. Powered roller conveyor sections are used to pull full module dunnage frames into the cell and to push empty module dunnage frames out of the cell. Each powered roller conveyor section has its own motor and motor starter. At the Cover Load Robot inside the cell, a perpendicular section of chain conveyor is used to transfer a single container from the input side to the output side.

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 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 personnel 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 conveyor equipment, refer to the equipment supplier documentation (Omni Metalcraft Technical Handbook).***



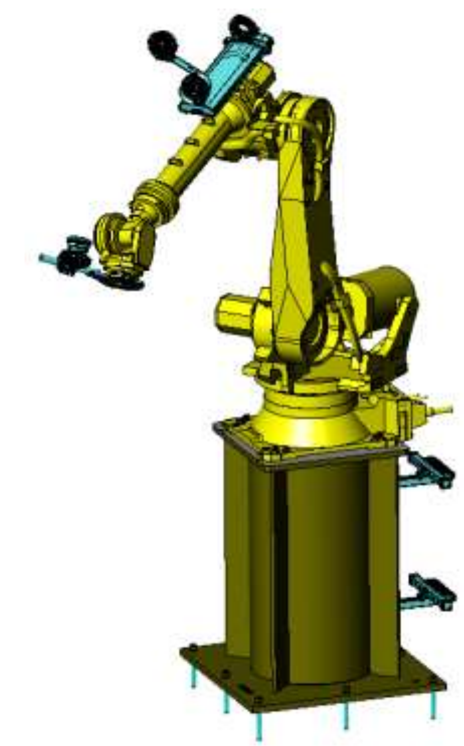
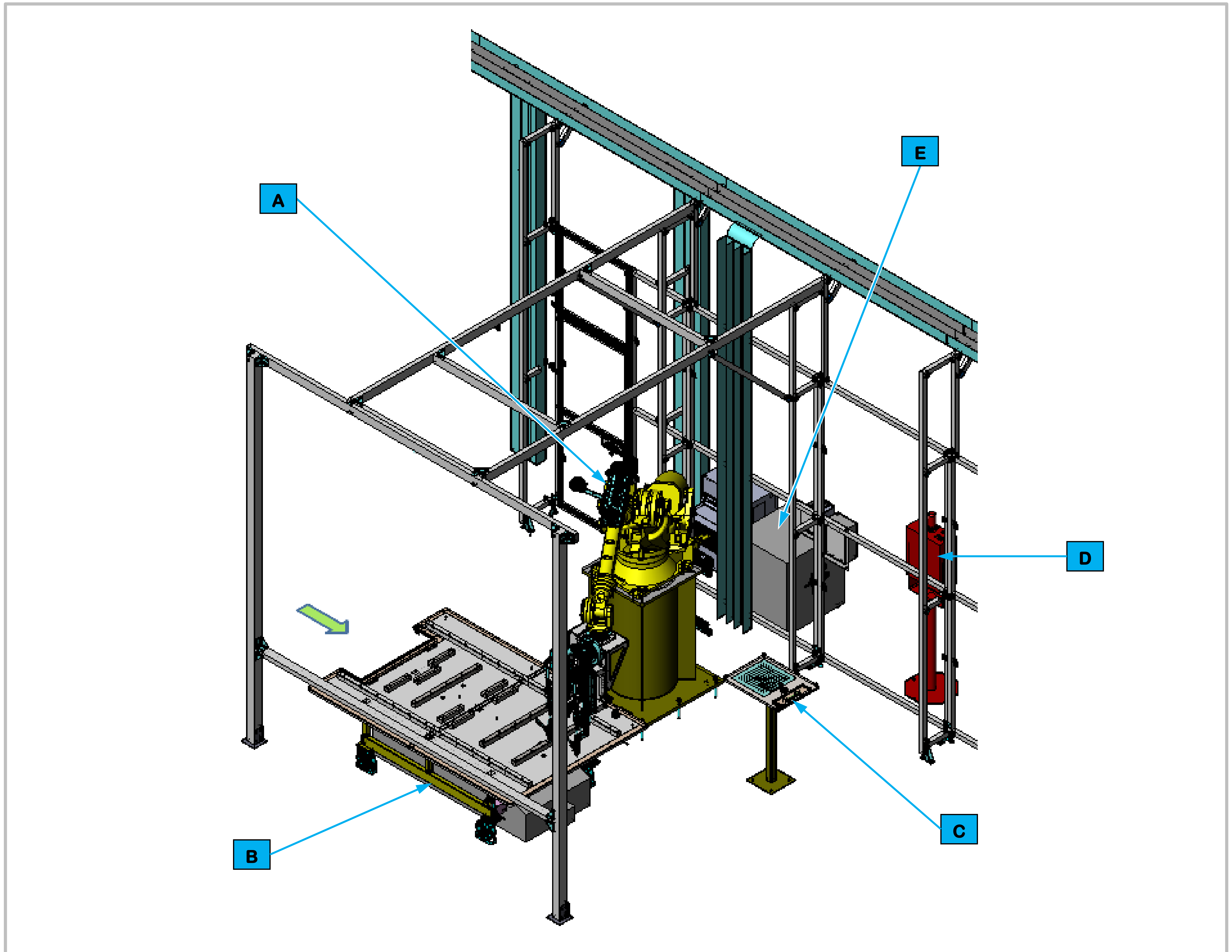


Figure 3-112. Cover Secure Robot

Equipment Callouts in Station EP630 Top View		
A	EP630R01	Cover Secure Robot
B	N/A	Automated Guided Cart (AGC)
C	N/A	Robot and Vision Calibration Stand
D	EP620D1	Operator Console HMI
E	EP630BF1	Fastener Feed System

Figure 3-113. EP630 Cover Secure Station Top View.



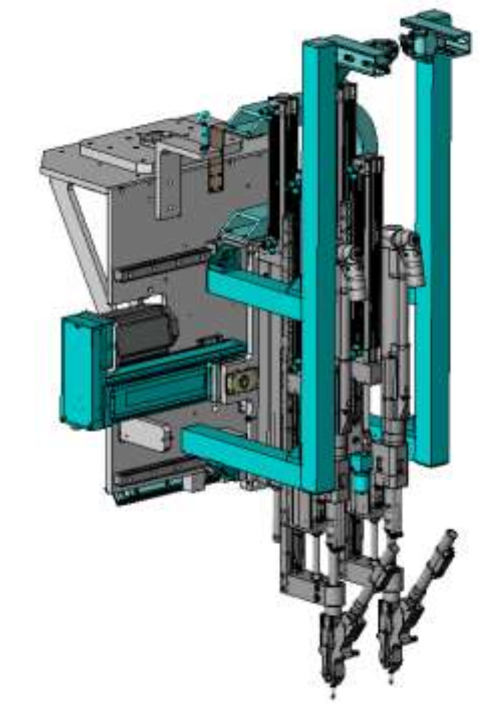


Figure 3-114. Cover Secure EOAT

Equipment Callouts in Station EP630 Isometric View		
A	EP630R01	Cover Secure Robot
B	N/A	Automated Guided Cart (AGC)
C	EP620D1	Operator Console HMI
D	N/A	Robot and Vision Calibration Stand
E	EP630BF1	Fastener Feed System

Figure 3-115. EP630 Cover Secure Station Isometric View.

3.6.32.10. Station EP630 Sequence of Operation

The Cover Secure Station equipment completes the following operations during a normal cycle:

1. The AGC enters Station EP630 from Station EP620 carrying a battery assembly.
2. The Cover Secure Robot (refer to callout **A** in ***Figure 3-115***) rotates and lowers to the battery assembly.
3. The Cover Secure Robot manipulates vision aligned End of Arm Tooling (EOAT) to the cover.
4. The Cover Secure Robot EOAT uses two (2) drivers to fasten blow-fed bolts to the cover of the battery assembly.
5. The Cover Secure Robot raises clear of the battery assembly.
6. The AGC moves forward to Station EP640.

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

3.6.32.11. Cover Secure Robot and EOAT

Station EP630 contains one Cover Secure Robot (EP630R01). The FANUC R2000IC-210F (refer to ***Figure 3-112***) is a 6-axis robot with a load capacity of 462 lbs. The robot rotates and lowers vision aligned EOAT to the battery assembly, receives blow-fed bolt to the EOAT and then fastens the bolts to the battery cover two (2) at a time using drivers. Having completed this operation, the Cover Secure Robot raises clear of the battery asse allowing the AGC to move forward to the next cell.

The Cover Secure EOAT (refer to ***Figure 3-114***) consists of a frame with a linear light, a camera, and pneumatic drivers with attached blow fed supply lines. A linear light is located at the back of the frame. Two (2) drivers are located at the front of the frame with one of the drivers mounted on a track allowing it to actuate sideways to facilitate bolt spacing. Mounted between the drivers is a FANUC iRVision camera used to align the EOAT with the Cover. When the EOAT is lowered to the cover on the battery assembly, the drivers are fed bolts that are vision aligned and torqued to a consistent value.

REFERENCE	***For more information about the robot equipment, refer to the equipment supplier documentation (FANUC Robot R-2000 iC Operator's Manual).***

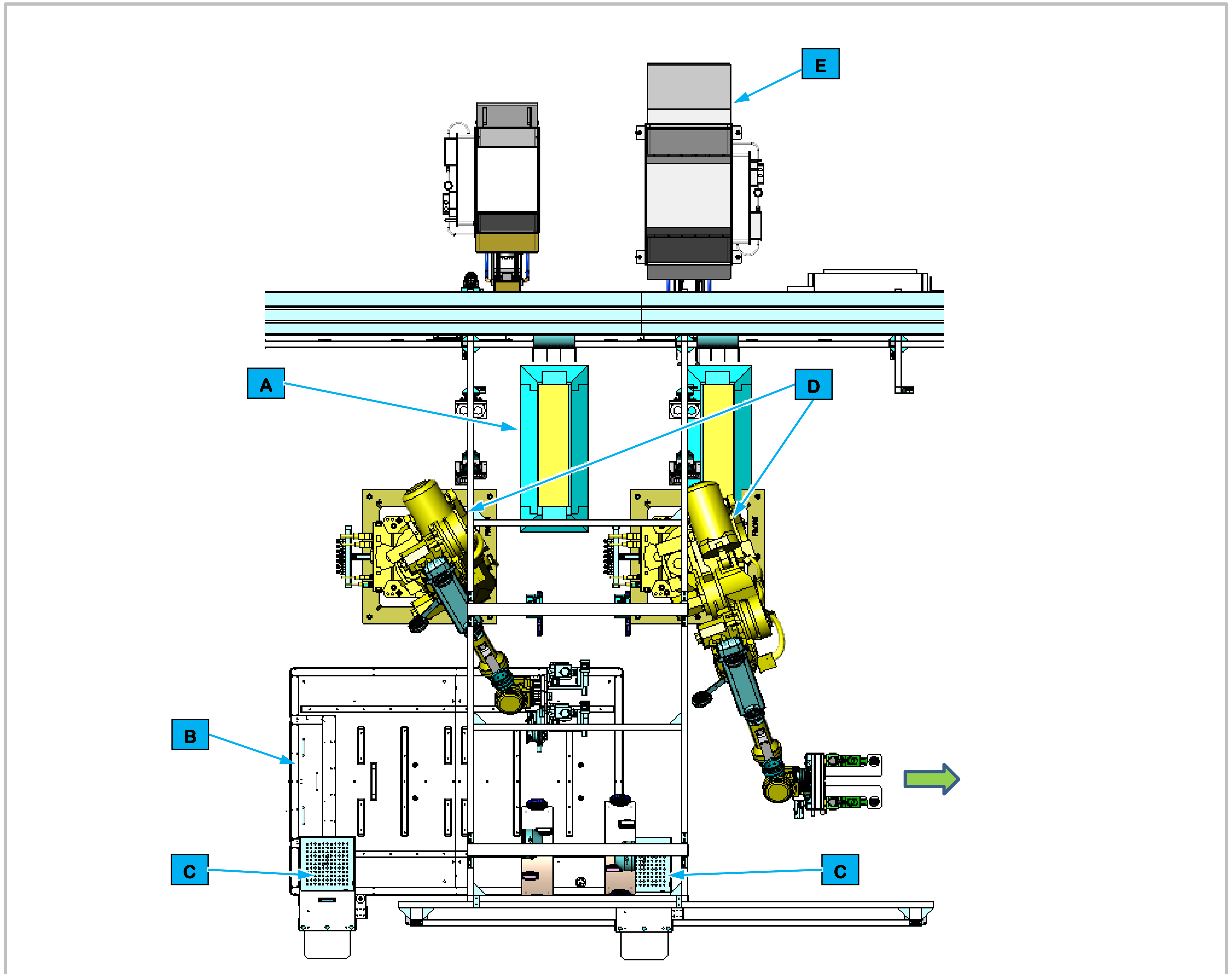
3.6.32.12. Robot and Vision Calibration Stand

The Robot and Vision Calibration Stand (refer to callout **C** in ***Figure 3-115***) provides a calibration grid that is used as a reference when calibrating the robot and robot vision equipment. Calibration of the robot and robot vision equipment is documented in the associated FANUC documentation.

3.6.32.13. Fastener Feed System

The Carlson S12 Fastener Feed System (EP630BF1, refer to callout **E** in ***Figure 3-115***) is an electrically motorized fastener assembly that sorts and aligns bolts into an inline track that are then blow fed into an air hose to the Midplate Fasten Robot EOAT.

REFERENCE	***For more information about fastener feed system equipment, refer to the equipment supplier documentation (Carlson S12 Technical Manual).***



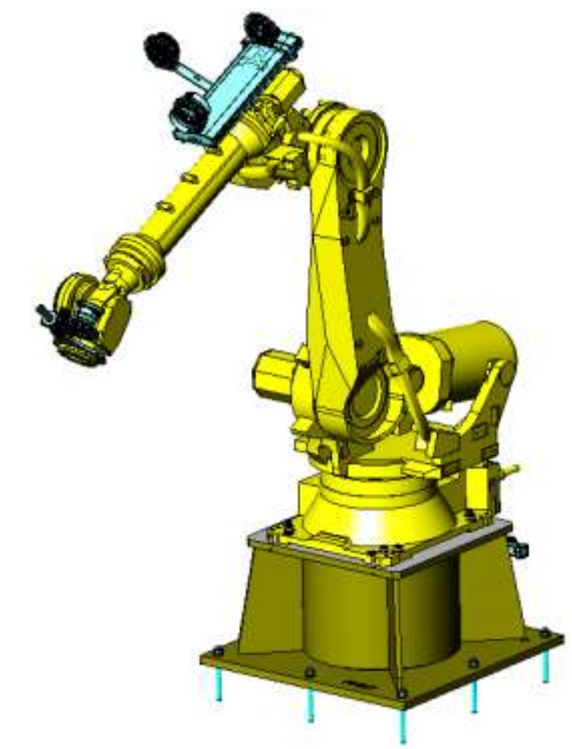
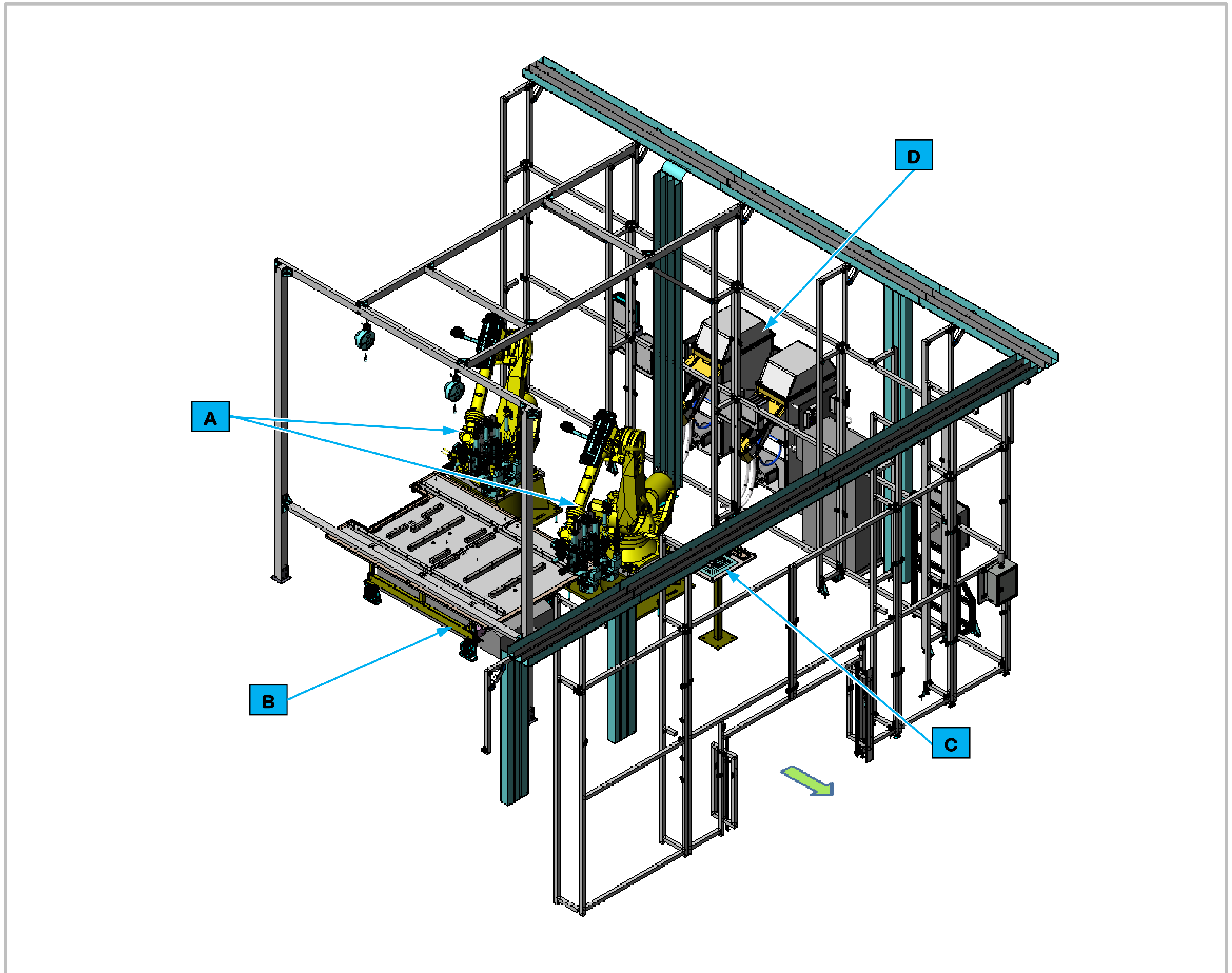


Figure 3-116. Cover Stanchion Secure Robot

Equipment Callouts in Station EP640 Top View		
A	N/A	Cable Protector
B	N/A	Automated Guided Cart (AGC)
C	N/A	Robot and Vision Calibration Stand
D	EP640R01 -2	Cover Stanchion Robot (2)
E	EP640BF1 -2	Fastener Feed System

Figure 3-117. EP640 Cover Stanchion Secure Station Top View.



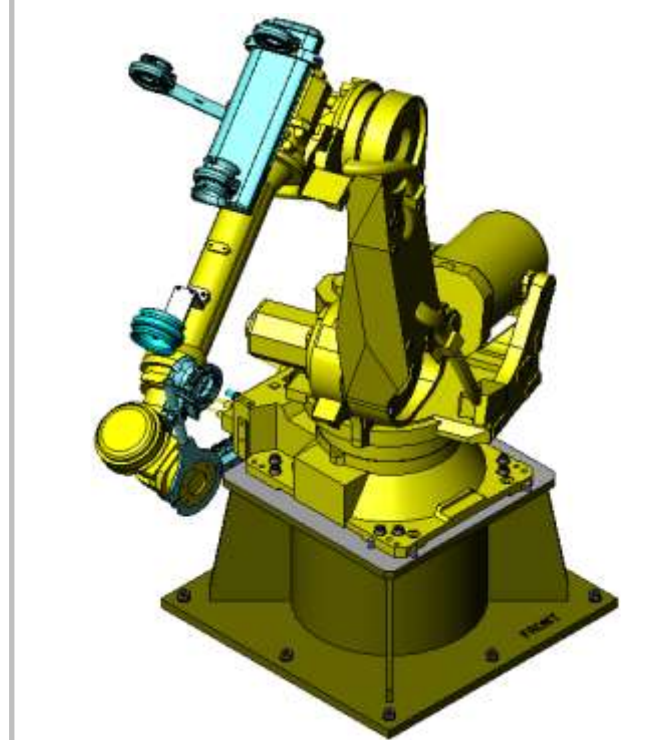
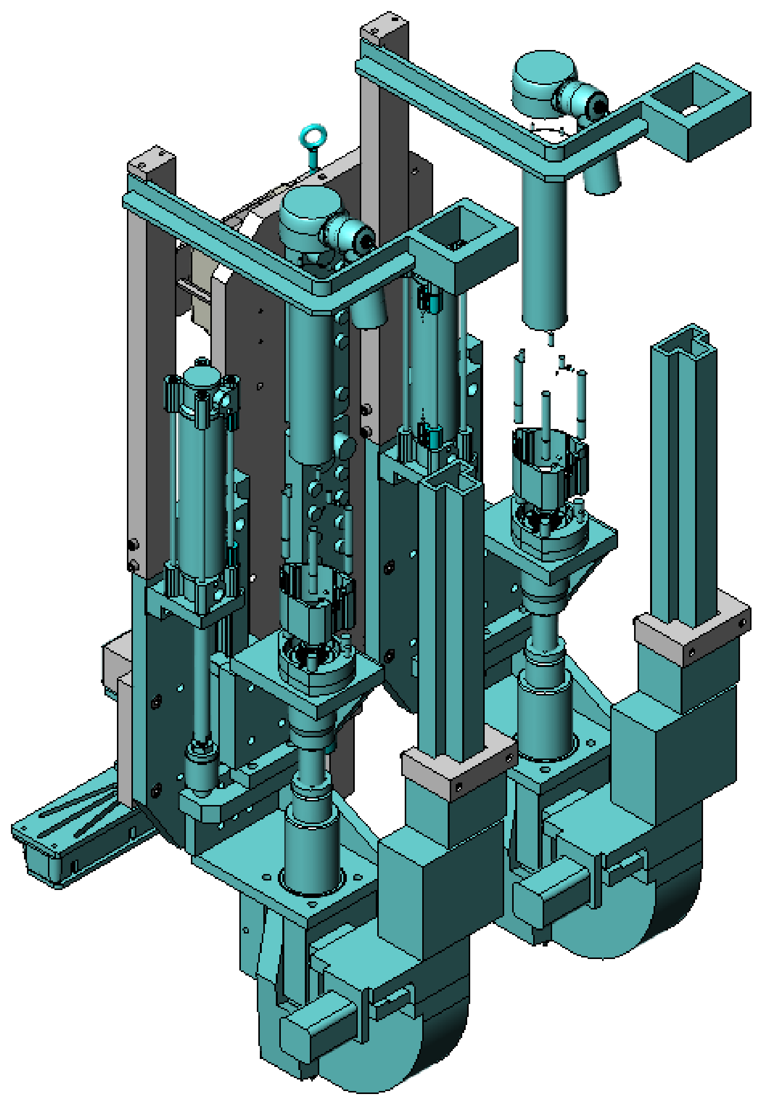


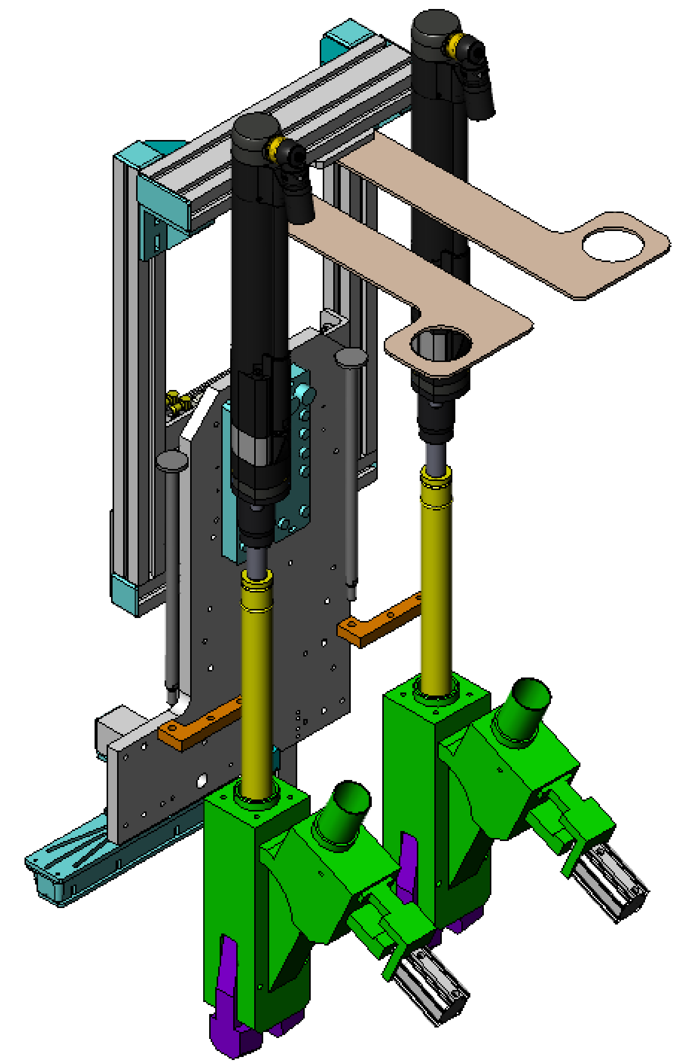
Figure 3-118. Cover Stanchion Robot

Equipment Callouts in Station EP640 Isometric View		
A	EP640R01 -2	Cover Stanchion Robot (2)
B	N/A	Automated Guided Cart (AGC)
C	N/A	Robot and Vision Calibration Stand
D	EP640BF1 -2	Fastener Feed System

Figure 3-119. EP640 Cover Stanchion Secure Station Isometric View.



Cover Stanchion Secure
EOAT - BEV



Cover Stanchion Secure
EOAT - BET

Figure 3-120. EP640 Cover Stanchion Secure Station EOAT.

3.6.32.14. Station EP640 Sequence of Operation

The Cover Stanchion Secure Station equipment completes the following operations during a normal cycle:

Note: Two (2) Cover Stanchion Secure Robots perform the same actions.

1. The AGC enters Station EP640 from Cell 630 carrying a battery assembly.
2. The Cover Stanchion Secure Robot (refer to callout **A** in ***Figure 3-119***) rotates and lowers to the battery assembly.
3. The Cover Stanchion Secure Robot manipulates vision aligned End of Arm Tooling (EOAT) to the cover.
4. The Cover Stanchion Secure Robot EOAT uses two (2) drivers to fasten blow-fed stanchion nuts to the cover of the battery assembly.
5. The Cover Stanchion Secure Robot raises clear of the battery assembly.
6. The AGC moves forward and exits the cell.

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

3.6.32.15. Cover Stanchion Secure Robot and EOAT

Station EP640 contains 2 Cover Stanchion Secure Robots (EP640R01 -2). The FANUC R2000IC-210F (refer to ***Figure 3-116***) is a 6-axis robot with a load capacity of 462 lbs. Both robots work on the same AGC at the same time. The robot rotates and lowers vision aligned EOAT to the battery assembly, receives blow-fed nuts to the EOAT and then fastens the bolts to the battery cover two (2) at a time using drivers. Having completed this operation, the Cover Stanchion Secure Robot raises clear of the battery asse allowing the AGC to move forward to exit the cell.

The Cover Stanchion Secure EOAT (refer to ***Figure 3-118***) consists of a frame with a linear light, a camera, and pneumatic drivers with attached blow fed supply lines. A linear light and a FANUC iRVision camera used to align the EOAT are located at the back of the frame. Two (2) drivers are located at the front of the frame. When the EOAT is lowered to the cover on the battery assembly, two (2) located on the front of the frame are fed bolts and torqued to a consistent value.

REFERENCE	***For more information about the robot equipment, refer to the equipment supplier documentation (FANUC Robot R-2000 iC Operator's Manual).***

3.6.32.16. Robot and Vision Calibration Stand

The Robot and Vision Calibration Stand (refer to callout **C** in ***Figure 3-119***) provides a calibration grid that is used as a reference when calibrating the robot and robot vision equipment. Calibration of the robot and robot vision equipment is documented in the associated FANUC documentation.

3.6.32.17. Fastener Feed System

The Airway Model 3 Fastener Feed System (refer to callout refer to callout **M** in ***Figure 3-12***) is an electrically motorized fastener assembly that sorts and aligns bolts into an inline track that are then blow fed into an air hose to the Tray/Skid Plate Assembly EOAT.

REFERENCE	***For more information about fastener feed system equipment, refer to the equipment supplier documentation (Airway Automation Equipment Manual).***

3.6.33. EP650 Cover Secure Manual Repair Station Description

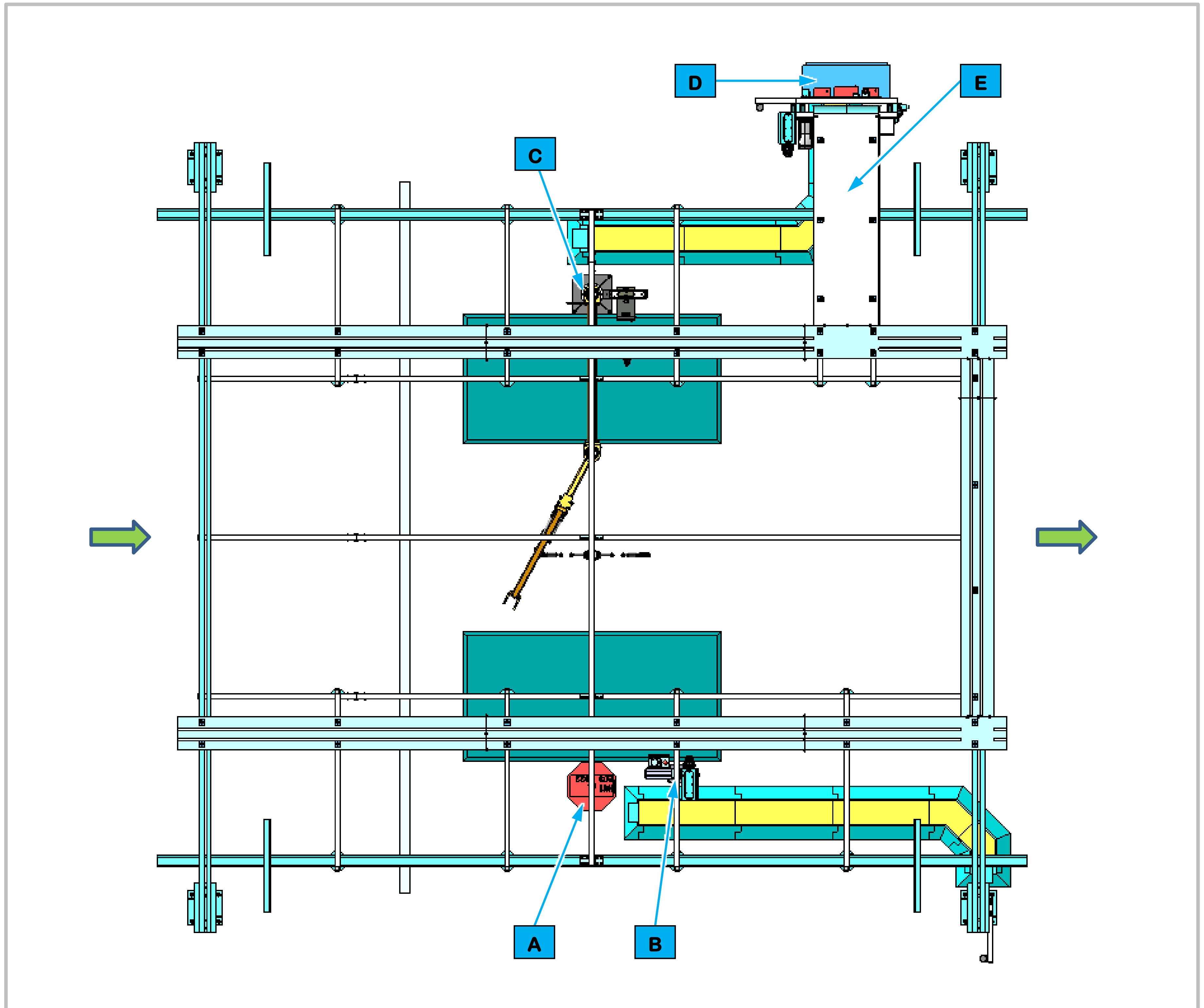


Figure 3-121. EP650 Cover Secure Manual Repair Station Top View

3.6.33.1. Station Description

Cell EP650 is a manual cell that is incorporated into automated Cell 620. An Operator makes required repairs to cover install operation performed in Cells 620, 630, and 640.

Equipment Callouts in Station EP650 Top View		
A	EP650D1	Operator Console HMI
B	EP650BC1	Barcode Scanner and E-Stop
C	N/A	Atlas Fastener System
D	EP650P2	Power Cabinet
E	N/A	Wireway

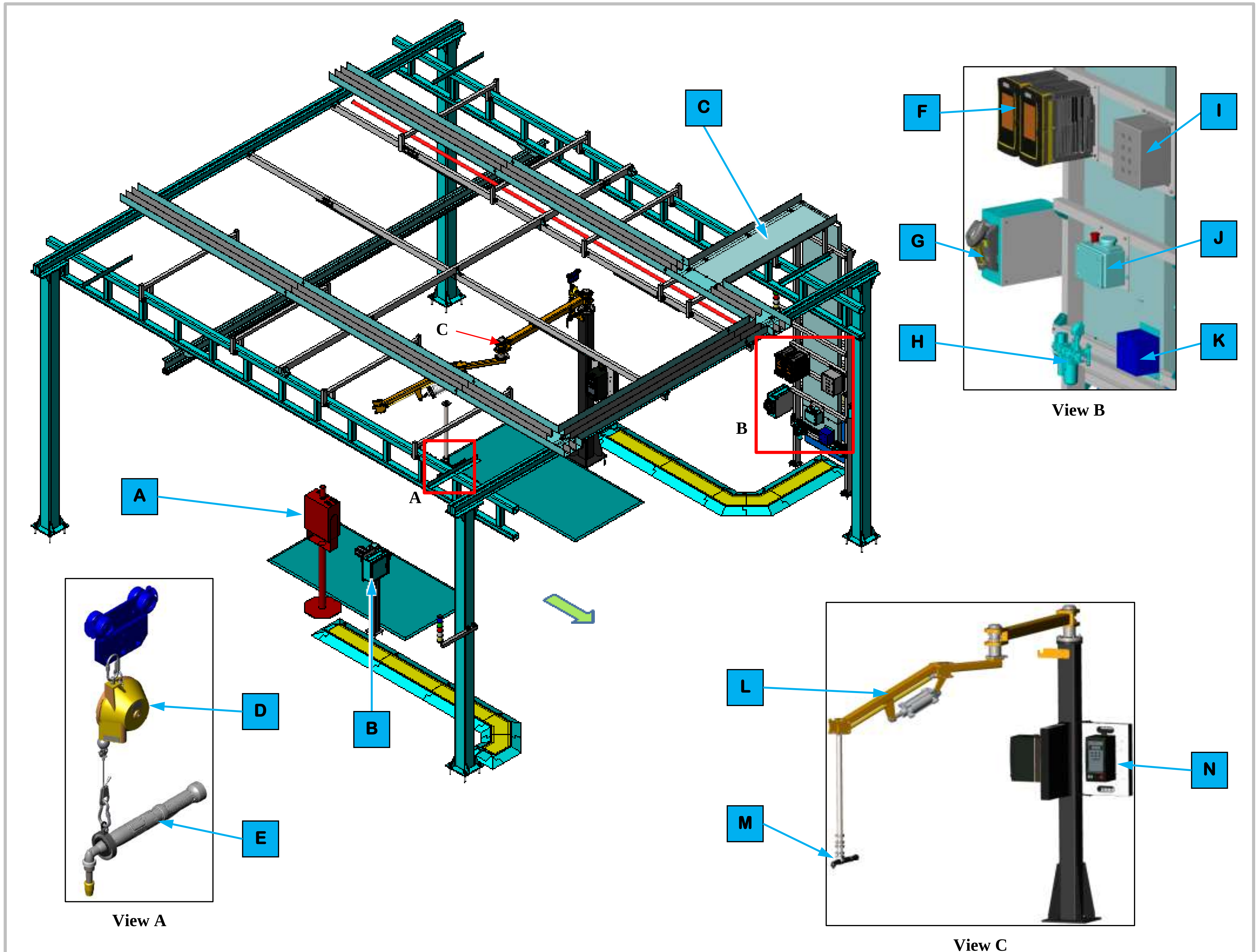


Figure 3-122. EP650 Cover Secure Manual Repair Station Isometric View

3.6.33.2. Sequence of Operation for BET

Step	Process
1	Follow repair procedure

3.6.33.3. Sequence of Operation for BEV3

Step	Process
1	Follow repair procedure

Equipment Callouts in Station EP650 Isometric View		
A	EP650D1	Operator Console HMI
B	EP650BC1	Barcode Scanner and E-Stop
C	N/A	Wireway
D	N/A	Tool Balancer
E	EP650TC1 -2	Nutrunner
F	EP650TC1 -2	Nutrunner Controllers
G	N/A	Barcode Scanner
H	AIRON	Air Preparation Unit
I	EP650E2	Operator Push Button Box
J	EP650E1	Operator Release/E-Stop
K	EP650RCP1	Electrical Outlet Box
L	N/A	Atlas Fastener System
M	PPX2	Atlas Fastener
N	N/A	Atlas Fastener Control Panel

3.6.34. EP660 Burst Valve Install Station Description

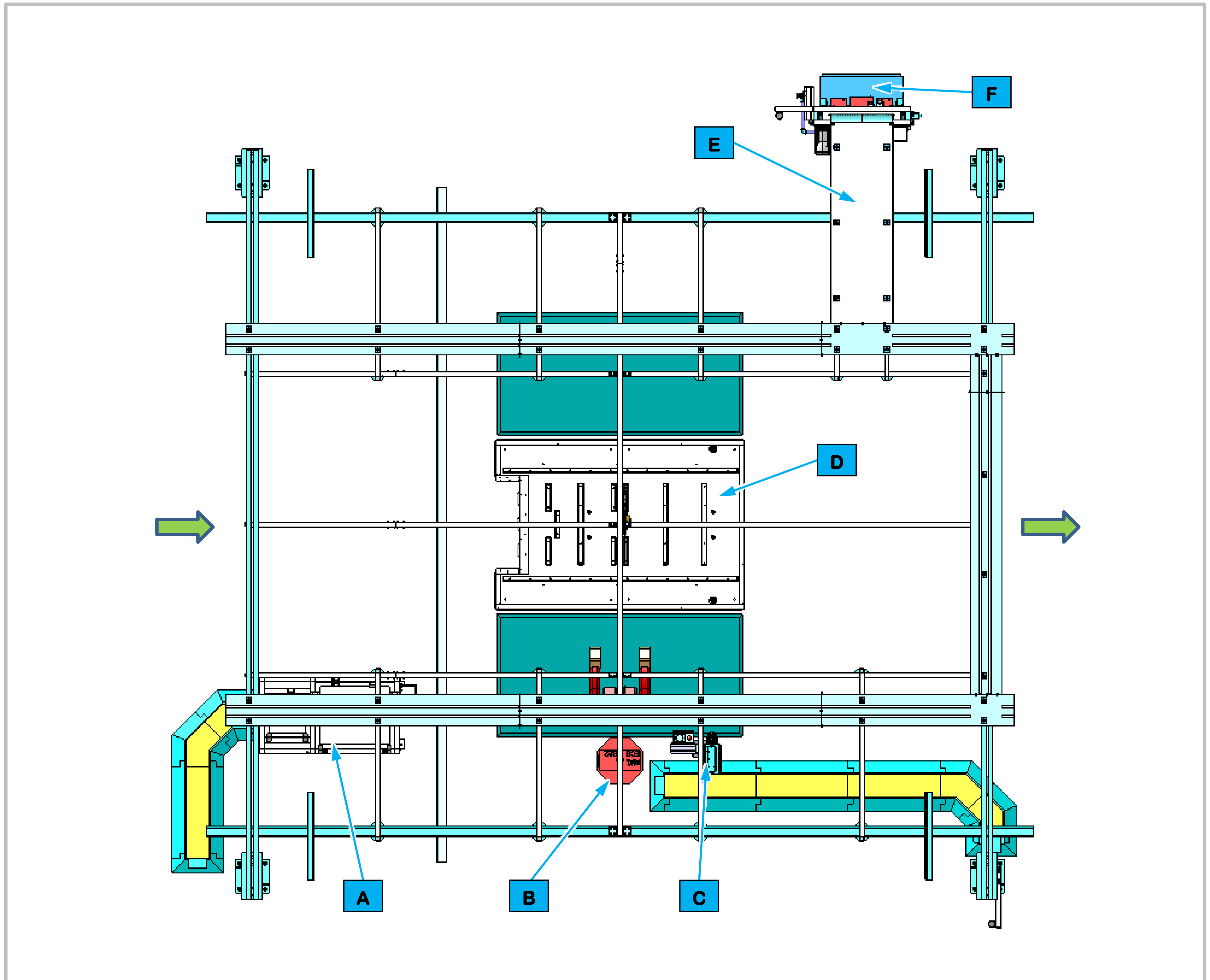


Figure 3-123. EP660 Burst Valve Install Station Top View

3.6.34.1. Station Description

Cell EP660 is a manual station for installing the burst values to the battery assembly on BET and BEV3 modules.

For BET batteries an Operator gets and installs the Burst Valve.

For BEV3 batteries the Operator gets and installs the Burst Valve.

Equipment Callouts in Station EP660 Top View		
A	EP660SF1	Fastener Feed System
B	EP660BC1	Barcode Scanner and E-Stop
C	EP660D1	Operator Console HMI
D	N/A	Automated Ground Cart (AGC)
E	N/A	Wireway
F	EP660P2	Power Cabinet

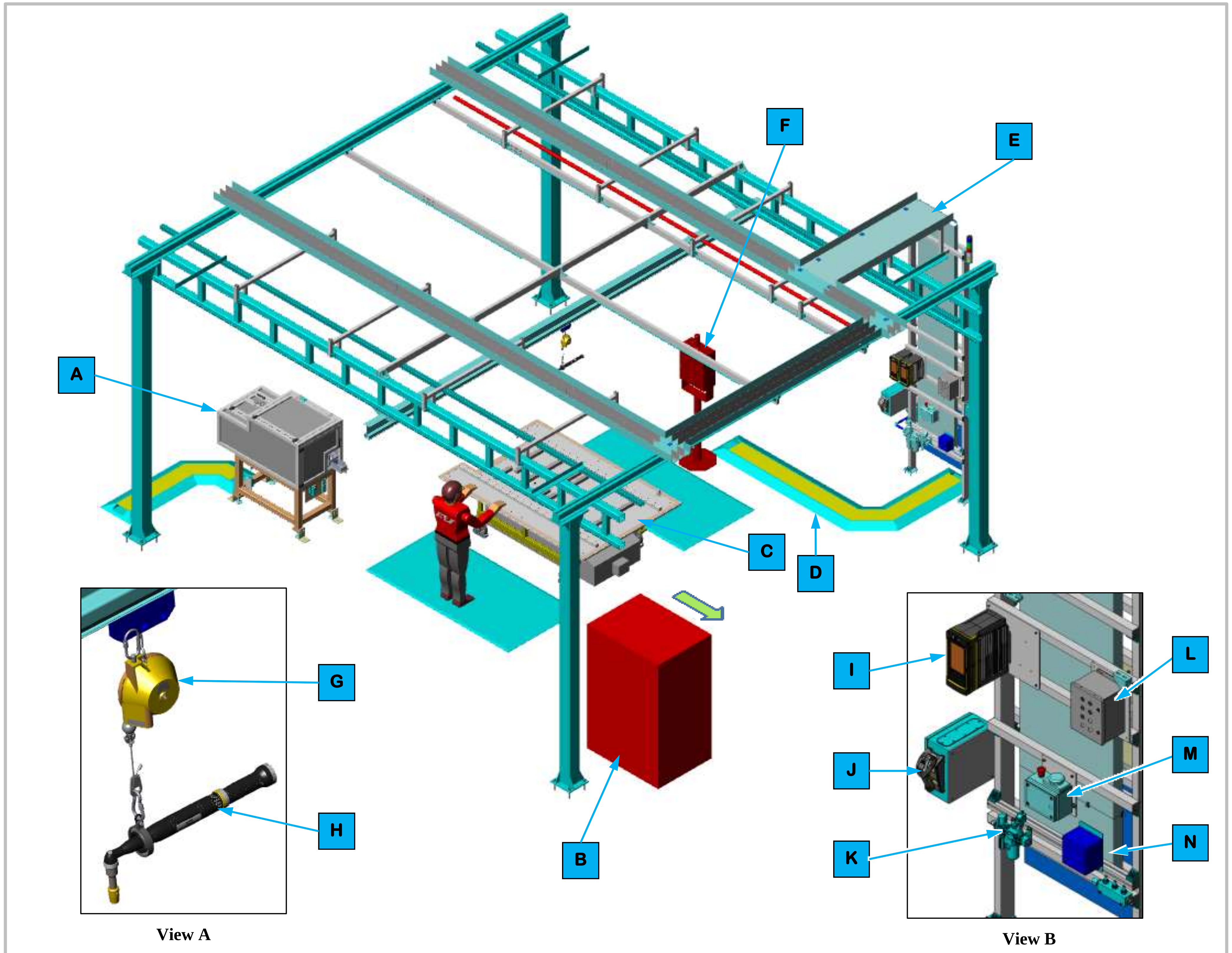


Figure 3-124. EP660 Burst Valve Install Station Isometric View

3.6.34.2. Sequence of Operation for BET

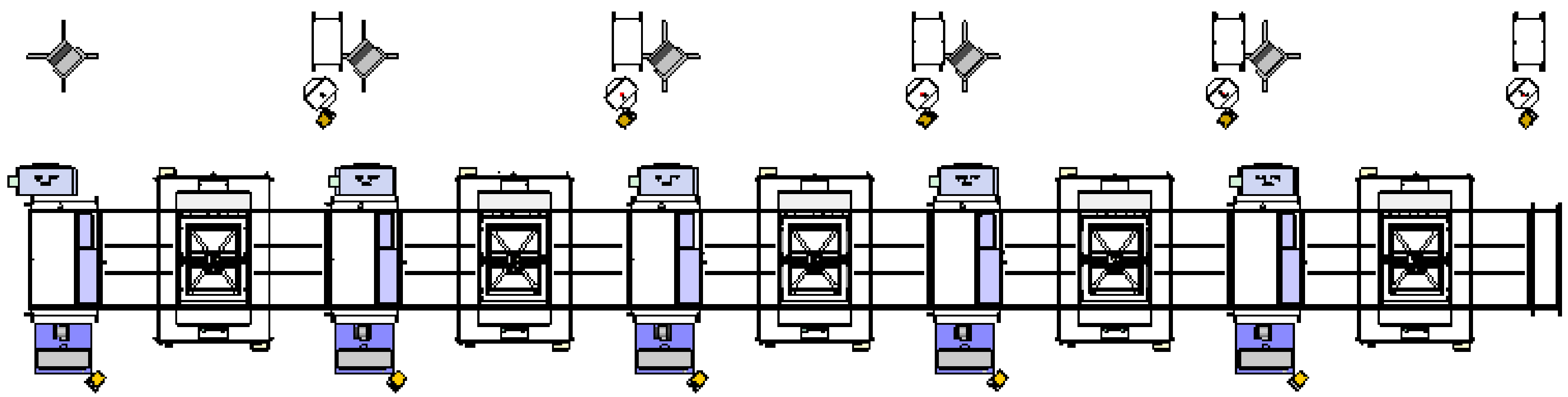
Step	Process
1	Get and install Burst Valve

3.6.34.3. Sequence of Operation for BEV3

Step	Process
1	Get and install Burst Valve

Equipment Callouts in Station EP660 Isometric View		
A	EP660SF1	Fastener Feed System
B	N/A	Dunnage
C	N/A	Automated Guided Cart (AGC)
D	N/A	Cable Protector
E	N/A	Wireway
F	EP660D1	Operator Console HMI
G	N/A	Tool Balancer
H	EP660TC1	Nutrunner
I	EP660TC1	Nutrunner Controllers
J	EP660BC1	Barcode Scanner
K	AIRON	Air Preparation Unit
L	EP660E2	Operator Push Button Box
M	EP660E1	Operator Release/E-Stop
N	EP660RCP1	Electrical Outlet Box

3.6.35. EP680 Cover Leak Test Station Description



For information regarding equipment located in Cell EP680, refer to *Battery Pack Test and Cover Leak Test Operation and Maintenance Manual*.

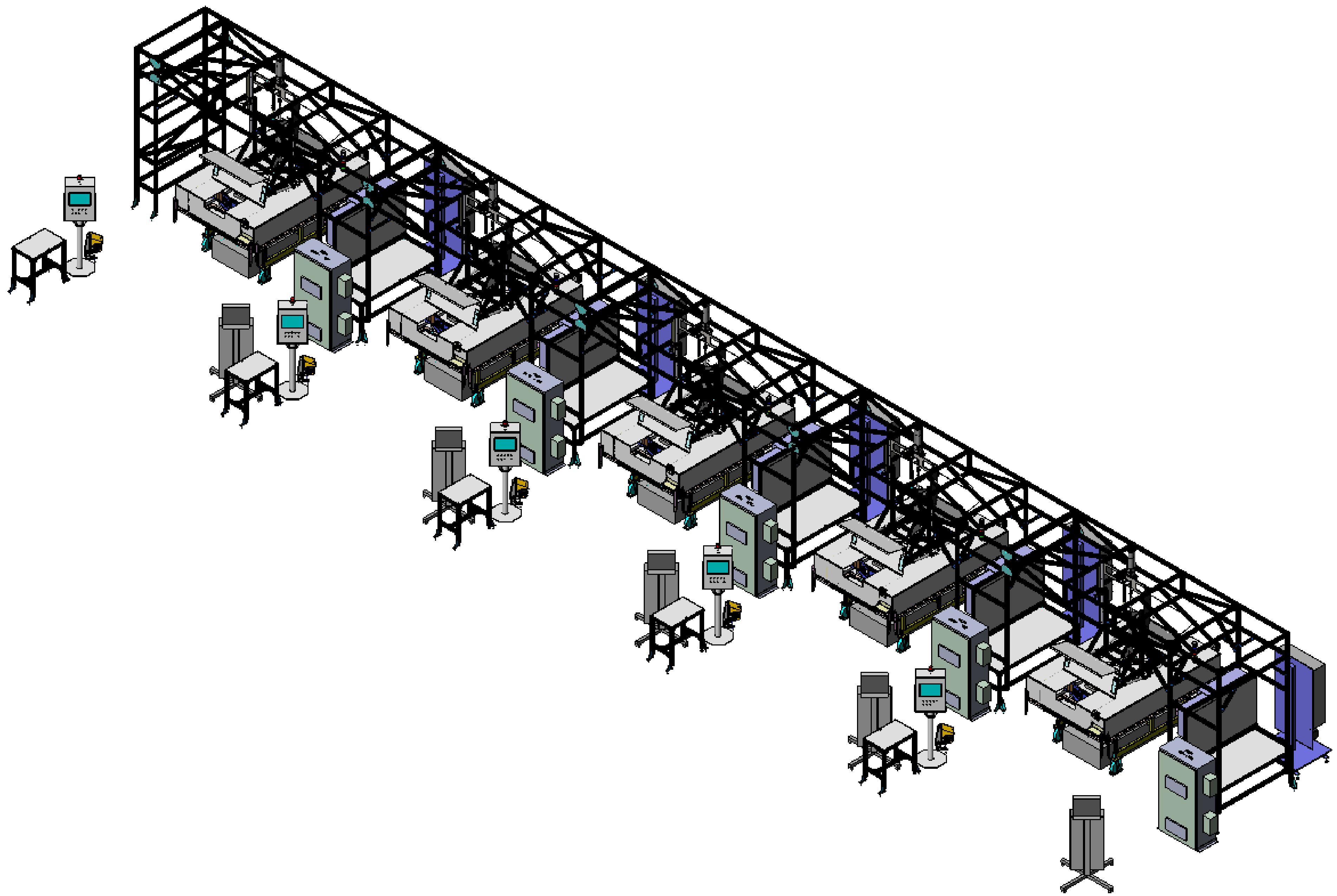
Figure 3-125. EP680 Cover Leak Test Station Top View

3.6.35.1. Station Description

Cell EP680 is a test station for performing a cover leak test on BET and BEV3 modules.

The AGC enters the station where an Operator performs a leak test on the battery assembly.

For more detailed information about Cell 580, refer to *Battery Pack Test and Cover Leak Test Operation and Maintenance Manual.*



For information regarding equipment located in Cell EP680, refer to *Battery Pack Test and Cover Leak Test Operation and Maintenance Manual.*

Figure 3-126. EP680 Cover Leak Test Station Isometric View

3.6.35.2. Sequence of Operation for BET

Step	Process
1	Operator performs an electrical leak test on battery assembly
	For more detailed information about Cell 680, refer to *Battery Pack Test and Cover Leak Test Operation and Maintenance Manual.*

3.6.35.3. Sequence of Operation for BEV3

Step	Process
1	Operator performs an electrical leak test on battery assembly
	For more detailed information about Cell 680, refer to *Battery Pack Test and Cover Leak Test Operation and Maintenance Manual.*

3.6.36. EP700 Continuity Test Station Description

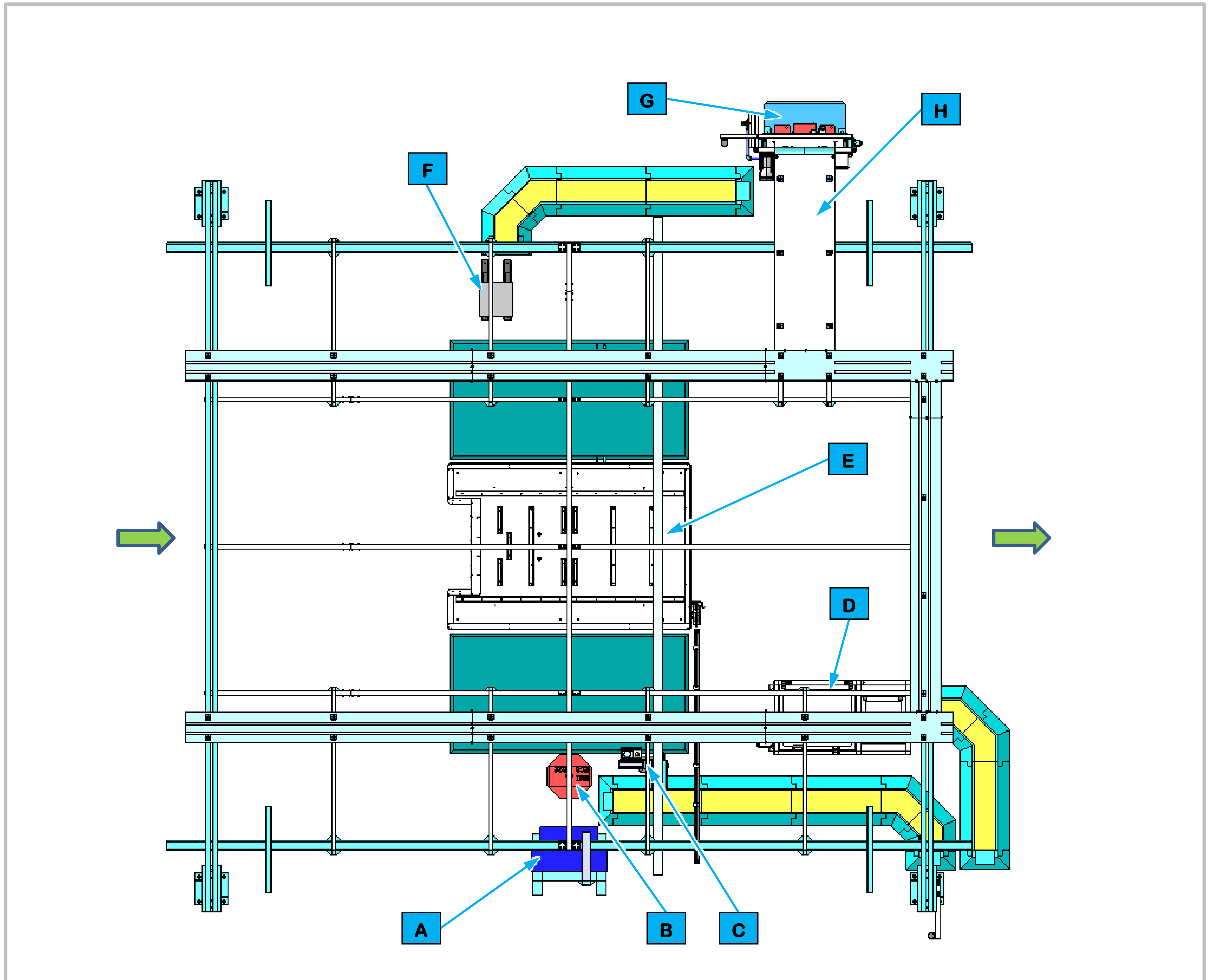


Figure 3-127. EP700 Continuity Test Station Top View

3.6.36.1. Station Description

Cell EP700 is a manual station for performing a continuity test on the assembled battery unit and then gets and installs a multi-purpose valve on BET and BEV3 modules.

For BET batteries an Operator performs a continuity test and then gets and installs the Multipurpose Valve.

For BEV3 batteries the Operator performs a continuity test and then gets and installs the Multipurpose Valve and Deflector.

Equipment Callouts in Station EP700 Top View		
A	N/A	Continuity Tester
B	EP700D1	Operator Console HMI
C	EP700BC1	Barcode Scanner and E-Stop
D	EP700SF1	Feeder
E	N/A	Automated Guided Cart (AGC)
F	N/A	Charger Stand
G	EP700E2	Power Cabinet
H	N/A	Wireway

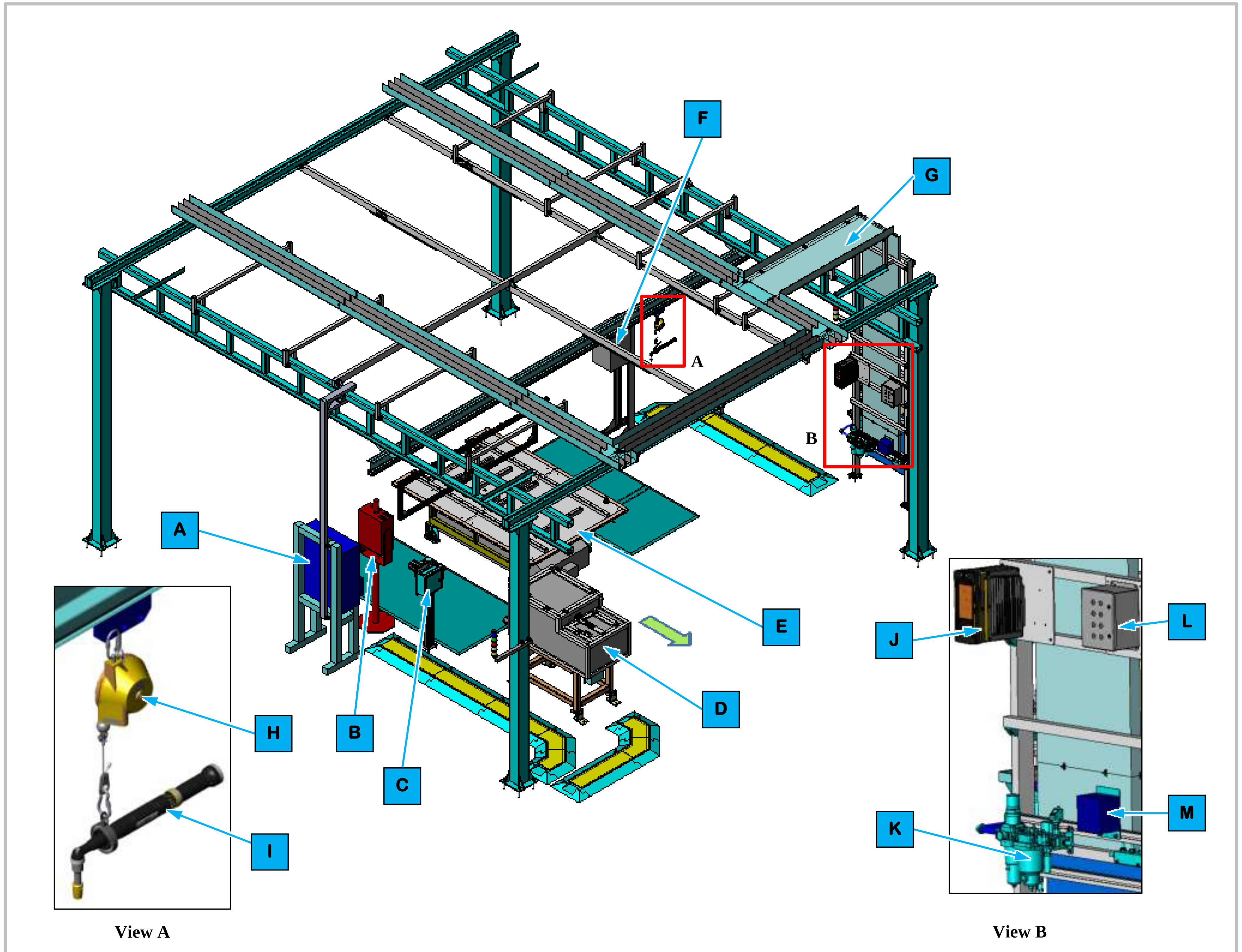


Figure 3-128. EP700 Continuity Test Station Isometric View

3.6.36.2. Sequence of Operation for BET

Step	Process
1	Perform continuity test
2	Get and install the Multipurpose Valve

3.6.36.3. Sequence of Operation for BEV3

Step	Process
1	Perform continuity test
2	Get and install the Multipurpose Valve
3	Get and install the Deflector

Equipment Callouts in Station EP700 Isometric View		
A	EP700EC1	Continuity Tester
B	EP700D1	Operator Console HMI
C	EP700BC1	Barcode Scanner and E-Stop
D	EP700SF1	Feeder
E	N/A	Automated Guided Cart
F	N/A	Charger Stand
G	N/A	Wireway
H	N/A	Tool Balancer
I	EP700TC1	Nutrunner
J	EP700TC1	Nutrunner Controller
K	AIRON	Air Preparation Unit
L	EP700E2	Operator Push Button Box
M	EP700RCP3	Electrical Outlet Box

3.6.37. EP905 General Repair Station Description

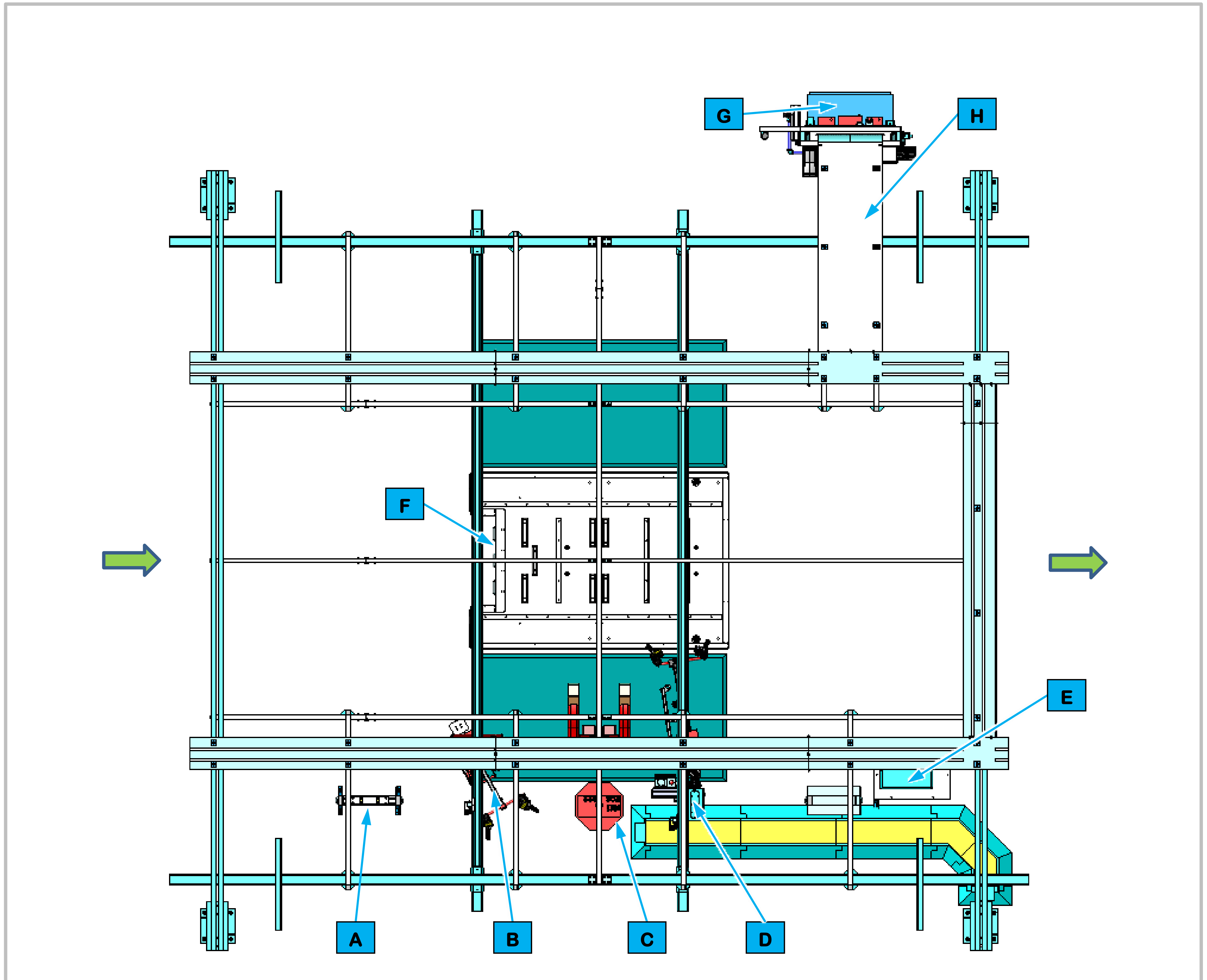


Figure 3-129. EP905 General Repair Station Top View

3.6.37.1. Station Description

Cell EP905 is a manual station for any required repairs to battery assemblies.

Equipment Callouts in Station EP905 Top View		
A	N/A	Stand
B	PPX5	BDU Lift Assist
C	EP905D1	Operator Console HMI
D	EP905BC1	Barcode Scanner and E-Stop
E	EP900PRT1	Printer
F	N/A	Automated Guided Cart (AGC)
G	EP905E2	Power Cabinet
H	N/A	Wireway

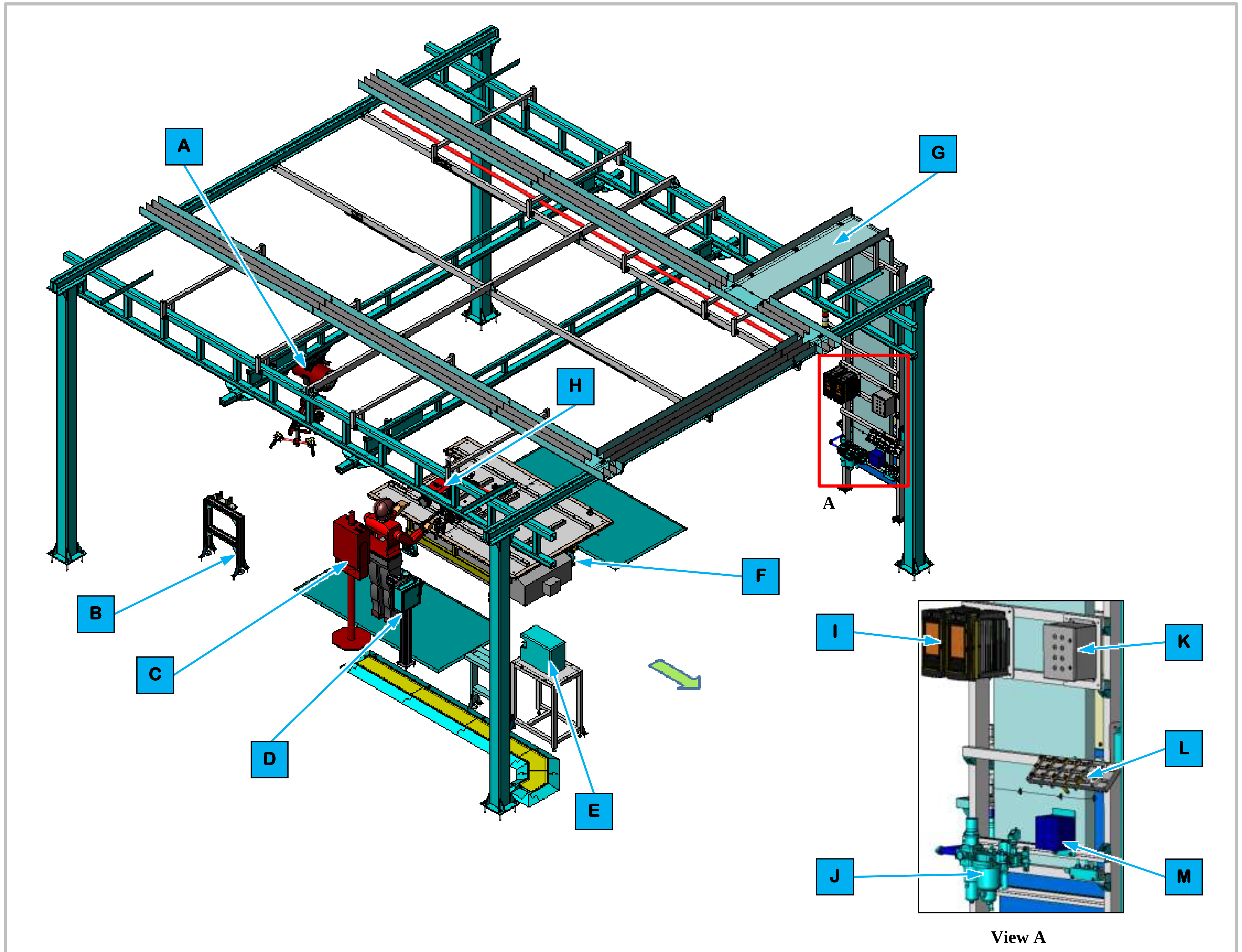


Figure 3-130. EP905 General Repair Station Isometric View

3.6.37.2. Sequence of Operation for BET

Step	Process
1	Follow repair procedure

3.6.37.3. Sequence of Operation for BEV3

Step	Process
1	Follow repair procedure

Equipment Callouts in Station EP905 Isometric View		
A	LS1	BDU Lift Assist
B	N/A	Stand
C	EP905D1	Operator Console HMI
D	EP905BC1	Barcode Scanner and E-Stop
E	EP905PRT1	Barcode Printer
F	N/A	Automated Guided Cart (AGC)
G	N/A	Wireway
H	LS2	Module Lift Assist
I	EP905TC1- 2	Nutrunner Controller
J	AIRON	Air Preparation Unit
K	EP905E2	Operator Push Button Box
L	N/A	Socket Tray Holder
M	EP905RCP3	Electrical Outlet Box

4. SYSTEM OPERATION

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Table of Figures

4.1. OPERATOR INTERFACE DEVICES

4.1.1. Summary

The following tables identify the common interface devices that are located at each cell.

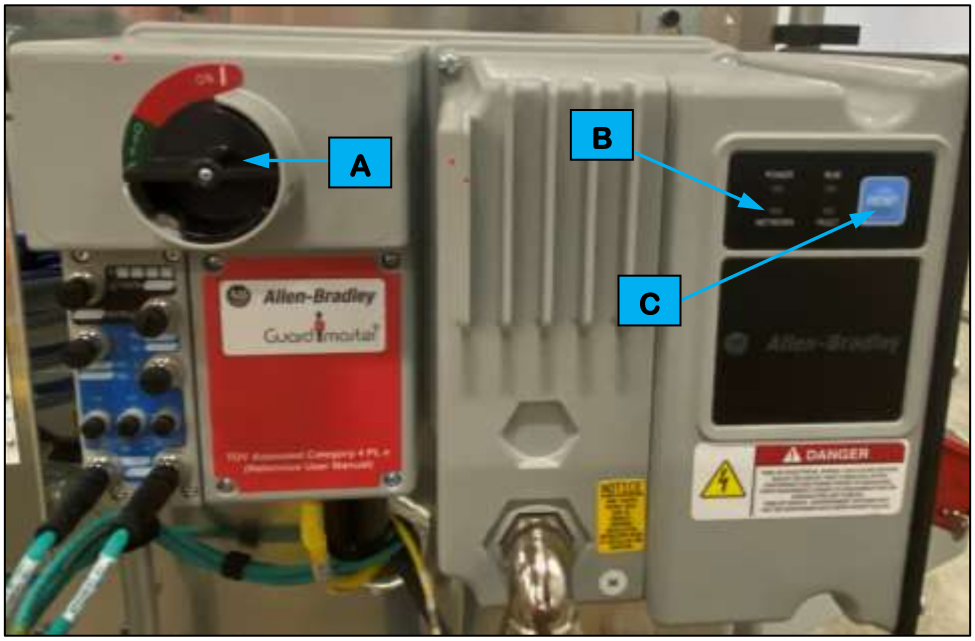
4.1.1.1. Common Interface Device Table – Automated Stations

<table>
<tr><th>Item</th><th>020</th><th>100</th><th>120</th><th>230</th><th>300</th><th>320</th><th>380</th><th>400</th><th>480</th><th>620</th><th>630</th><th>640</th><th>720</th></tr>
<tr><td>ArmorStart Controller Set</td><td>47</td><td>21</td><td rowspan="6">Part of EP100</td><td>7</td><td>11</td><td rowspan="6">Part of EP300</td><td>21</td><td></td><td>7</td><td>18</td><td rowspan="6">Part of EP620</td><td rowspan="6">Part of EP620</td><td rowspan="2">Part of EP020</td></tr>
<tr><td>Conveyor Electrical Disconnect</td><td>6</td><td>2</td><td>1</td><td>1</td><td>2</td><td></td><td>1</td><td>2</td></tr>
<tr><td>Entrance Gate Box</td><td>2</td><td>1</td><td>1</td><td>1</td><td>1</td><td></td><td>1</td><td>1</td><td></td></tr>
<tr><td>Operator Console HMI</td><td>2</td><td>1</td><td></td><td>1</td><td>1</td><td></td><td>1</td><td>2</td><td>1</td></tr>
<tr><td>Power Distribution Panel</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td></td><td>1</td><td>1</td><td></td></tr>
<tr><td>Safety Device Junction Box</td><td>9</td><td>4</td><td>3</td><td>4</td><td>4</td><td></td><td>3</td><td>5</td><td></td></tr>
</table>

4.1.1.2. Common Interface Device Table – Manual Stations

Item	040	060	080	090	125	160	180	200	220	235	240	260	270	280	325	340	420	485	500	520	540	560	580	600	610	650	660	680	700	905
Barcode Reader	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Cycle Start Button	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Nutrunner Controller	4	3	2	4	1	3	3	3	2	1	2	3	3		1		3	1	2	1	1	1				2	1		2	
Operator Console HMI	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Operator Push Button Box	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

4.1.2. ArmorStart Controller



Device Callouts for Figure 4-1	
A	Main Switch
B	Status Indicators
C	RESET Button

Figure 4-1. An Example of a ArmorStart Controller.

Automated stations that have conveyor systems use ArmorStart Controllers to control power that is distributed from the cell Conveyor Electrical Disconnect. The Allen-Bradley ArmorStart Controller is a motor controller that allows for disabling conveyor system motors for maintenance and service. The controller is mounted on station guarding with other ArmorStart Controllers.

Main Switch

The Main Switch (refer to **A** in ***Figure 4-1***) is used to turn the conveyor motor on and off.

Status Indicator

The Status Indicators (refer to **B** in ***Figure 4-1***) display the conveyor motors current state, with indicators for Power, Run, Network, and Fault.

RESET BUTTON

The RESET button (refer to **C** in ***Figure 4-1***) is used to reset the controller after a fault.

REFERENCE	***For more information about the ArmorStart Controller equipment, refer to the equipment supplier documentation (Allen-Bradley ArmorStart ST Motor Controllers Guide).***

4.1.3. Barcode Reader

Figure 4-2. An Example of a Barcode Reader

Each manual station is equipped with a handheld Honeywell Granit 1911i Industrial Scanner barcode reader. The Barcode Reader consists of a handheld scanner and a base mount charging holder. The scanner is operated by pulling on the scanner trigger.

REFERENCE	***For more information about the barcode reader, refer to the equipment supplier documentation (Xenon/Granit Area-Imaging Scanners User Guide).***

4.1.4. Conveyor Electrical Disconnect

Figure 4-3. An Example of a Conveyor Electrical Disconnect

Automated stations use Conveyor Electrical Disconnects to control power that is distributed from the cell Power Distribution Panel 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.

4.1.5. Cycle Complete Button

Device Callouts for Figure 4-4	
A	Cycle Start button
B	E-Stop button

Figure 4-4. An Example of a Cycle Complete Button.

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.***

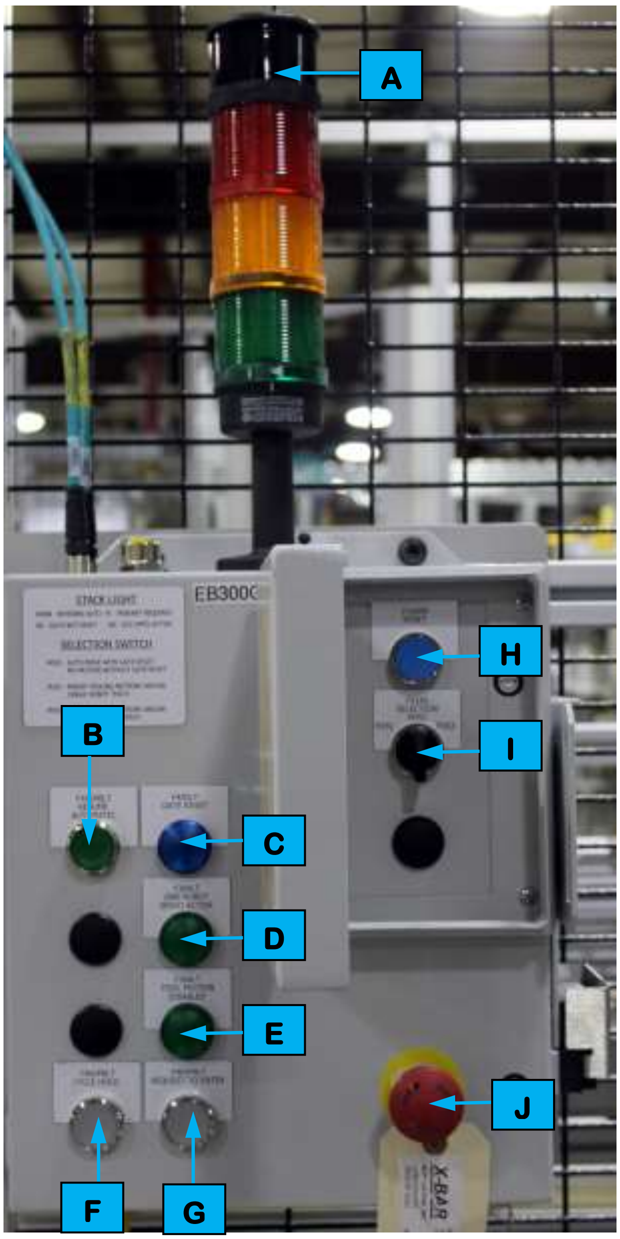
Each manual cell has a Cycle Complete Button (refer to **A** in ***Figure 4-4***) that when pressed by the Operator will release the Automated Guided Cart.

Each manual cell has an Emergency Stop (E-Stop) Button (refer to **B** in ***Figure 4-4***) that when used will removed all power from a cell and bring all tooling to a stop. 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 ***4.3.2 Starting a Manual Cell***.

4.1.6. Entrance Gate Box

Each automated cell has an entrance gate box (refer to ***Figure 4-5***) 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 4-5	
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 4-5. An Example of an Entrance Gate Box.

Stack Light Indicators

On top of the entrance gate box is a stack light (refer to **A** in ***Figure 4-5***) 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 (refer to **B** in ***Figure 4-5***) 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 (refer to **C** in ***Figure 4-5***) illuminates to indicate the gate is closed and reset.

One Robot Servo Active Indicator

The One Robot Servo Active indicator (refer to **D** in ***Figure 4-5***) 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 (refer to **E** in ***Figure 4-5***) 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 (refer to **F** in ***Figure 4-5***) 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 (refer to **G** in ***Figure 4-5***) 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 (refer to **H** in ***Figure 4-5***) 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 (refer to **I** in ***Figure 4-5***) 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 teaching.

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

E-STOP Button

The EMERGENCY STOP button (refer to **J** in ***Figure 4-5***) 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.

4.1.7. Nutrunner Controller

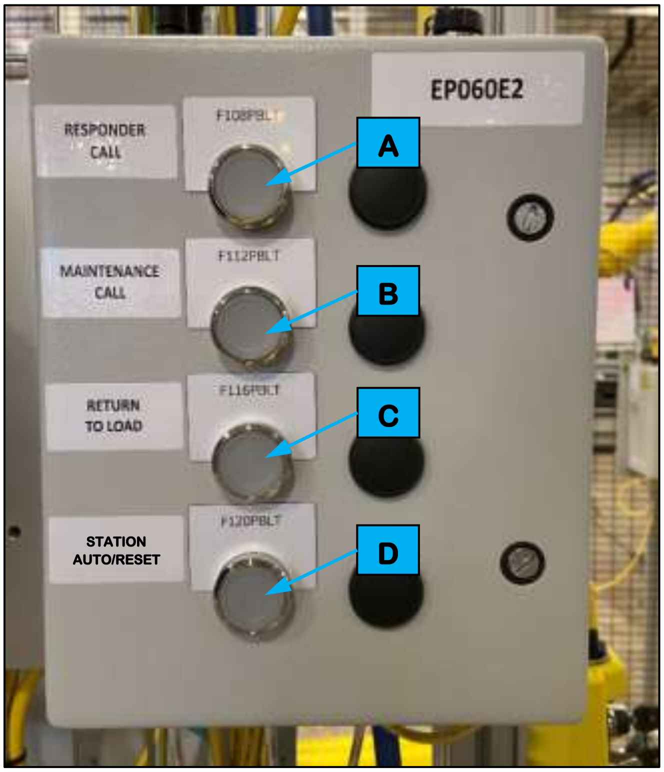
Device Callouts for Figure 4-6	
A	Touch Screen
B	Home Button
C	Result View Button

Figure 4-6. An Example of a Nutrunner Controller.

Some manual stations have Atlas COPCO Nutrunner Controller PF-6000 systems for configuring and operating Atlas COPCO Nutrunners. Nutrunner Controllers are normally configured to pre-programed jobs, and control functions built into the Controller prevent the Operator deviating from the required process.

REFERENCE	*For more information about the nutrunner controller equipment, refer to the equipment supplier documentation (Atlas COPCO Power Focus 6000 Configuration Guide).*

4.1.8. Operator Push Button Box



Device Callouts for Figure 4-7	
A	RESPONDER CALL button
B	MAINTENANCE CALL button
C	RETURN TO LOAD button
D	STATION AUTO/RESET button

Figure 4-7. An Example of an Operator Push Button Box.

RESPONDER CALL BUTTON

The RESPONDER CALL button (refer to **A** in ***Figure 4-7***) is used to call a Team Lead.

MAINTENANCE CALL Button

The MAINTENANCE CALL button (refer to **B** in ***Figure 4-7***) is used to call Maintenance Personnel.

RETURN TO LOAD Button

The RETURN TO LOAD button (refer to **C** in ***Figure 4-7***) is used to return any tooling in the station to a load position.

STATION AUTO/RESET Button

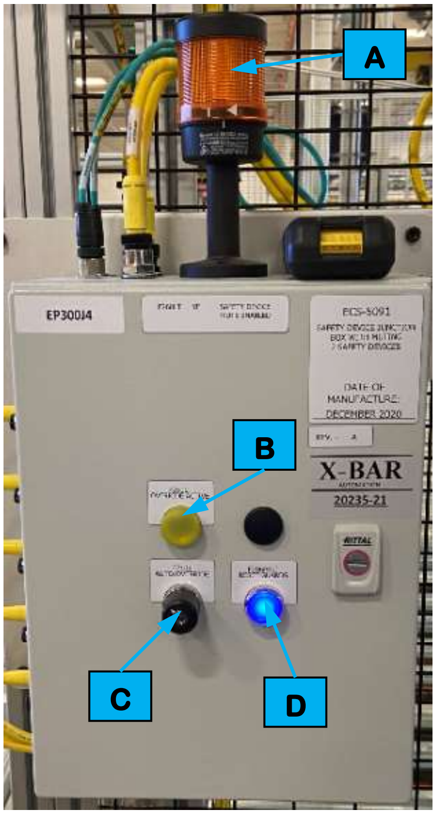
The STATION AUTO/RESERT button (refer to **D** in ***Figure 4-7***) is used to restart the power to the cell

4.1.9. Power Distribution Panel

Figure 4-8. An Example of a 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 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.

4.1.10. Safety Device Junction Box



Device Callouts for Figure 4-9	
A	Status Light
B	OVERRIDE ACTIVE Indicator
C	AUTO/OVERRIDE key
D	RESET GUARDS button

Figure 4-9. An Example of a Safety Device Junction Box.

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

Status Light

An amber colored Status Light (refer to **A** in ***Figure 4-9***) sits on top the junction box and is used to identify when the cell safety circuit is muted.

Override Active Indicator

An override active indicator light (refer to **B** in ***Figure 4-9***) illuminates whenever the AUTO/OVERRIDE key is set to OVERRIDE.

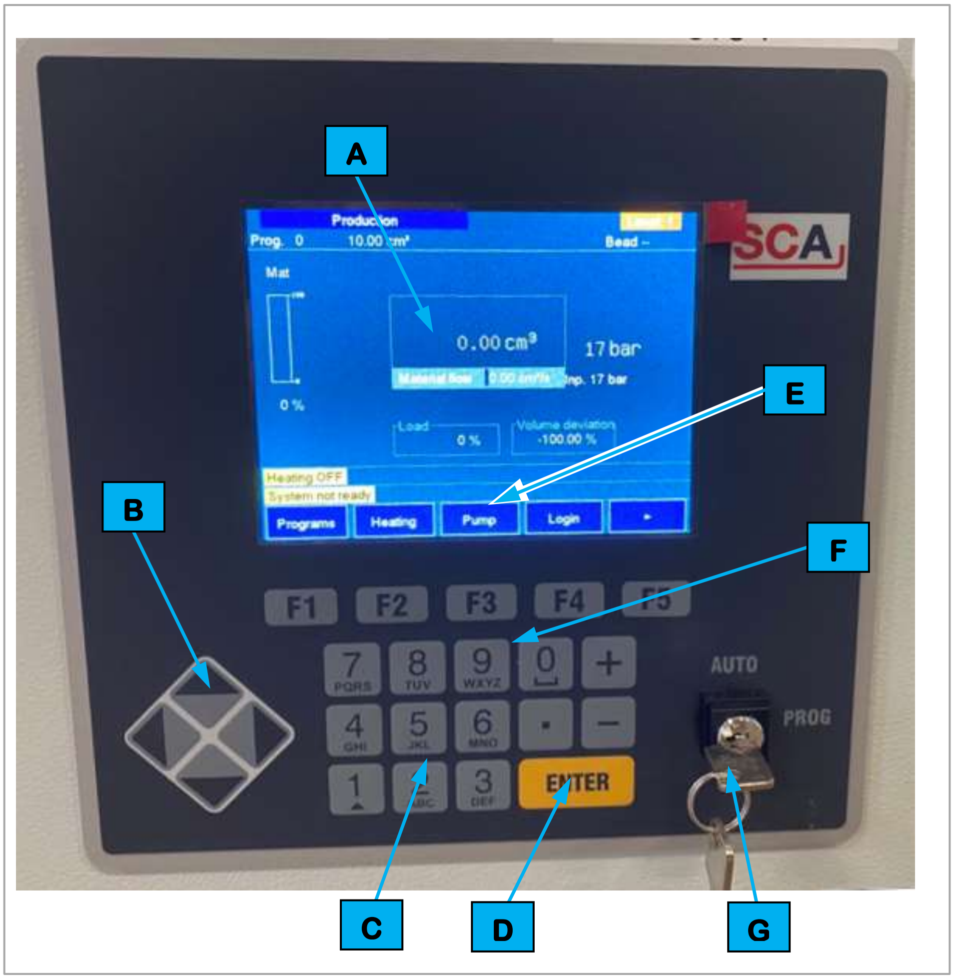
AUTO/OVERRIDE Key

The AUTO/OVERRIDE key (refer to **C** in ***Figure 4-9***) 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 (refer to **D** in ***Figure 4-9***) button is used to reset the guard safety circuit.

4.1.11. RTV Dispense System Controller



Device Callouts for Figure 4-10	
A	Menu Screen
B	Control Pad
C	Keypad
D	ENTER button
E	FUNCTION KEY input menu
F	FUNCTION buttons
G	Mode Select Switch

Figure 4-10. RTV Dispense System Controls

Cell EP620 contains the SCA Controller SYS6000 that allows for the operation and configuration of the RTV Dispense System.

REFERENCE	***For more information about the dispense controller equipment, refer to the equipment supplier documentation (SCA Controller SYS6000 Manual).***

4.1.12. RTV Dispense Pump Control Panel

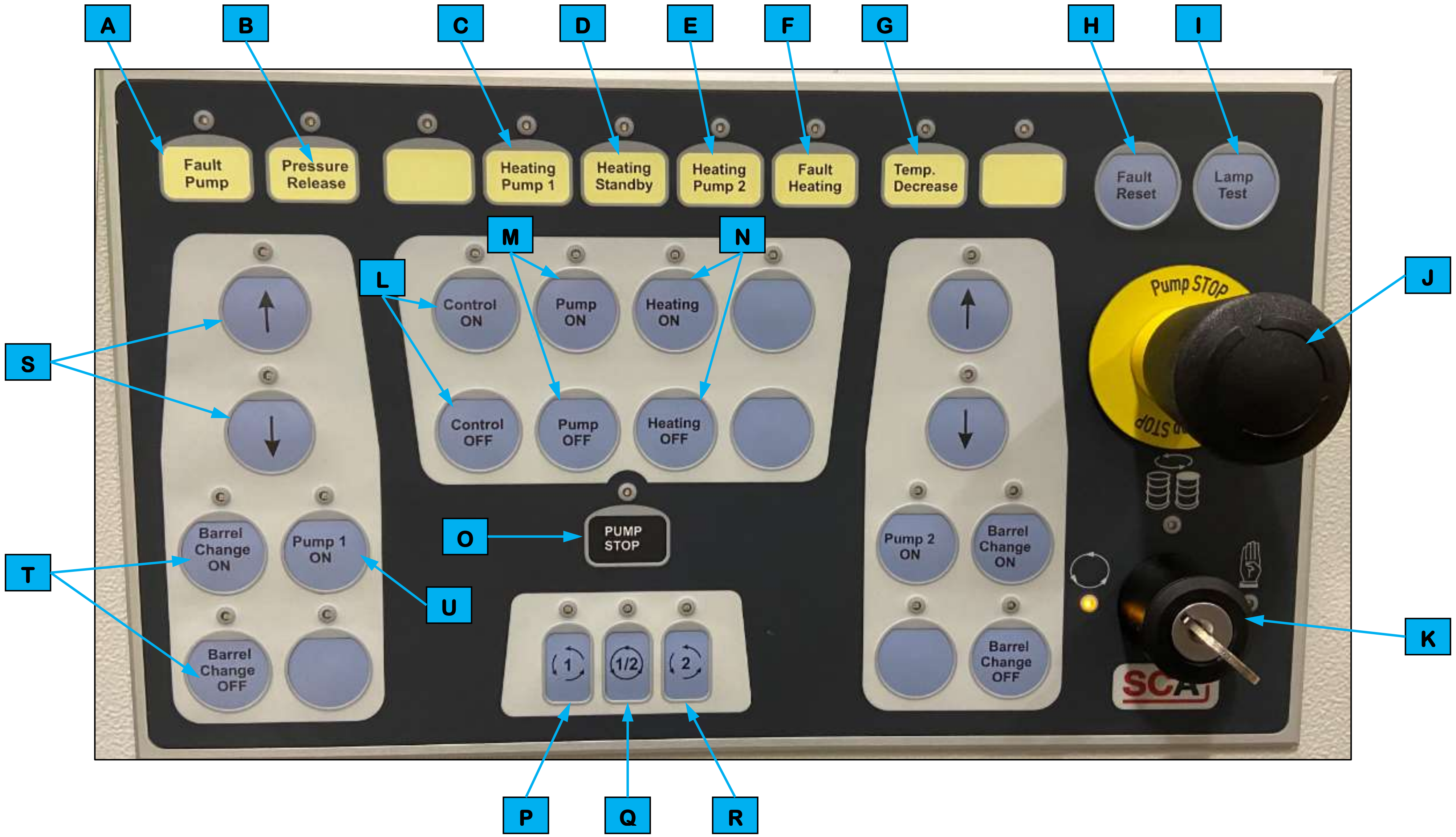


Figure 4-11. RTV Dispense Pump Controls.

Device Callouts for Figure 4-11	
A	FAULT PUMP indicator
B	PRESSURE RELEASE indicator
C	HEATING PUMP 1 indicator
D	HEATING STANDBY indicator
E	HEATING PUMP 2 indicator
F	FAULT HEATING indicator
G	TEMPERATURE DECREASE indicator
H	FAULT RESET button
I	LAMP TEST button
J	PUMP STOP button
K	Selector Switch Key
L	Controller ON and OFF buttons
M	Pump ON and OFF buttons
N	Heating ON and OFF buttons
O	PUMP STOP Indicator
P	SINGLE BARREL MODE PUMP 1 button
Q	BARREL CHANGE MODE button
R	SINGLE BARREL MODE PUMP 2 button
S	PUMP LIFTER UP AND DOWN buttons
T	BARREL CHANGE ON and OFF buttons
U	PUMP ON button

Cell EP620 contains the SCA HPS/PCU5000 that allows for the operation and configuration of the RTV Dispense Pump.

REFERENCE

For more information about the dispense controller equipment, refer to the equipment supplier documentation (SCA HPS/PCU5000 Manual).

4.1.13. Inline Repair Cell EP625

The Cover Load Robot (EP620R01) places a cover to be repaired to the Repair Shuttle Table. The Repair Shuttle Table moved into the Repair Cell. Once the Shuttle has come to a stop the Operators are clear to enter the Repair Cell and remove the cover from the Shuttle. Once the Cover is removed and the Repair Cell guarding has been reset, the Shuttle returns back into Cell EP620.

4.2. HMI SCREENS

The following flow chart identifies the screen navigation paths.

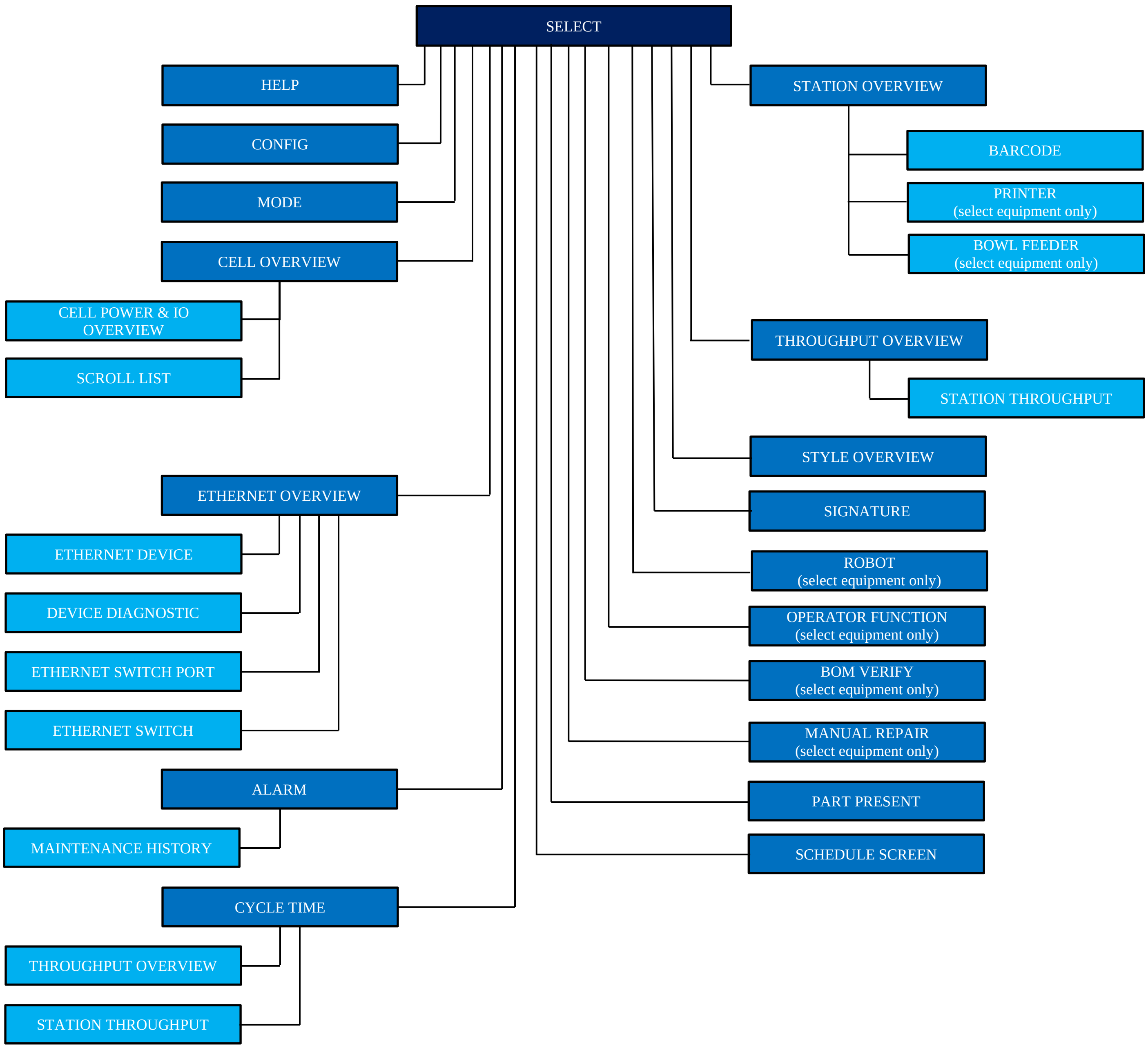


Figure 4-12. An example of screen header.

4.2.1. Screen Header

Each screen that displays on the touch panel features a common header (refer to ***Figure 4-13***).

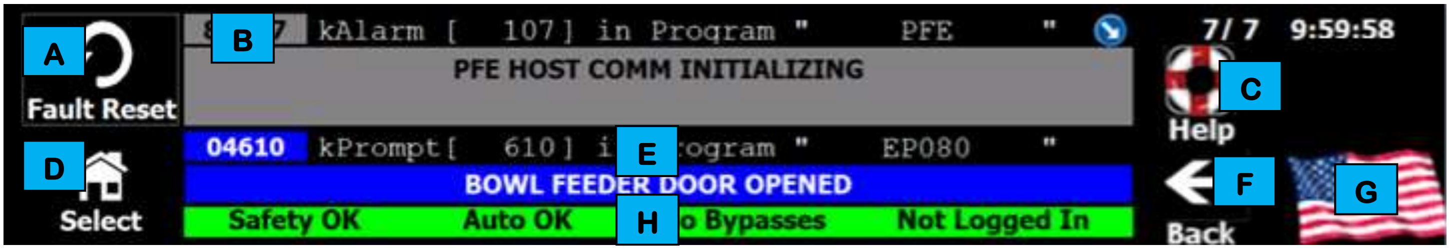


Figure 4-13. An example of screen header.

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 screen button 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*.

4.2.2. Select Screen

Touching the **SELECT** button on the top of any screen navigates directly to a screen (refer to ***Figure 4-14***) that provides a menu of the screens available at the terminal.

Figure 4-14. An example of a Select screen.

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

A This touch-button opens the Mode Select screen.

B This touch-button opens the Station Overview screen.

C This touch-button opens the Barcode screen.

D This touch-button opens the Signature screen.

E This touch-button opens the Printer screen.

4.2.3. Mode Screen

Touching the **MODE** button on the Select screen navigates directly to a screen (refer to ***Figure 4-15***) that can be used to toggle the system operating mode.

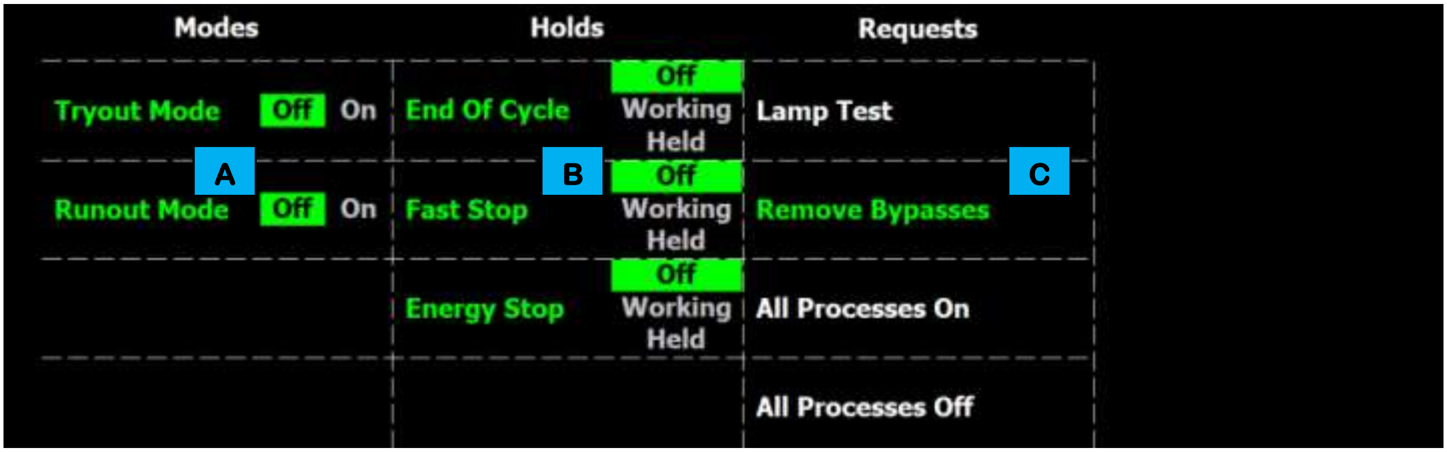


Figure 4-15. An example of a Mode screen.

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.

4.2.4. Service Screen

Touching the **SERVICE** button on the Select screen navigates directly to a screen (refer to ***Figure 4-16***) that can be used to manually interface with the cell cycle and process equipment.

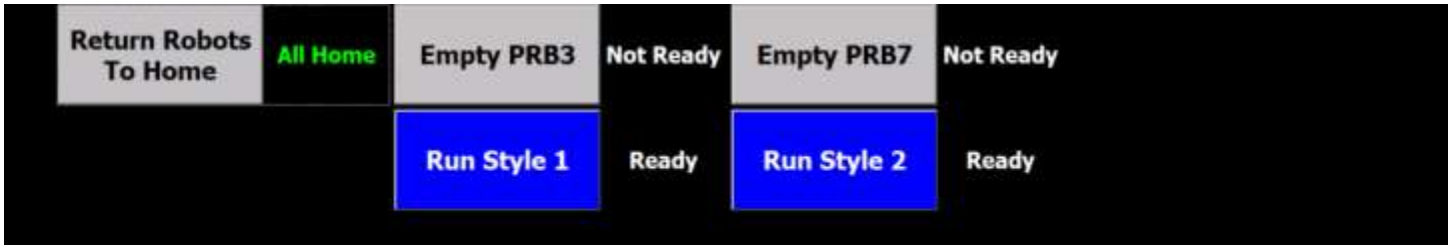


Figure 4-16. An example of a Service screen.

The screen features several areas of information and control. The top of the screen identifies the control program status. Various control functions can be enabled or disabled from this screen, such as bypassing the cell.

4.2.5. Cell Overview Screen

Touching the **CELL OVERVIEW** button on the Select screen navigates directly to a screen (refer to ***Figure 4-17***) 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.

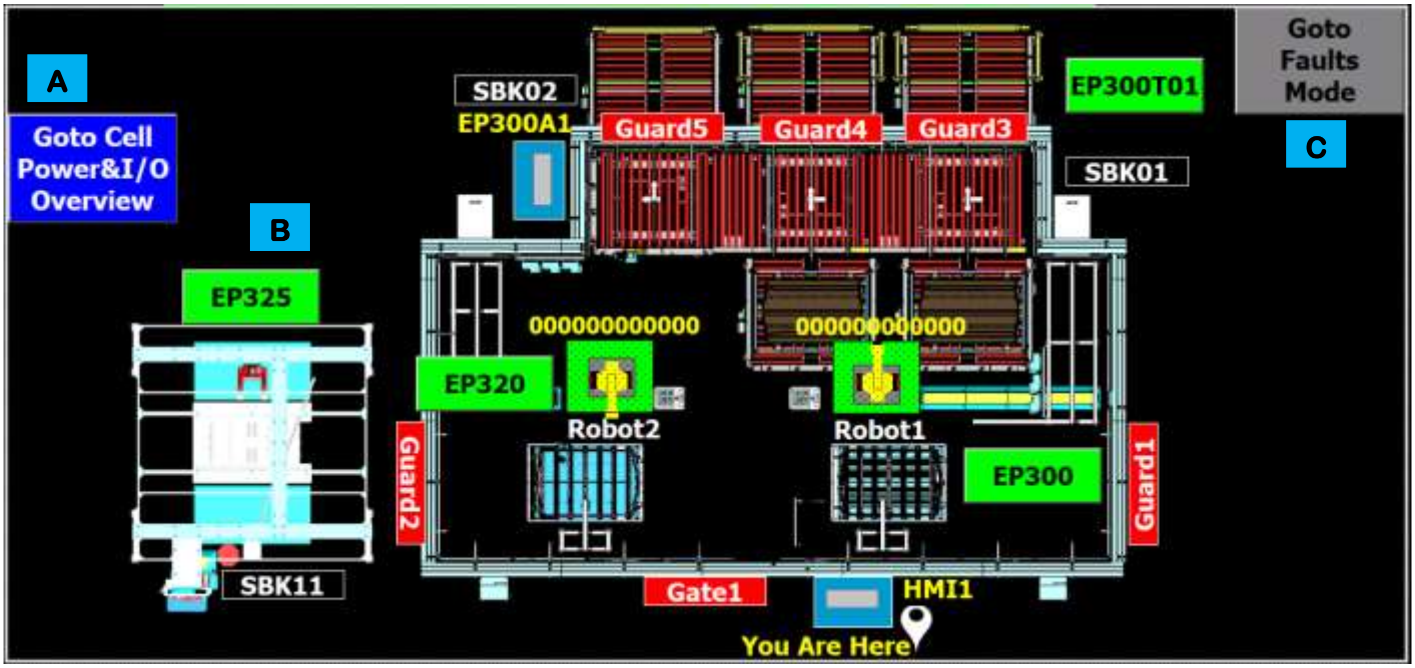


Figure 4-17. An example of a Cell Overview screen.

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.

4.2.6. Cell Power and I/O Screen

Touching the **GOTO CELL POWER&IO OVERVIEW** button on the Cell Overview screen navigates directly to a screen (refer to *Figure 4-18*) that identifies the status of the cell power supplies and safe I/O blocks.

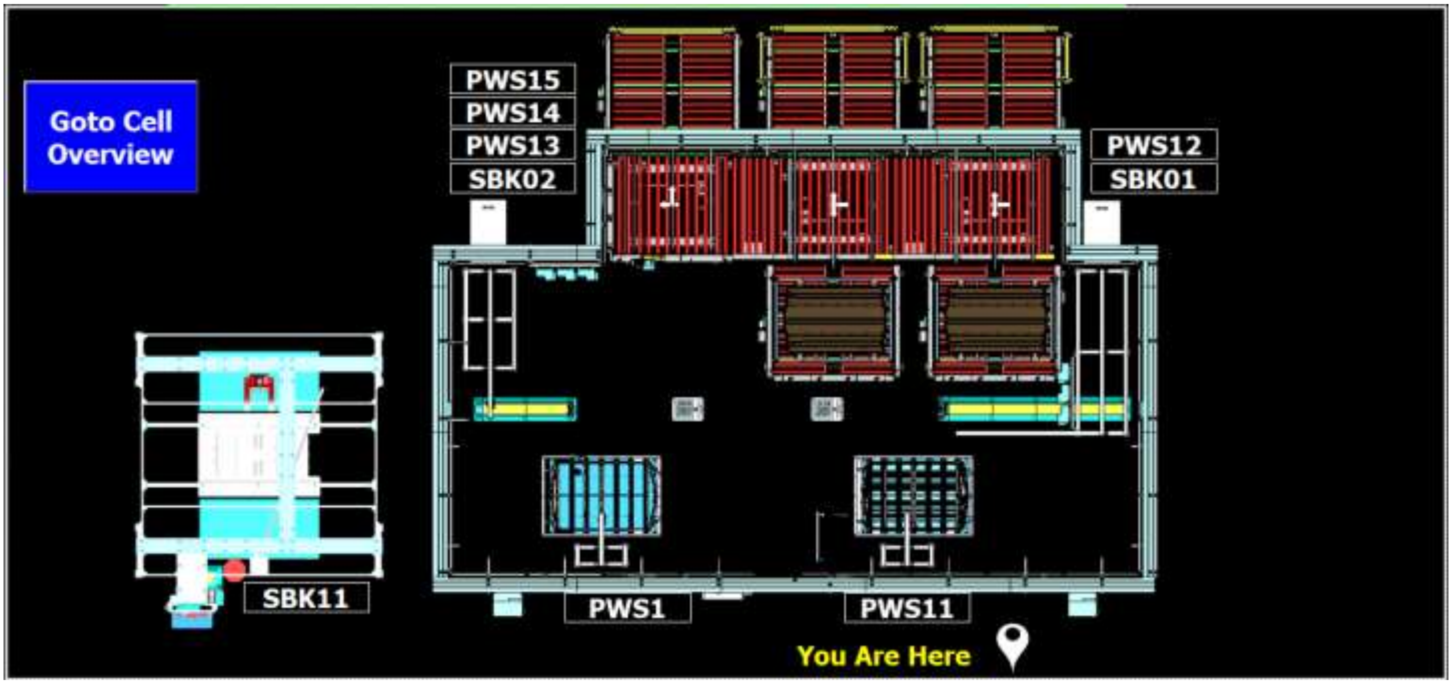


Figure 4-18. An example of a Cell Power and I/O screen.

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

4.2.7. EtherNet Screen

Touching the **ETHERNET** button on the Select screen navigates directly to a screen (refer to ***Figure 4-19***) that identifies the current state of each EtherNet connection at the cell.

Figure 4-19. An example of an EtherNet screen.

Each Ethernet 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.

C The bottom of the screen identifies the meaning of each indicator color.

D This touch-button will refresh the EtherNet screen.

4.2.8. Alarm Screen

Touching the **Alarm Screen** button on the Select screen navigates directly to a screen (refer to ***Figure 4-20***) that identifies currently active alarms.

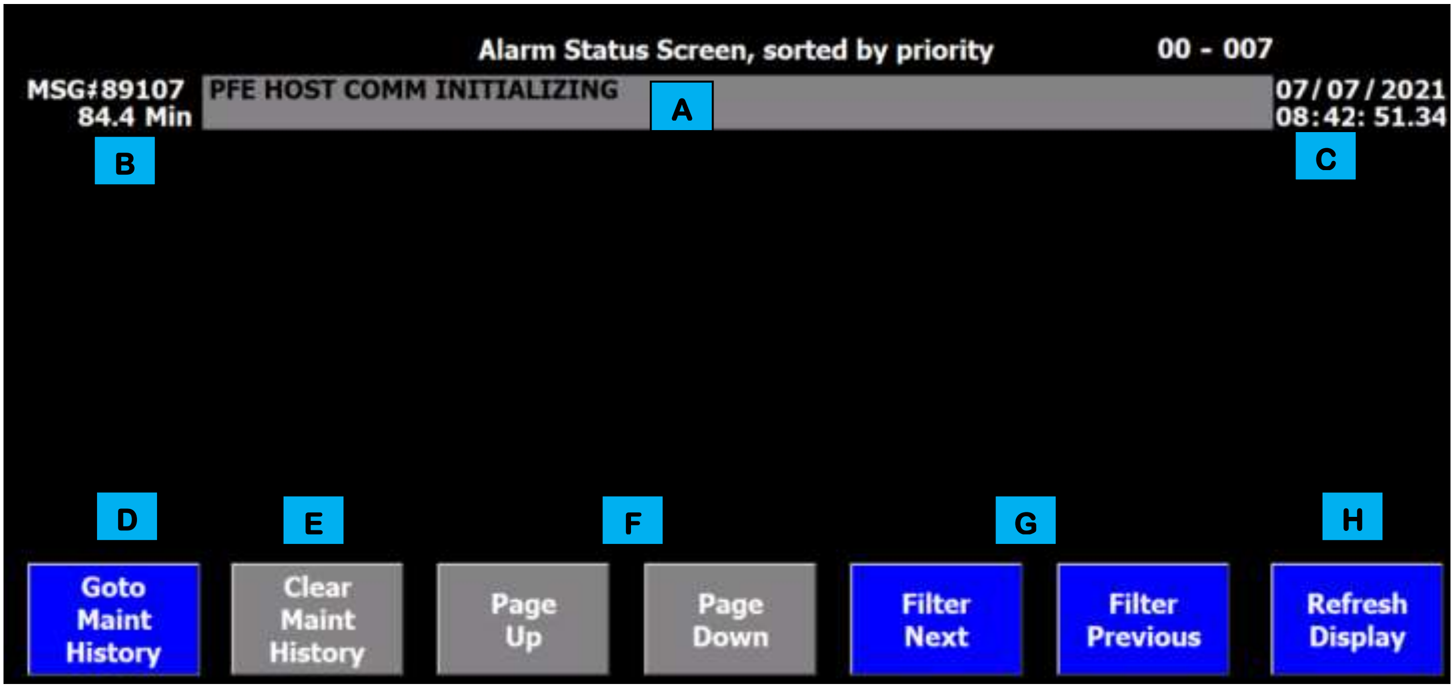


Figure 4-20. An example of an Alarm screen.

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

- **A** This area lists the current alarm messages, with the highest priority at the top and descending in order.
- **B** This area lists the alarm number associated with the message and the time elapsed since the alarm occurred.
- **C** This area lists the time and data of the alarm occurrence.
- **D** This touch-button opens a screen that displays past alarm messages.
- **E** This touch-button is not used on the active Alarm screen.
- **F** 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.
- **G** These touch-buttons toggle filters used to sort the alarms listed.
- **H** This touch-button refreshes the messages on the screen to identify the highest priority alarm.

4.2.9. Maintenance History Screen

Touching the **GOTO MAINT HISTORY** button on the Alarm screen navigates directly to a screen (refer to ***Figure 4-21***) that lists alarms that have previously occurred.

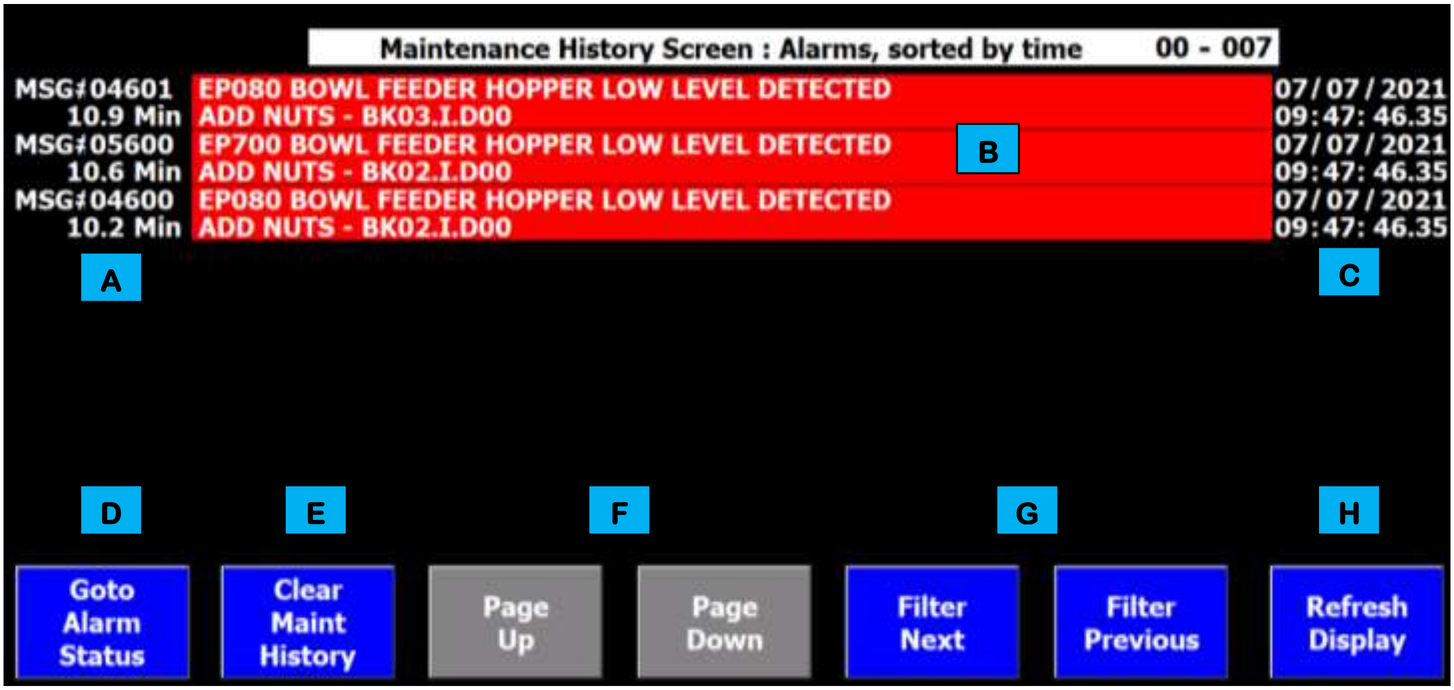


Figure 4-21. An example of a Maintenance History screen.

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

- **A** 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.
- **B** 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.
- **C** This area of the screen indicates when the alarm was initially active.
- **D** This touch-button returns to the active Alarm screen.
- **E** This touch-button erases the data on the Maintenance History screen (historical fault data).
- **F** These touch-buttons scroll up and down through the list of alarms (from oldest to most recent) until the newest alarm is displayed first.
- **G** These touch-buttons allow the historical alarms to be sorted by priority or time.
- **H** This touch-button refreshes the messages on the screen to identify the latest recovered alarms.

4.2.10. Throughput Overview Screen

Touching the **CYCLE TIME** button on the Select screen navigates directly to a screen (refer to ***Figure 4-22***) that displays data about the system cycle.

Figure 4-22. An example of a 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.

4.2.11. Station Throughput Screen

Touching the **STATION TPUT** button on the Throughput Overview screen navigates directly to a screen (refer to ***Figure 4-23***) that displays detailed production data for a specific station.

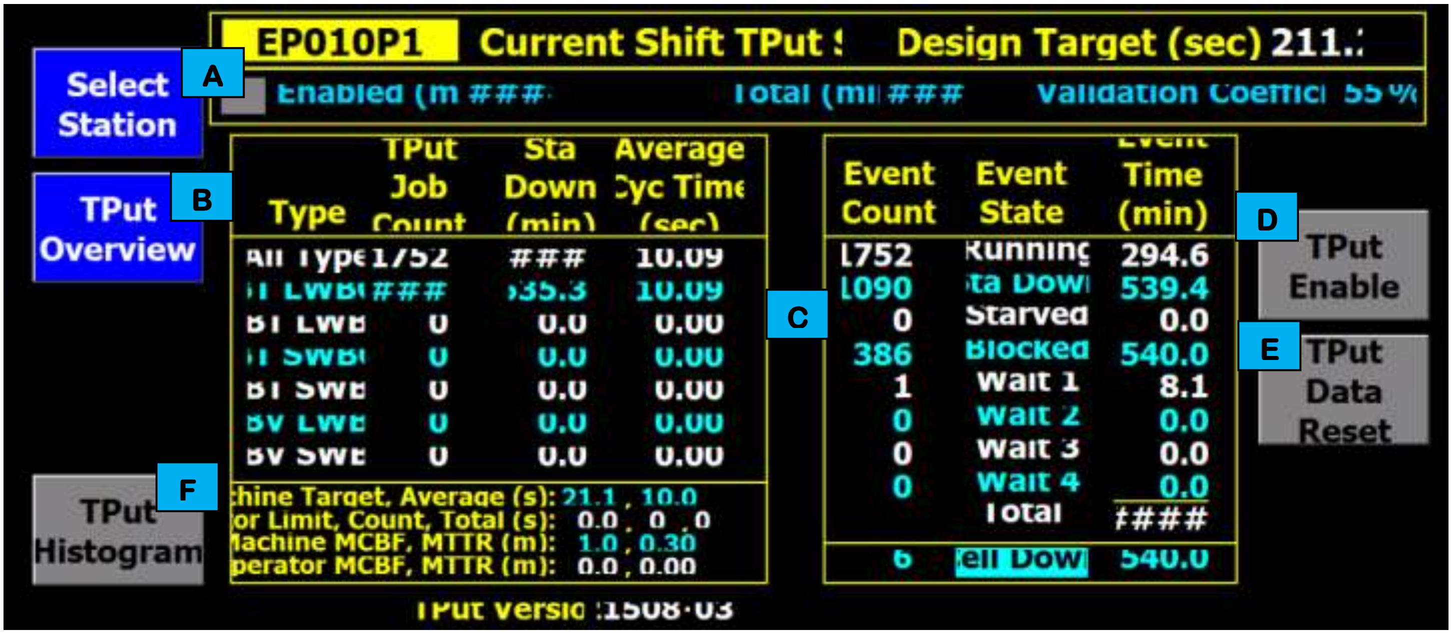


Figure 4-23. An example of a Station Throughput screen.

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.
F This touch-button displays throughput history for the currently selected station.

4.2.12. Scroll List Screen

Touching the **SCROLL LIST** button on the Cell screen navigates directly to a screen (refer to *Figure 4-24*) that identifies the current state of devices and provides the ability to manually actuate device functions within the selected station.

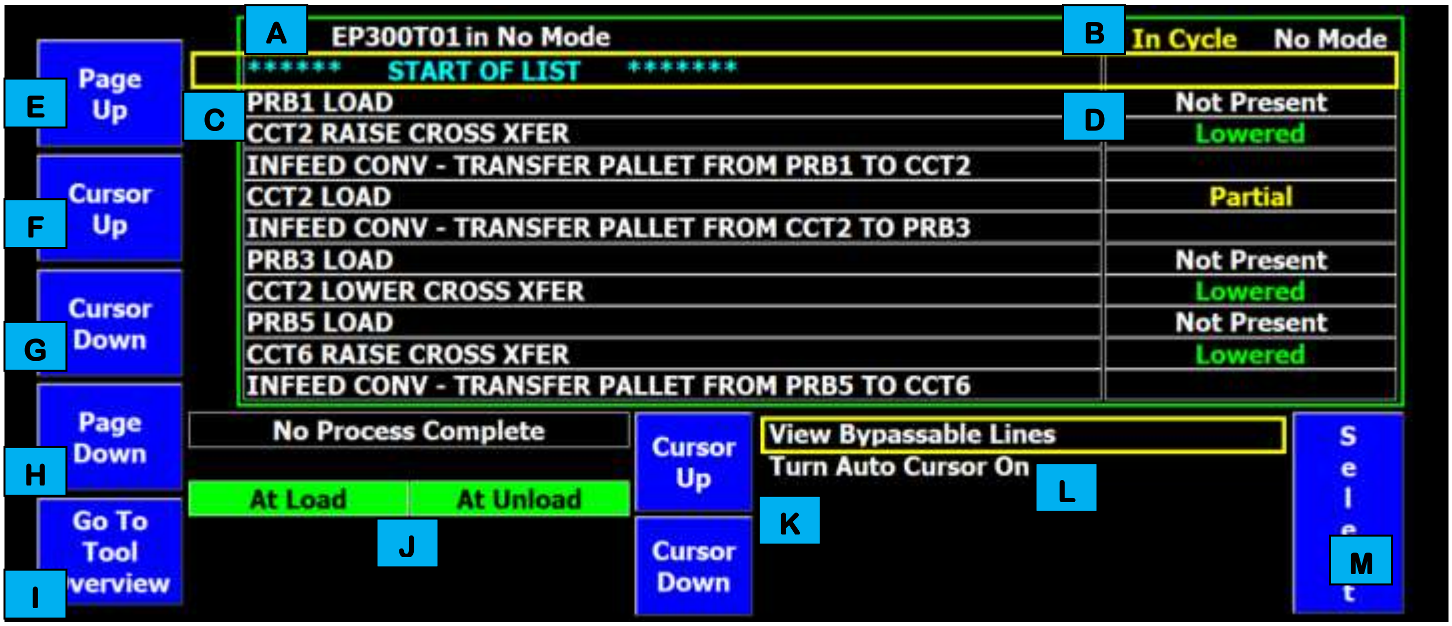


Figure 4-24. An example of Scroll List screen.

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 **C**) 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 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 **E** through **H**] for list navigation.
- **D** This row identifies the current state of each action.
- **E** This touch-button scrolls the action list [area **C**] up one page.
- **F** This touch-button scrolls the action selector [top] upward one action.
- **G** This touch-button scrolls the action selector [top] down one action.
- **H** This touch-button scrolls the action list [area **C**] down one page.
- **I** This touch-button displays the selected station Tool Overview screen.
- **J** This area uses built-in and user-configurable indicators to identify the progress of the station cycle.
- **K** These touch-buttons scroll the Scroll List Function List (bottom) selector up or down, one option at a time.
- **L** 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 **M**] to interface with the option (interface in top list).
- **M** This touch-button chooses the selected function [item **L**].

4.2.13. Station Overview Screen

Touching the **STA OVERVIEW** button on the Select screen navigates to a screen (refer to ***Figure 4-25***) that displays station data.

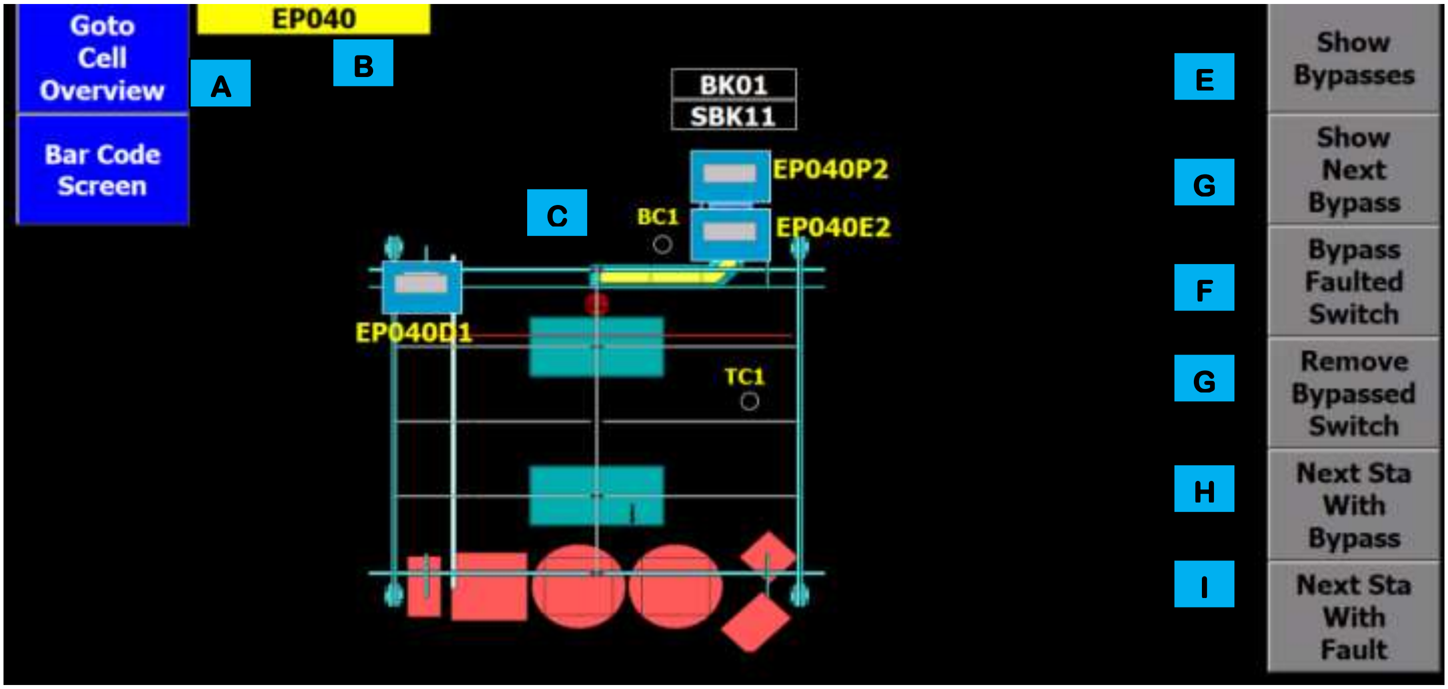


Figure 4-25. An example of a Station Overview screen.

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

A These touch-buttons display the Cell Overview and Barcode Screens.

B This indicator identifies which station is being displayed.

C 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.

D 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 **C** will illuminate red.

E If more than one sensor is bypassed, this touch-button will cycle the screen display to show the next bypass.

F 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.

G This touch-button removes an override from the displayed bypassed device switch.

H 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.

I 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.

4.2.14. Robot Screen

Touching the **ROBOT** button on the Select screen navigates directly to a screen (refer to ***Figure 4-26***) that provides interface with the cell robot(s).

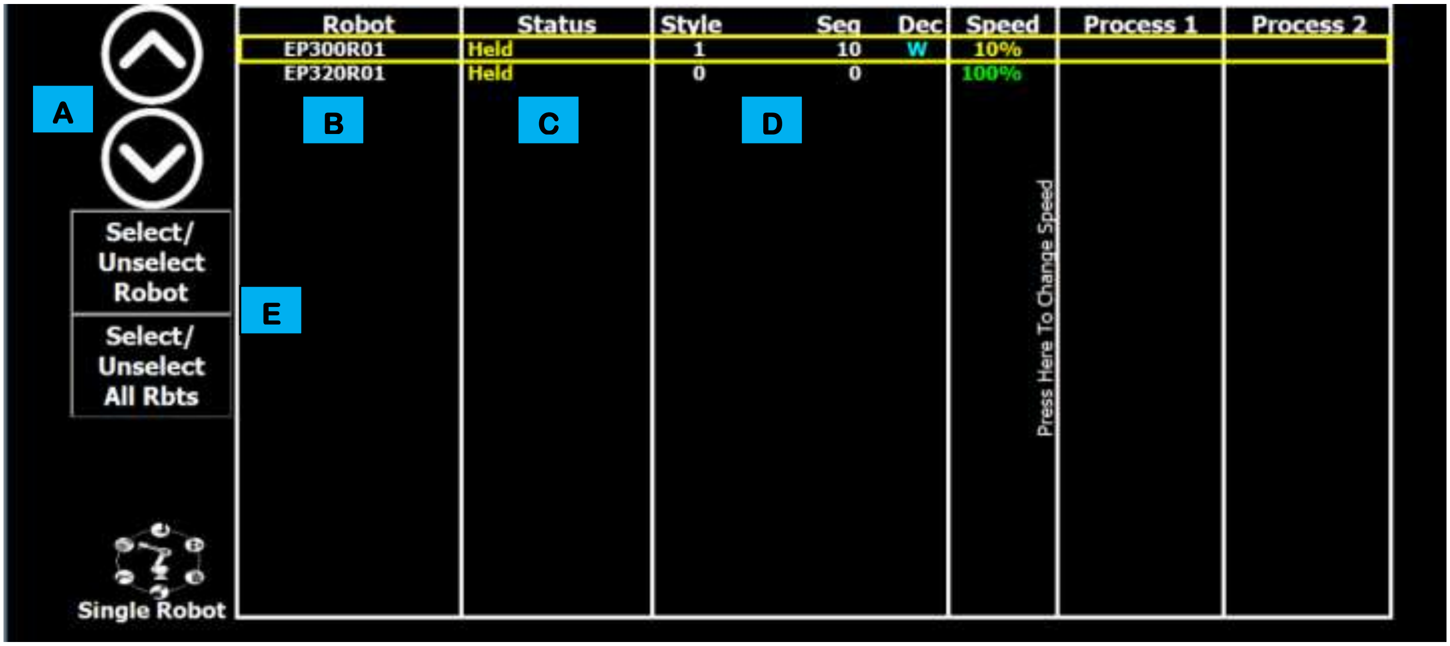


Figure 4-26. An example of a Robot screen.

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.

4.2.15. Barcode Screen

Touching the **BAR CODE** button on the Station screen navigates directly to a screen (refer to ***Figure 4-27)*** that provides interface with the cell barcode scanner.

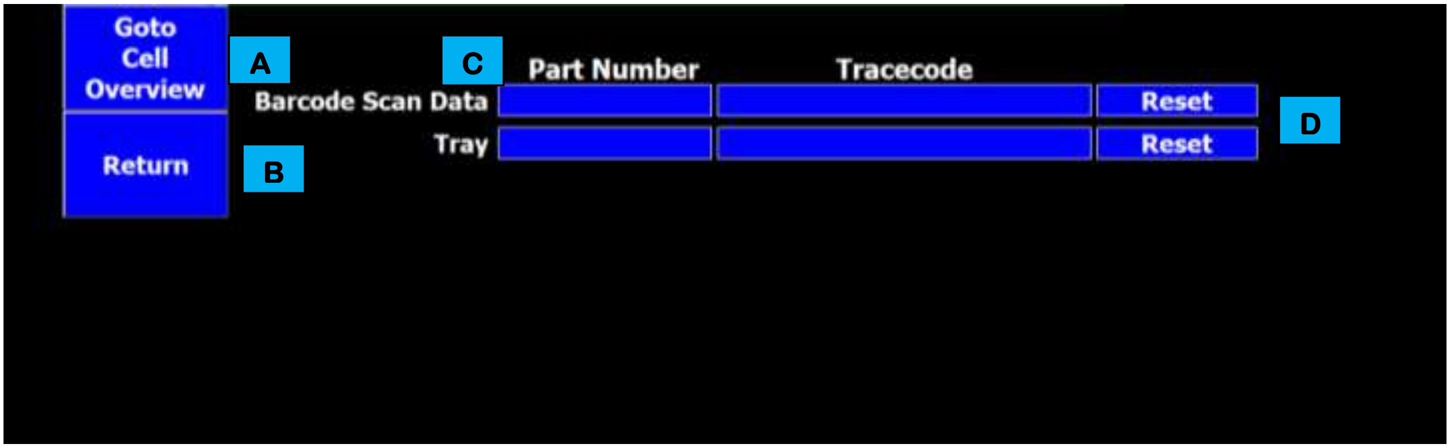


Figure 4-27. An example of a Barcode screen.

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

- **A** This touch-button opens the Cell Overview screen.
- **B** This touch-button opens the Station Overview screen
- **C** These fields identify the last scanned item and tray.
- **D** These touch-buttons will reset the scanned item or tray fields.

4.2.16. Printer Screen

Touching the **PRINTER** button on the Station screen navigates directly to a screen (refer to ***Figure 4-28***) that provides interface with the cell printer.

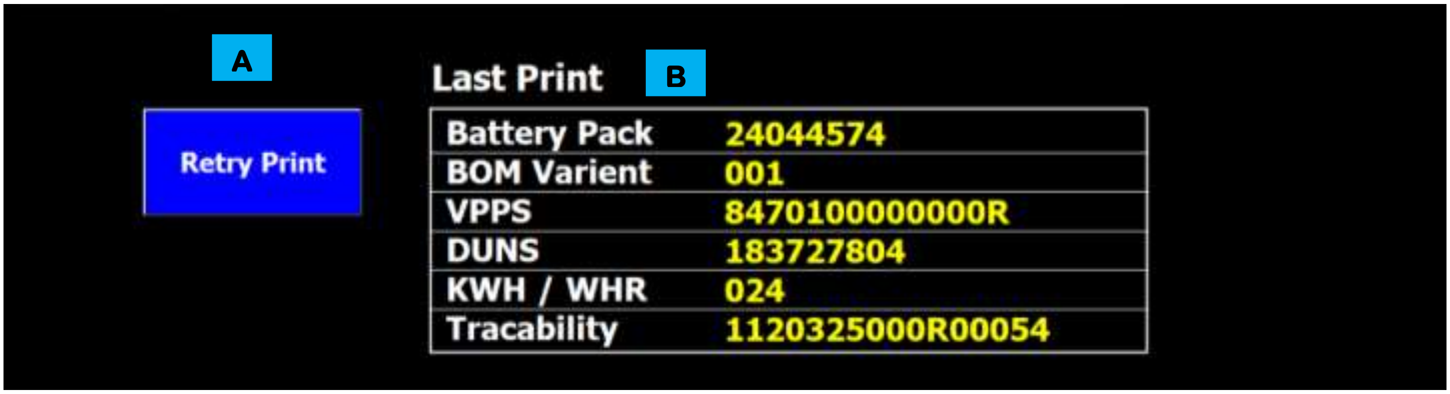


Figure 4-28. An example of a Printer screen.

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

A This touch-button is used to reprint the last recorded label printed.

B These fields identify the last printed label.

4.2.17. Bowl Feeder Screen

Touching the **BOWL FEEDER** button on the Station screen navigates directly to a screen (refer to ***Figure 4-29***) that provides interface with the cell bowl feeder.

Figure 4-29. An example of a Bowl Feeder screen.

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

- **A** This field identifies the type and number of fasteners dispensed by the bowl feeder.
- **B** This touch-button is used to dispense the last number of fasteners.

4.2.18. Device Diagnostic Screen

Touching the **DEVICEDIAG** button on the Ethernet screen navigates directly to a screen (refer to ***Figure 4-30***) that identifies the current state of each Device connection at the system.

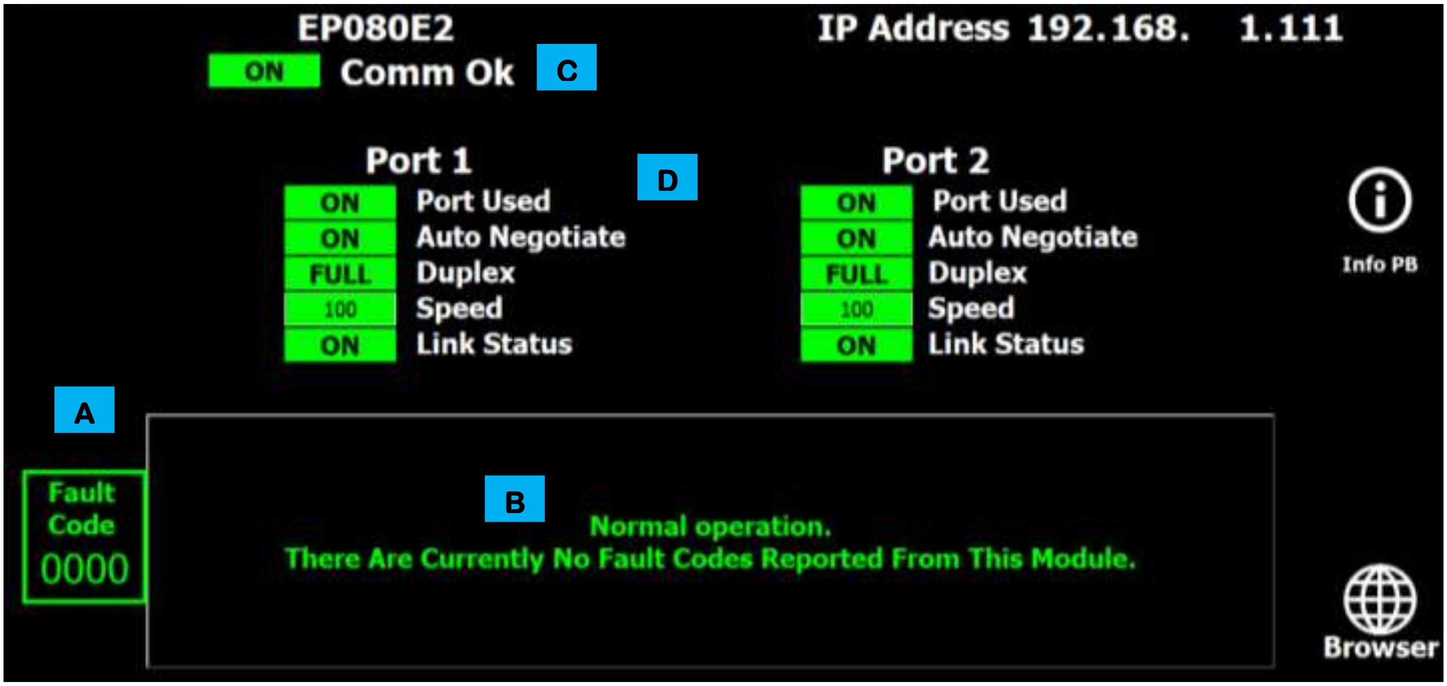


Figure 4-30. An example of a Device Diagnostic screen.

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

- **A** This area of the screen identifies the fault code number and node number accompanying the fault message displayed on the screen.
- **B** This area of the screen displays active fault messages. Multiple messages scroll through the area. As each message displays, the indicators [item **D**] change states to identify the appropriate states.
- **C** This area of the screen identifies the net currently displayed.
- **D** This area of the screen displays a grid of indicators that display nodes that are configured on the selected network. The bottom of the screen identifies the meaning of each indicator state.

4.2.19. Configuration Screen

Touching the **GOTO CONFIG** button on the Select screen navigates directly to a screen (refer to ***Figure 4-31***) that displays the configuration options for the HMI.

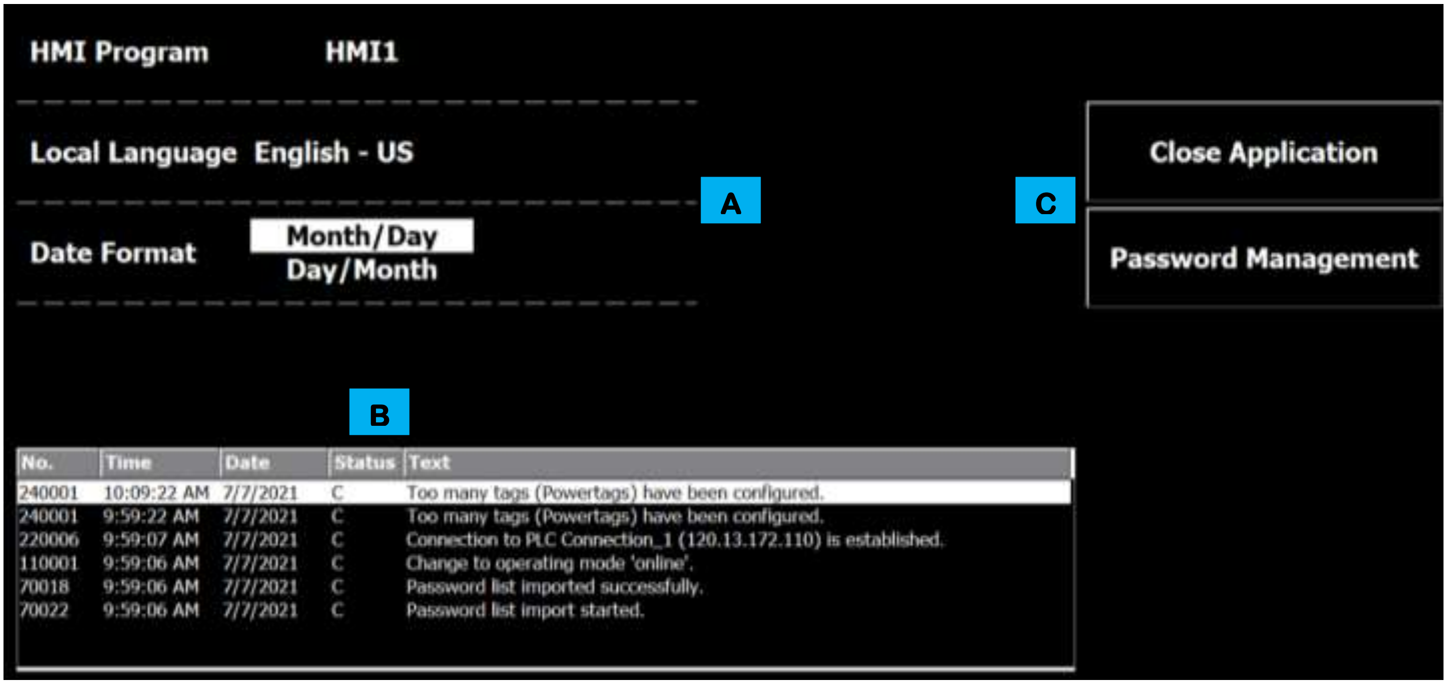


Figure 4-31. An example of a Configuration screen.

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

A This area of the screen identifies current HMI program in use, selected language, and date format.

B This area of the screen identifies settings that have previously been set in the HMI.

C These touch-buttons will close the Configuration screen and open the Password Management screen.

4.2.20. Operator Function Screen

Touching the **OPERATOR FUNCTION** button on the Select screen navigates directly to a screen (refer to ***Figure 4-32***) that identifies the sequence of operation associated with the cell. Refer to your company operating procedures for more information about this screen.

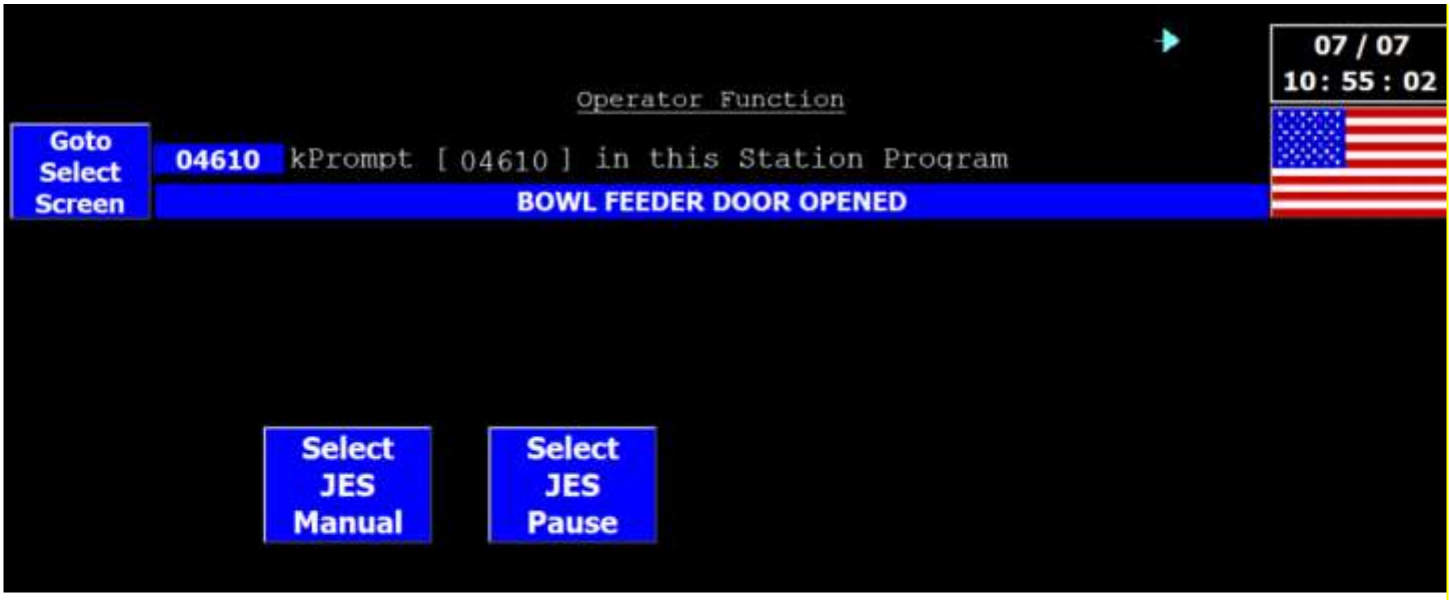


Figure 4-32. An example of an Operator Function screen.

4.2.21. Signature Screen

Touching the **SIGNATURE** button on the Select screen navigates directly to a screen (refer to ***Figure 4-33***) 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 4-33. An example of a Signature screen.

4.2.22. Camera Screen

Touching the **CAMERA** button on the Select screen navigates directly to a screen (refer to ***Figure 4-34***) that displays camera data.

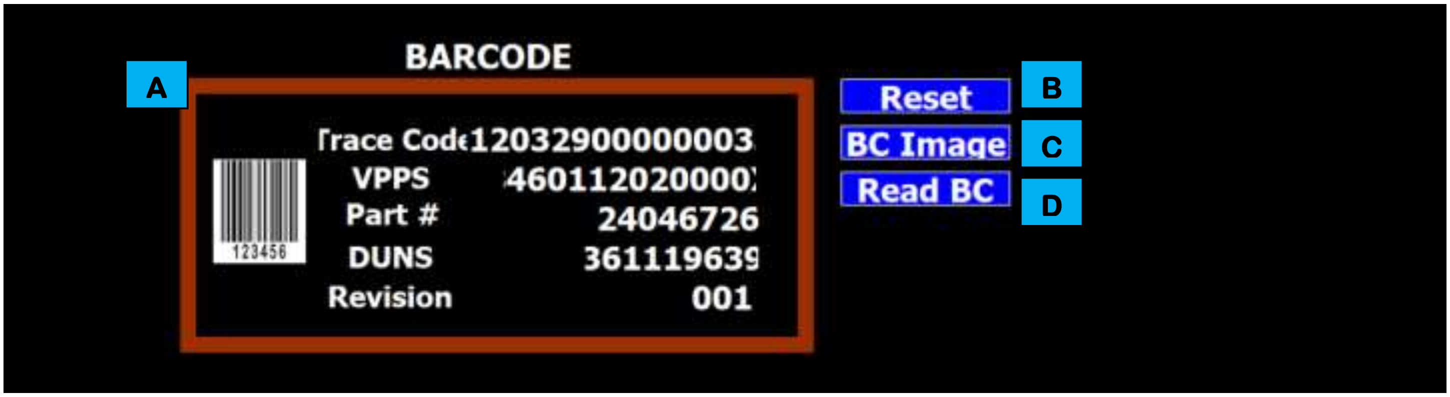


Figure 4-34. An example Camera screen.

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

- **A** This area displays the last read barcode.
- **B** This touch-button is used to reset the data of the last read barcode.
- **C** This touch-button is used to display an image of the last read barcode.
- **D** This touch-button is used to manually take an image of a barcode.

4.2.23. Manual Repair Screen

Touching the **TWR REPAIR** button on the Select screen navigates directly to a screen (refer to ***Figure 4-35***) that an operator utilizes when working with the module on a pallet at the manual repair station. The screen identifies status of the various processes and gives the operator the ability to change the status and to control what happens to the pallet after it leaves the station.

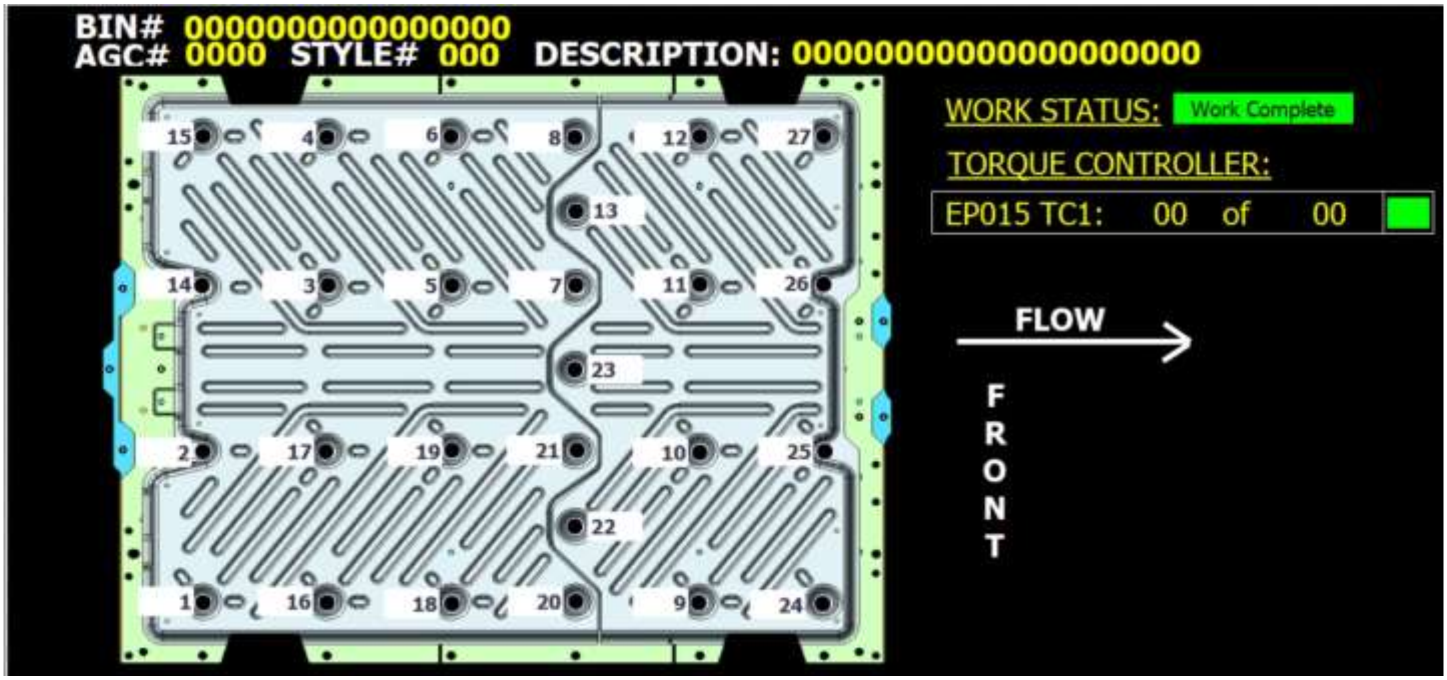


Figure 4-35. An example Manual Repair screen.

4.2.24. Inline Repair Cell EP015

Touching the **EPXXX OPERATOR STATION** button on the Select screen navigates directly to a screen (refer to ***Figure 4-36***) that an operator utilizes when working with the pack at the inline repair station.

The Tray Robot (EP010R01) places a tray to be repaired onto the Repair Shuttle Table. The Operator uses a pushbutton to close the clamps on the Repair Shuttle Table and then a second pushbutton to move the shuttle into the Repair Cell. The Operator can then view the screen on the HMI to determine which fasteners of the skid plate need to be repaired or retorqued. The Operator can use "Rotate to Pos 1" or “Rotate to Pos 2” pushbuttons to move the Repair Shuttle Table to reach fasteners. Once all repairs are complete, the Operator uses a pushbutton to return the Repair Shuttle Table back to the Tray Robot.

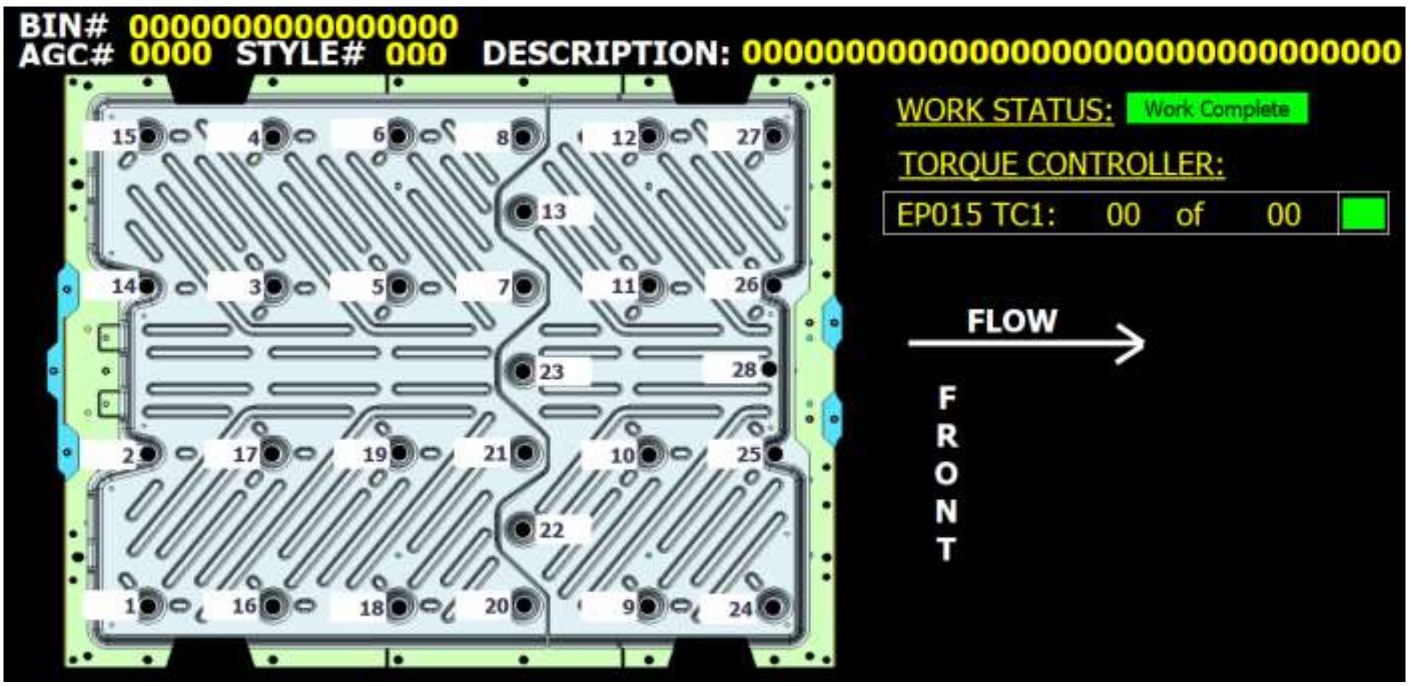


Figure 4-36. An example Inline Repair Cell EP015 screen.

4.2.25. Inline Repair Cell EP125 and EP405

Touching the **EPXXX OPERATOR STATION** button on the Select screen navigates directly to a screen (refer to ***Figure 4-37***) that an operator utilizes when working with the pack on the AGC at the inline repair station.

When an AGC enters into the inline repair station an image of the tray appears on the station screen and there is an indicator for each bolt that was secured in the previous station (EP120 or EP400). The indicator for the bolts that failed in the previous station flash red. The count on the right side of the screen will reflect how many bolts were incomplete from the last station. Once the work has been completed, all of the indicators on the part will turn green and the operator will release the cart.

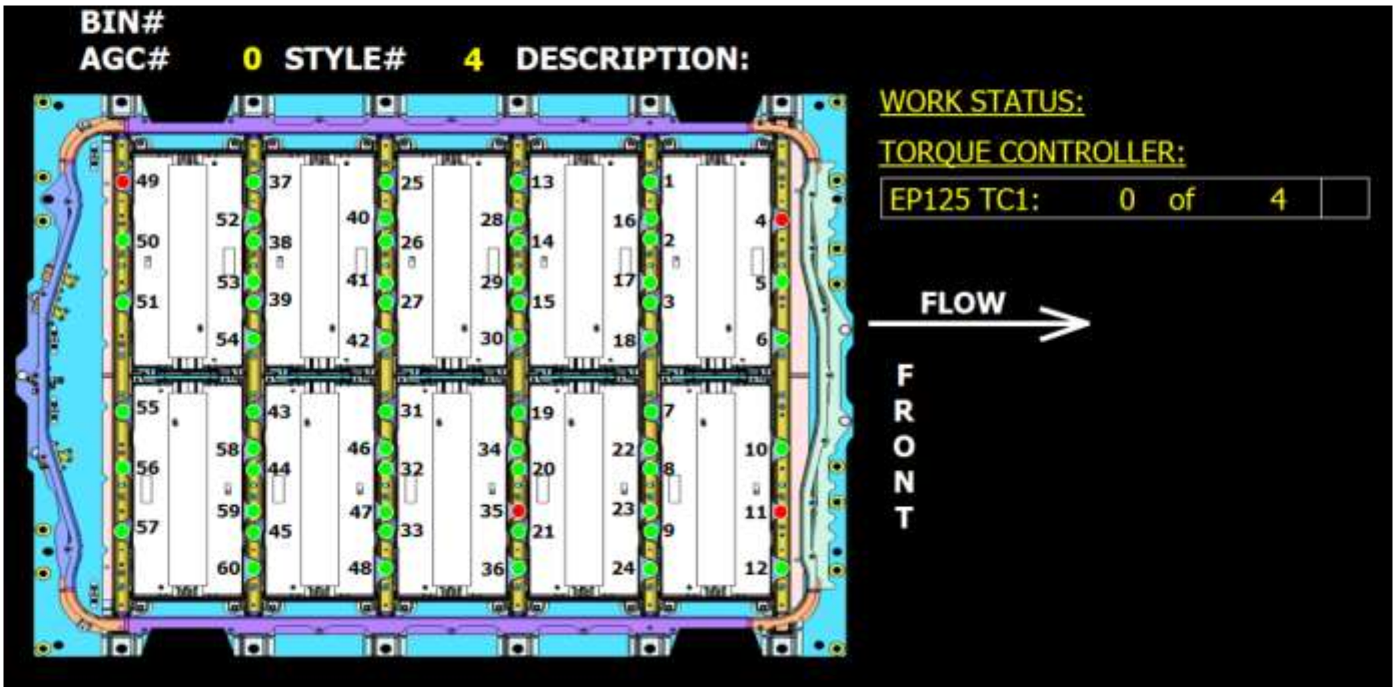


Figure 4-37. An example Inline Repair Cell EP125 and EP405 screen.

4.2.26. Inline Repair Cell EP235 and EP485

Touching the **EPXXX OPERATOR STATION** button on the Select screen navigates directly to a screen (refer to ***Figure 4-38***) that an operator utilizes when working with the pack on the AGC at the inline repair station.

When an AGC enters into the inline repair station an image of the tray appears on the station screen and there is an indicator for each bus bar that was not successfully installed in the previous station (EP230 or EP480). The indicator for the busbars that failed in the previous station flash red. The count on the right side of the screen will reflect how many busbars were incomplete from the last station. Once the work has been completed, all of the indicators on the part will turn green and the operator will release the cart.

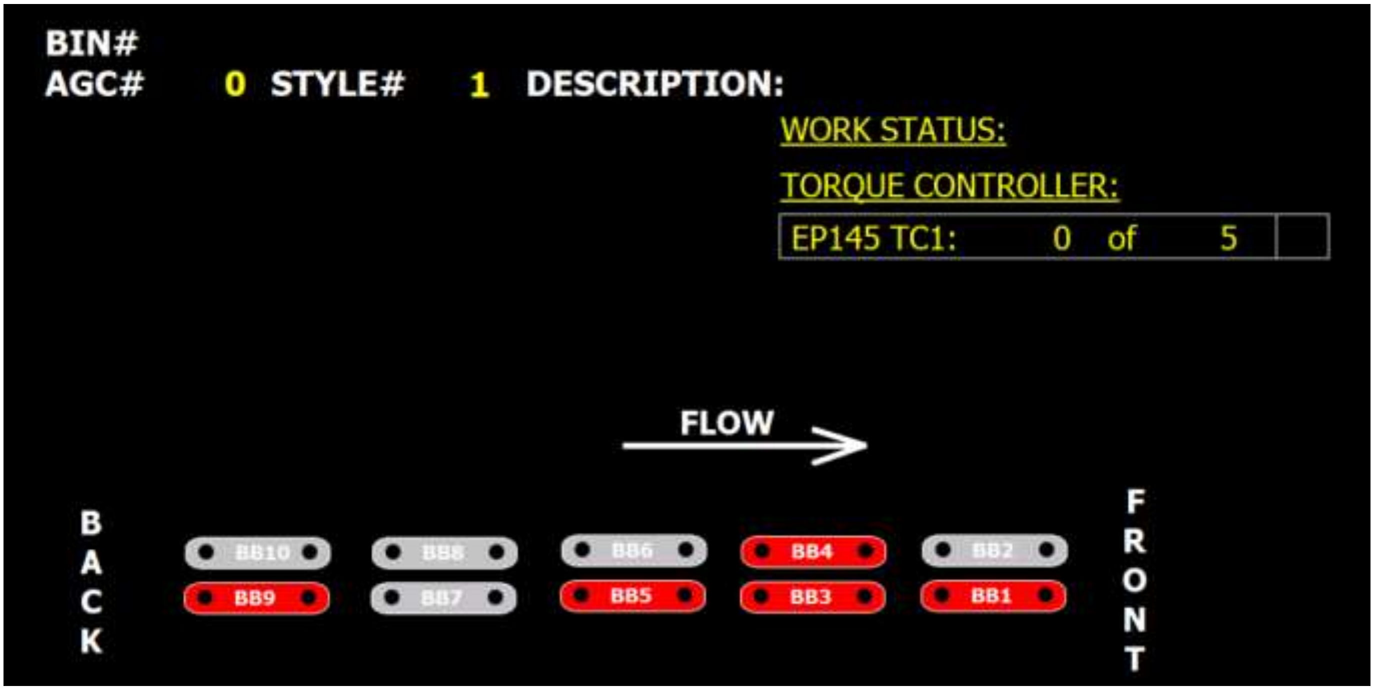


Figure 4-38. An example Inline Repair Cell EP235 and EP485 screen.

4.2.27. Inline Repair Cell EP325

Touching the **EPXXX OPERATOR STATION** button on the Select screen navigates directly to a screen (refer to ***Figure 4-39*** ***)*** that an operator utilizes when working with the pack on the AGC at the inline repair station.

When an AGC enters into the inline repair station an image of the tray appears on the station screen and there is an indicator for each bolt that was secured in the previous station (EP320). The indicator for the bolts that failed in the previous station flash red. The count on the right side of the screen will reflect how many bolts were incomplete from the last station. Once the work has been completed, all of the indicators on the part will turn green and the operator will release the cart.

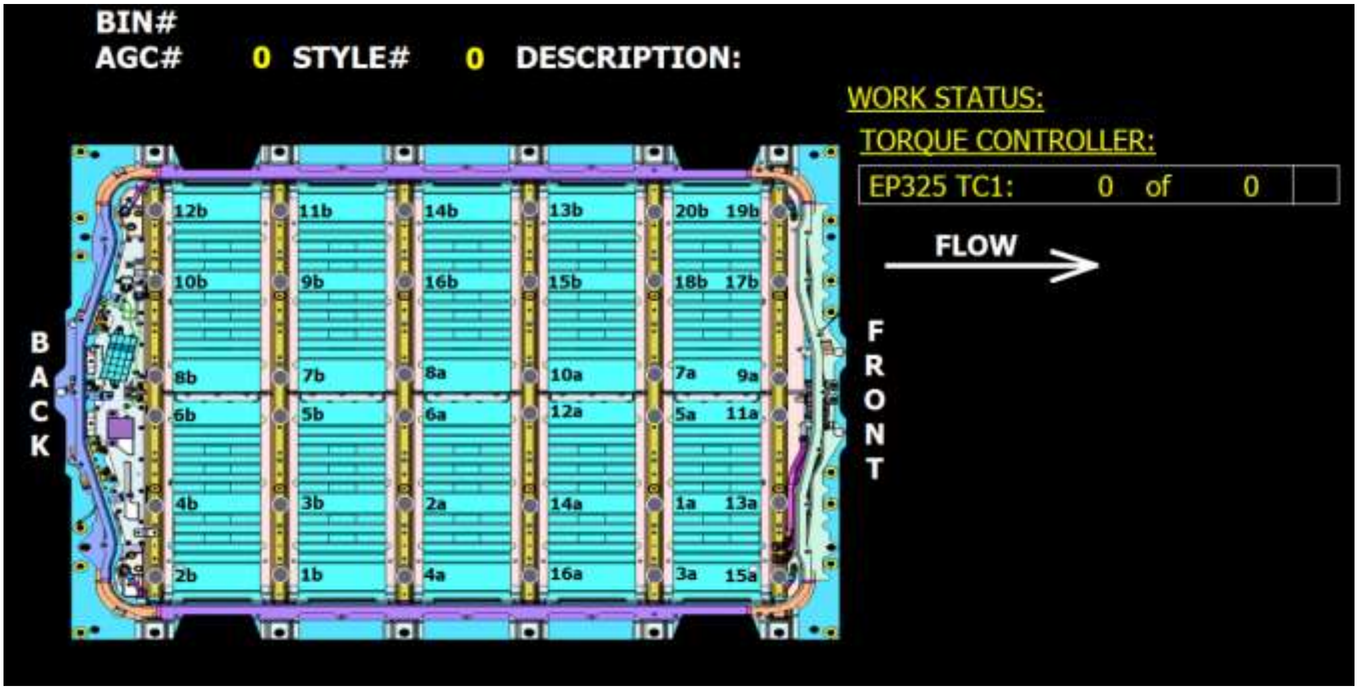


Figure 4-39. An example Inline Repair Cell EP325 screen.

4.2.28. Inline Repair Cell EP650

Touching the **EPXXX OPERATOR STATION** button on the Select screen navigates directly to a screen (refer to ***Figure 4-40)*** that an operator utilizes when working with the pack on the AGC at the inline repair station.

When an AGC enters into the inline repair station an image of the tray appears on the station screen and there is an indicator for each bolt that was secured in the previous station (EP640). The indicator for the bolts that failed in the previous station flash red. The count on the right side of the screen will reflect how many bolts were incomplete from the last station. Once the work has been completed, all of the indicators on the part will turn green and the operator will release the cart.

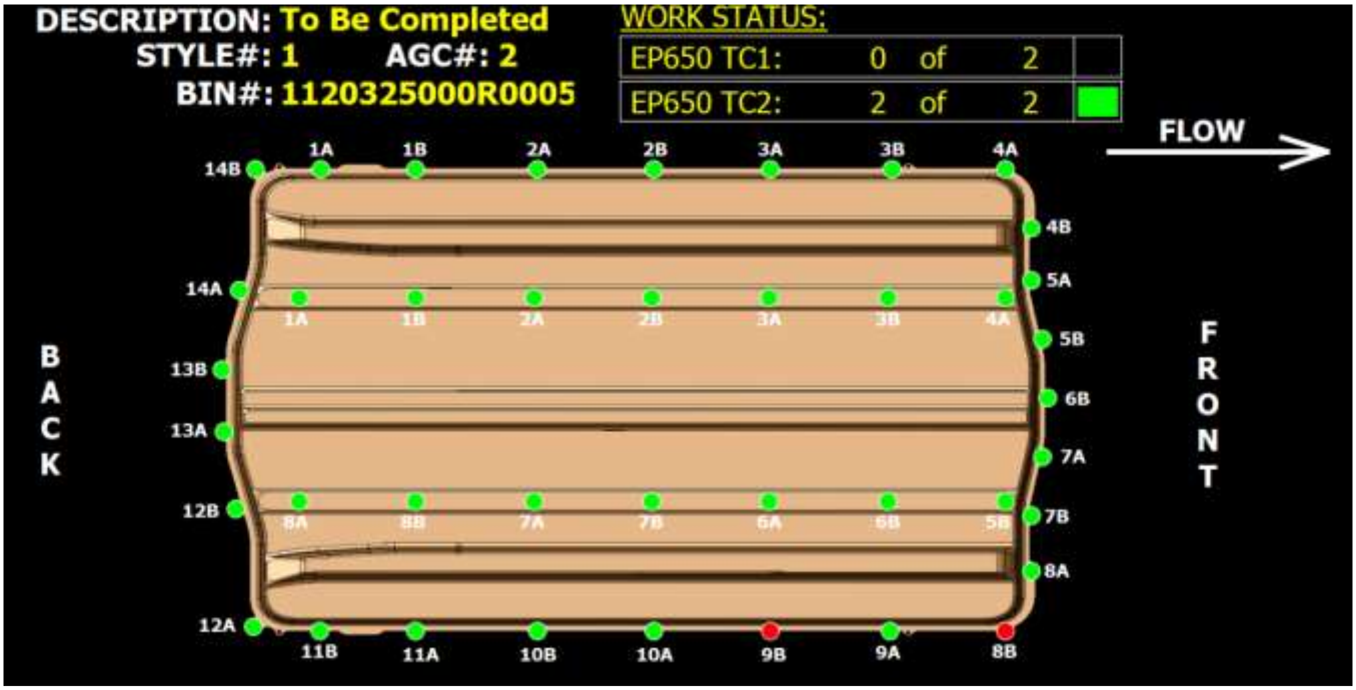


Figure 4-40. An example Inline Repair Cell EP620 screen.

4.2.29. Part Present Screen

Touching the **PART PRESENT SCREEN** button on the Select screen navigates directly to a screen that provides access to the Part Present screens. (refer to ***Figure 4-41***). The Part Present screen displays the existence of each necessary part for a battery pack.

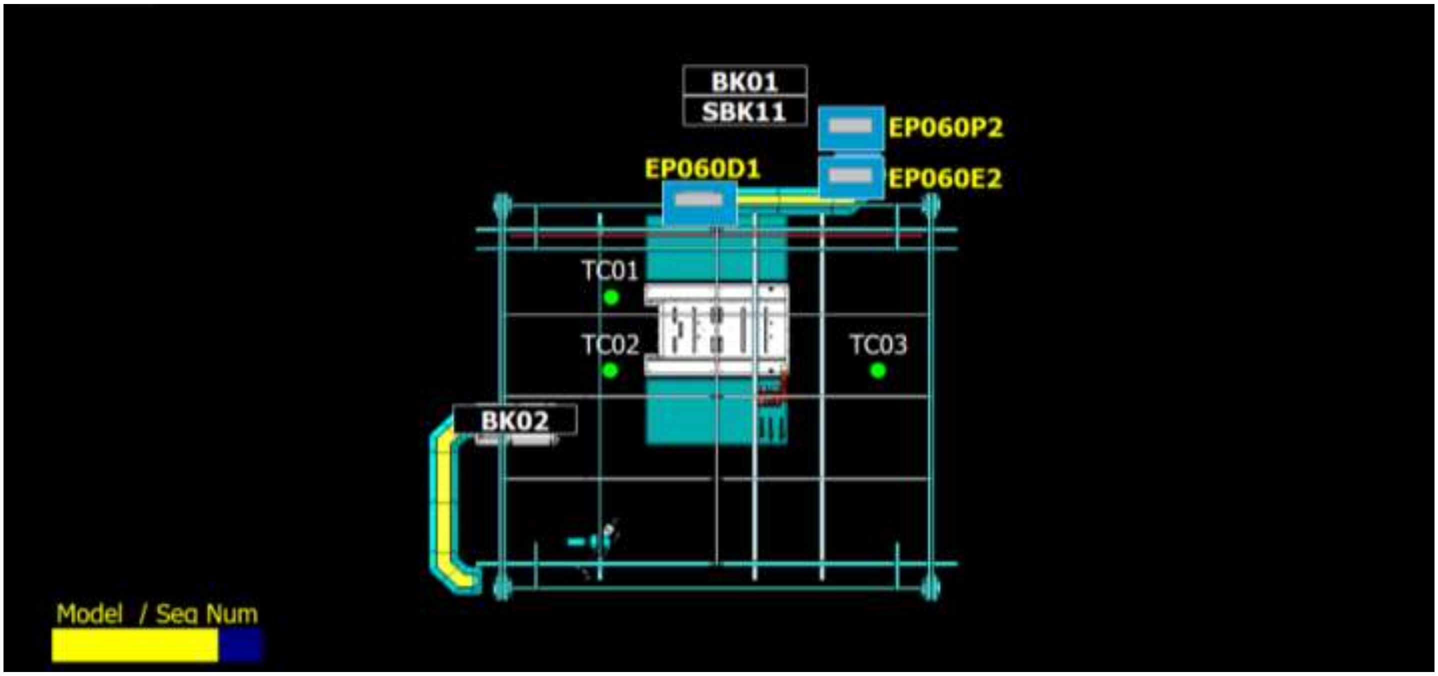


Figure 4-41. An example of a Part Present screen.

4.2.30. Schedule Screen

Touching the **PAS SCHEDULE** button on the Select screen navigates directly to a screen (refer to ***Figure 4-42***) that displays information about the production schedule. The screen is a data display only; changes to the schedule cannot be made on this screen. Use the **SELECT PAS MANUAL SCHEDULING** button to make changes.

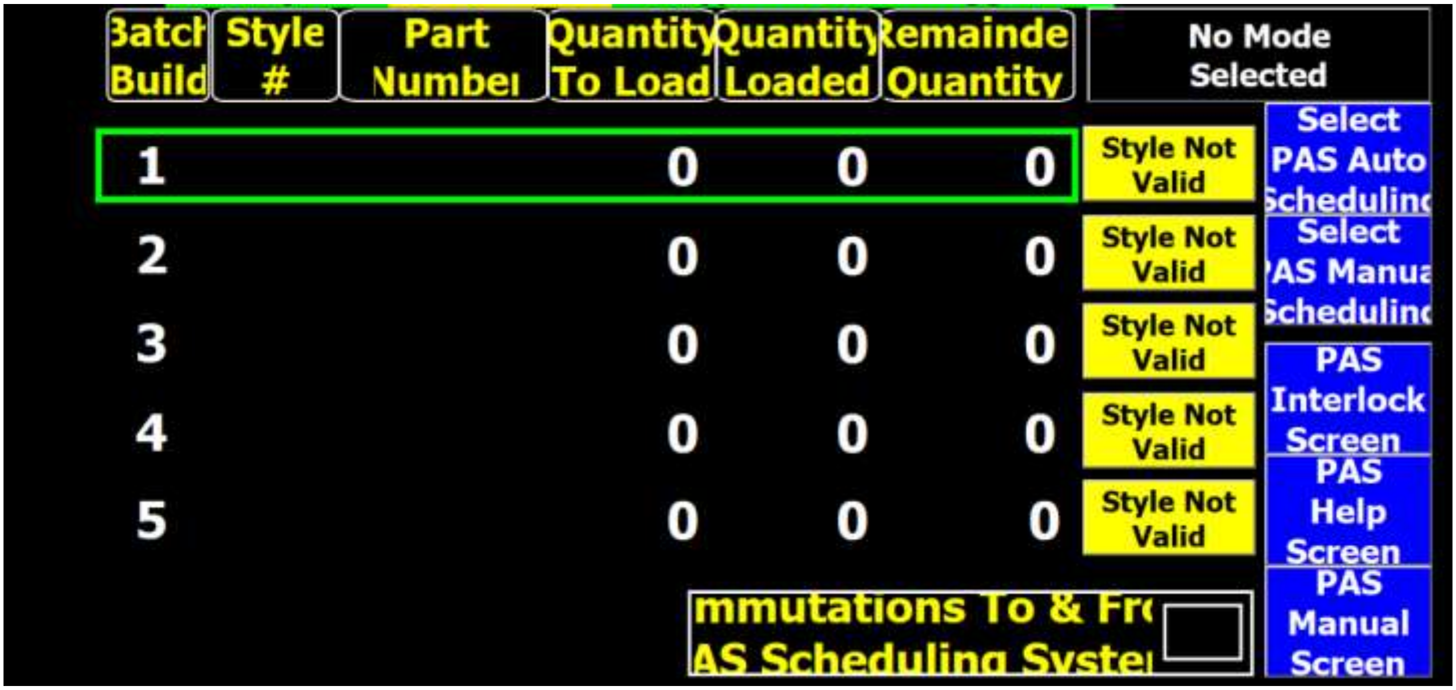


Figure 4-42. An example Schedule screen.

4.2.31. Style Overview Screen

Touching the **STYLE OVERVIEW** button on the Select screen navigates directly to a screen (refer to ***Figure 4-43***) that displays style data. Touch the **EDIT** button to change a part number as needed. Touch the **PASTE** button to distribute the changes to another device. Refer to your company operating procedures for the proper use of this screen.

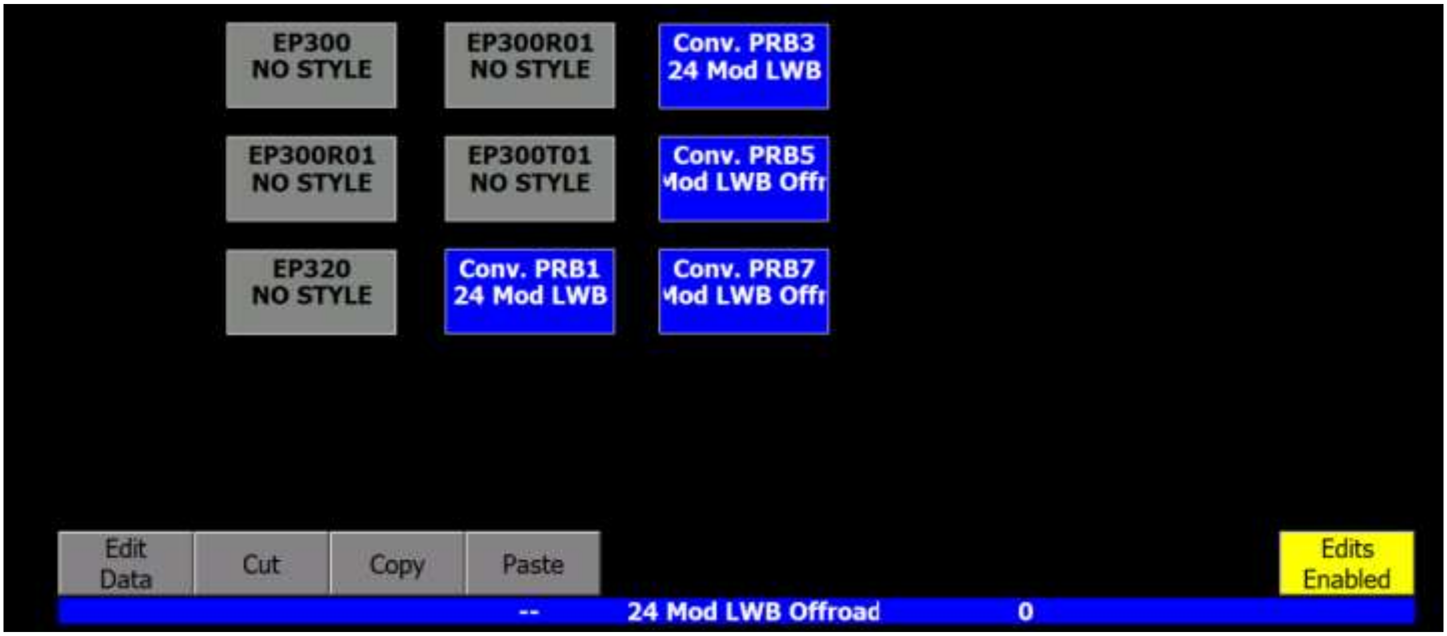


Figure 4-43. An example Style Overview screen.

4.3. COMMON OPERATING PROCEDURES

Only trained operators are to operate the assembly line. Operators use this section to operate the assembly line daily. This section describes the procedures for inspecting, starting, running, stopping, shutting down, emergency stopping, and recovering from faults on the assembly 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 is on.
- Ensure the PDP main disconnect switch 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, automated cell devices.

4.3.2. Starting a Manual Cell

Use the following procedure to start a manual cell. After completing this procedure, the cell will be started. To start a manual cell:

1. Ensure all cell disconnects are not disabled and that control power is present. Ensure the cell pneumatic equipment is enabled and up to pressure.
2. Press the Start button on the PB box for 3 seconds.
3. Return the AUTO/MANUAL key switch to the AUTO position.
4. If any faults are displayed at the top of the screen, touch the Fault Reset button in the screen header to reset each fault.

4.3.3. Starting an Automated Cell

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

4.3.4. Stopping a Cycle

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

4.3.4.1. 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.

4.3.4.2. 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.***

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

4.3.5. 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 Pack Main 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 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 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.

4.3.6. 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.

4.3.7. 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.

4.3.8. Opening and Closing an Entrance Gate

Each automated 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*** Modes of Operation

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

4.4. MODES OF OPERATION

4.4.1. Manual Station Operation

Auto mode is the standard operating mode for a manual cell. While in auto mode, the cell processor monitors the operation of the associated equipment and receives inputs from the operation through the HMI and associated cell 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 equipment jam, the cell will stop all equipment. Once the fault has been corrected, refer to ***4.3.2 Starting a Manual Cell*** to restore operation.

4.4.2. Automated Station Operation - Auto Mode

Auto mode is the standard operating mode for an automated 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, equipment within the cell may have lost automatic mode. Once the fault has been corrected, refer to ***4.3.3 Starting an Automated Cell*** to restore operation.

4.4.3. Automated Station Operation - Manual Mode

Manual mode for automated stations 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.

4.4.3.1. Entering Manual Mode

The following steps detail the operations required to operate the cell 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.

4.4.3.2. 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 ***4.4.3.1 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 ***4.3.3 Starting an Automated Cell.***

6. If additional manual actions are needed, repeat Steps 2 through 5 for the action and option.

4.4.3.3. 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 ***4.4.3.1 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.

4.4.3.4. 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 ***4.3.3 Starting an Automated Cell.***
6. To cancel tryout mode, stop the cell using **END OF CYCLE HOLD** (refer to ***4.4.3.6 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.

4.4.3.5. 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.

4.4.3.6. 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.

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:

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.***

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

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

Lock Considerations – When performing a lockout 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

5.3.1. Lock, Tag, and Try Procedure

Any time maintenance is to be performed on a 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 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 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 REFERENCE

Preventive maintenance must be performed at established intervals to keep the Pack Main 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
ATLAS COPCO_GENERIC_ANNUAL CALIBRATION OF TORQUE TOOLS_7.6_REV1.	Atlas Copco Nutrunner	Calibration of nutrunner	Annual
ATS_EEP_AGC_LOAD_EOAT_7.1_REV2	AGC Load EOAT	End of Tool Arm inspection	Monthly
		Linear rail lubrication	283 Hours
GENERIC_STARTUP_WEEKLY INSPECTION AND CLEANING DURING START-UP_7.6_REV2	All Cells	Daily cleaning and inspection of cells	Daily
ATS_EEN_BUSSBAR_EOAT_7.1_REV2	Bus Bar EOAT	End of Tool Arm inspection	Monthly
		Linear rail lubrication	566 Hours
FAB_CARLSON_FEEDER_7.1_REV1	Carlson Feeder	Clean and inspect feeder	Monthly
CARLSON_FXD_190_DRIVER_7.1_REV1	Carlson FXD 190 Driver	Daily inspection	Daily
		Monthly inspection	Monthly
		Linear rail lubrication	Monthly
ATS_OMNI DUNNAGE CONVEYORS_7.1_REV1	Conveyors	Inspect chain tension	Monthly
		Inspect bearing seals	Monthly
		Grease vertical guide tubes	Monthly
		Grease chain drive roller bearings	13 Weeks
		Inspect Air Spring	60 Days
ATS_EEP_COVER_LOAD_EOAT_7.1_REV2	Cover Load EOAT	End of Tool Arm inspection	Monthly
ATS_EEN_COVER_SECURE_EOAT_7.1_REV2	Cover Secure EOAT	End of Tool Arm inspection	Monthly
		End of Tool Arm lubrication	101 Hours
CROWN_FEEDER_7.1_REV1	Crown Feeder	Clean and inspect feeder	Monthly
FANUC_M2000IA1700L_ROBOT ARM_7.1_REV1	FANUC M2000iA/1700L Robot	Grease balancer bushings	3840 Hours
		Replace mechanical unit batteries	5760 Hours
		Grease mechanical unit axis	11520 Hours
		Replace mechanical unit cable	15360 Hours
FANUC_M2000IA1700L_ROBOT CONTROLLER_7.1_REV1		Replace controller battery	15360 Hours
FANUC_M900IB280L_ROBOT ARM_7.6_REV1	FANUC M900iB/280L Robot	Grease balancer bushings	3840 Hours
		Replace mechanical unit batteries	5760 Hours
		Grease mechanical unit axis	11520 Hours
		Replace mechanical unit cable	15360 Hours
FANUC_M900IB280L_ROBOT CONTROLLER_7.6_REV1		Replace controller battery	15360 Hours

Job Plan File Name	Device	Task Description	Task Frequency
FANUC_R2000iC210L_ROBOT ARM_7.6_REV1	FANUC R2000iC/210L Robot	Grease balancer bushings	3840 Hours
		Replace mechanical unit batteries	5760 Hours
		Grease mechanical unit axis	11520 Hours
		Replace mechanical unit cable	15360 Hours
FANUC_R2000iC210L_ROBOT CONTROLLER_7.6_REV1		Replace controller battery	15360 Hours
FANUC_GEN VI _RTU_7.6_REV1	FANUC Rail Transport Unit	Clean and inspect unit	560 Hours
		Inspect and lubricate rack	2240 Hours
FANUC_M900IB280L_ROBOT ARM_7.6_REV1	FANUC_M900iB/280L Robot	Grease balancer bushings	3840 Hours
		Replace mechanical unit batteries	5760 Hours
		Grease mechanical unit axis	11520 Hours
		Replace mechanical unit cable	15360 Hours
FANUC_M900IB280L_ROBOT CONTROLLER _7.6_REV1		Replace controller battery	15360 Hours
FANUC_R2000iC210F_ROBOT ARM_7.6_REV1	FANUC_R2000iC/210F Robot	Grease balancer bushings	3840 Hours
		Replace mechanical unit batteries	5760 Hours
		Grease mechanical unit axis	11520 Hours
		Replace mechanical unit cable	15360 Hours
FANUC_R2000iC210F_ROBOT CONTROLLER_7.6_REV1		Replace controller battery	15360 Hours
MTT_ATS_FIXTURE_TABLE__7.1_REV2	Fixture Rotate Table/Tilt Table	Fixture table inspection	1 Month
		Fixture table lubrication	720 Hours
HLC_GIVENS_LIFT_ASSIST_7.1_REV1	Lift Assist	Lift assist inspection	1 Month
ATS_EEP_MIDPLATE_LOAD_EOAT_7.1_REV2	Midplate Load EOAT	End of Tool Arm inspection	Monthly
		End of Tool Arm linear rail lubrication	556 Hours
		End of Tool Arm shotpin bearing lubrication	595 Hours
ATS_EEN_MIDPLATE_SECURE_EOAT_7.1_REV2	Midplate Secure EOAT	End of Tool Arm inspection	Monthly
		End of Tool Arm lubrication	556 Hours
ATS_EEP_MODULE_LOAD_EOAT_7.1_REV2	Module Load EOAT	End of Tool Arm inspection	Monthly
		End of Tool Arm linear rail lubrication	556 Hours
		End of Tool Arm gripper rail lubrication	1603 Hours
ATS_EEP_MODULE_SECURE_EOAT_7.1_REV2	Module Secure EOAT	End of Tool Arm inspection	Monthly
ATS_EEP_PACK_UNLOAD_EOAT_7.1_REV2	Pack Unload EOAT	End of Tool Arm inspection	Monthly
		End of Tool Arm linear rail lubrication	87 Hours
		End of Tool Arm locating pin rail lubrication	308 Hours

Job Plan File Name	Device	Task Description	Task Frequency
SCHUCKER_System 6000 Gen 1.2_1 PART DISPENSE_7.1_REV1.xlsx	RTV Dispense System	Schucker System 6000 Part Dispense connections inspection	Daily
		Schucker System 6000 Part Dispense plasticizer replacement	Weekly
		Schucker System 6000 Part Dispense high pressure hoses replacement	4 years
SCHUCKER_System 6000 Gen 1.2_2 PART MIXING DISPENSE_7.1_REV1.xlsx	RTV Dispense System	Schucker System 6000 Part mix inspection	Daily
		Schucker System 6000 Part Mix plasticizer replacement	Weekly

5.5. LUBRICATION CHARTS REFERENCE

Proper lubrication is required to keep some of the Main Pack Line equipment operating at peak performance. ATS has provided lubrication charts for equipment requiring lubrication. The following charts have been provided:

Number	Chart Name
1	EP720 Battery Assembly Unload Station
2	EP020 Tray Load Station
3	EP040 Insulation and Label Install Station
4	EP060 Headers Install Station
5	EP080 DCFC Station
6	EP100/EP120 Lower Module Load and Secure Station
7	EP125 Module Secure, Lower Deck Manual Repair Station
8	EP160 BDU Install Station
9	EP180 BRFM Install Station
10	EP200 Coolant Hose Station
11	EP220 Coolant Outlet Install
12	EP230 Lower Bus Bar Install and Secure Station
13	EP235 Lower Bus Bar Install and Secure, Lower Deck Manual Repair Station
14	EP240 Lower Thermal Barrier Install
15	EP260 Idle Station
16	EP280 Electrical Leak Test Station
17	EP300/EP320 Midplate Load and Secure Station
18	EP325 Midplate Load and Secure Manual Repair Station
19	EP340 Midplate To Tray Dimensional Check Station
20	EP360 Idle Station
21	EP380/EP400 Upper Module Load and Secure Station
22	EP405 Module Secure, Upper Deck Manual Repair Station
23	EP420 Z-Blocker Install
24	EP440 Idle Station
25	EP460 FPIM Install Station
26	EP480 Upper Bus Bar Install and Secure Station
27	EP485 Bus Bar Install and Secure, Upper Deck Manual Repair Station
28	EP500 Midpack Bus Bar Station
29	EP520 Upper Thermal Barrier Install Station
30	EP540 Front to Back Bus Bar Station
31	EP560 Idle Station
32	EP580 Upper Deck Electrical Leak Test Station
33	EP600 O-Ring Install Station
34	EP620/EP630/EP640 Upper Bus Bar Install and Secure Station
35	EP650 Cover Secure Manual Repair Station
36	EP660 Burst Valve Install Station
37	EP680 Cover Leak Test Station
38	EP700 Continuity Test Station
39	EP900 General Repair Cell
40	EP905 General Repair Cell

5.6. MAINTENANCE TASK INSTRUCTION SHEETS REFERENCE

The Main Pack 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
302.13	Repair/Adjust Tooling on Robot End Effector and Valve Packs - Cover Fastener EOAT Stanchion
302.4	Repair/Adjust Tooling on Robot End Effector and Valve Packs - Pack EOAT
302.5	Repair/Adjust Tooling on Robot End Effector and Valve Packs - Load AGC EOAT
302.1_C020	Repair/Adjust Tooling on Robot End Effector and Valve Packs - Tray EOAT
302.2_C020	Repair/Adjust Tooling on Robot End Effector and Valve Packs - Fasten Skid Plate EOAT
302.3_C020	Repair/Adjust Tooling on Robot End Effector and Valve Packs - Skid Plate EOAT
302.6_C100 and C380	Repair/Adjust Tooling on Robot End Effector and Valve Packs - Module EOAT
302.7_C120 and C400	Repair/Adjust Tooling on Robot End Effector and Valve Packs - Fasten Module EOAT
302.8_C140 and C480	Repair/Adjust Tooling on Robot End Effector and Valve Packs - Busbar Fasten EOAT
302.9_C300	Repair/Adjust Tooling on Robot End Effector and Valve Packs - Midplate EOAT
302.10_C320	Repair/Adjust Tooling on Robot End Effector and Valve Packs - Fasten Midplate EOAT
302.11_C620	Repair/Adjust Tooling on Robot End Effector and Valve Packs - Cover EOAT
302.12_C630	Repair/Adjust Tooling on Robot End Effector and Valve Packs - Cover Fastener - Bolt - EOAT
303.1. C020	Repair/Adjust Tooling on Robot End Effector and Valve Packs - Tray EOAT
303.2. C020	Repair/Adjust Tooling on Robot End Effector and Valve Packs - Fasten Skid Plate EOAT
303.3. C020	Repair/Adjust Tooling on Robot End Effector and Valve Packs - Skid Plate EOAT
303.4. C020	Repair/Adjust Tooling on Robot End Effector and Valve Packs - Pack EOAT - BET
303.5. C020	Repair/Adjust Tooling on Robot End Effector and Valve Packs - Load AGC EOAT
303.6. C100 and C380	Repair/Adjust Tooling on Robot End Effector and Valve Packs - Module EOAT
303.7. C120 and C400	Repair/Adjust Tooling on Robot End Effector and Valve Packs - Fasten Module EOAT
303.8. C140 and C480	Repair/Adjust Tooling on Robot End Effector and Valve Packs - Busbar Fasten EOAT
303.9. C300	Repair/Adjust Tooling on Robot End Effector and Valve Packs - Midplate EOAT
303.10. C320	Repair/Adjust Tooling on Robot End Effector and Valve Packs - Fasten Midplate EOAT
303.11. C620	Repair/Adjust Tooling on Robot End Effector and Valve Packs - Cover EOAT
303.12. C630	Repair/Adjust Tooling on Robot End Effector and Valve Packs - Cover Fastener EOAT
303.13. C640	Repair/Adjust Tooling on Robot End Effector and Valve Packs - Cover Fastener - Stanchion EOAT
304	Repair/Adjust Tooling on Robot End Effector and Valve Packs - Replace Switches on EOAT
305	Adjust Switches
307	Replace Leoni Dress
308	Replace Servo Motor on Robot
309	Teach, Master Path verification
314	Make Tooling Adjustments
321	Replace Cylinder
332	Home Axis Servo
337.1. C020	Repair/Adjust Tooling on Lift Assist - Tray Lift Assist
337.2. C060 and C905	Repair/Adjust Tooling on Lift Assist - BEV-BDU Lift Assist
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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.

Fault	Possible Cause	Recovery
		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.
	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

Fault	Possible Cause	Recovery
		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. • 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.

6.3. 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.

6.4. SYSTEM TROUBLESHOOTING

6.4.1. Fixture Rotate Table Faults

Fault	Possible Cause	Recovery
Table does not rotate	Table is obstructed	Remove the obstruction.
	No power to the table	Ensure that power is supplied to the table.
	No power is connected to servo motor	Check electrical connections to servo motor
	Servo motor is damaged or worn	Inspect servo motor for damage or wear, replace as needed.
Battery tray shifts or falls from table	Holding clamp is obstructed	Remove the obstruction.
	Holding clamp is not aligned correctly	Inspect holding clamp for correct alignment, correct as needed.
	The clamp actuator is damaged or worn	Inspect actuator for damage or wear, replace as needed.

6.4.2. Conveyor Equipment Faults

Fault	Possible Cause	Recovery
Product on conveyor stops	Conveyor is obstructed	Remove the obstruction
	Roller is not aligned correctly	Inspect roller for correct alignment.
	No power is connected to motor	Check electrical connections to motor.
	Motor is damaged or worn	Inspect motor for damage or wear, replace as needed.
Product is not stable on conveyor	Roller is not aligned correctly	Inspect roller for correct alignment.
	Roller is damaged or worn	Inspect roller for damage or wear, replace as needed.
	Conveyor is not level	Inspect conveyor system for correct level.

REFERENCE

For more information about the conveyor equipment, refer to the equipment supplier documentation (Omni Metalcraft Technical Handbook).

6.4.3. Robot Faults

REFERENCE

For more information about the robot equipment faults, refer to the equipment supplier documentation (FANUC Robot M900 iB Operator's Manual, FANUC Robot M-2000 iA Operator's Manual, and FANUC Robot R-2000 iC Operator's Manuals).

6.4.4. End of Arm Tool Faults

6.4.4.1. Vacuum Faults

Fault	Possible Cause	Recovery
Vacuum pad has weak or no suction	Inadequate vacuum	Ensure that air lines are secured and free of blockage. Ensure that the suction pump unit is functioning properly.
	Vacuum pad is not aligned correctly	Adjust the vacuum pad.
	Vacuum pad is damaged or worn	Inspect vacuum pad for damage or wear, replace as needed.

6.4.4.2. Gripper Faults

Fault	Possible Cause	Recovery
Gripper does not open or close	Sensor is obstructed	Remove the obstruction.
	Sensor cable is loose or not connected	Secure cable to the sensor body.
	Sensor is misaligned	Adjust the sensor.
	Sensor is malfunctioning	Replace sensor.
	Inadequate air supply	Ensure that air lines are secured and free of blockage. Ensure that the air preparation unit is functioning properly. Ensure facility air supply is functioning correctly.
	Gripper is obstructed	Remove the obstruction.
	Actuator is obstructed	Remove the obstruction.
	The actuator is damaged or worn	Inspect actuator for damage or wear, replace as needed.
Gripper is not in correct position	Camera is obstructed	Remove the obstruction.
	Camera cable is loose or not connected	Secure cable to the camera body.
	Camera is misaligned	Adjust the camera.
	Camera is malfunctioning	Replace camera.
	Inadequate air supply	Ensure that air lines are secured and free of blockage. Ensure that the air preparation unit is functioning properly. Ensure facility air supply is functioning correctly.
	Gripper is obstructed	Remove the obstruction.
	Rail is damaged or worn	Inspect rail for damage or wear, replace as needed.
	Actuator is obstructed	Remove the obstruction.
	Actuator is damaged or worn	Inspect actuator for damage or wear, replace as needed.

6.4.4.3. Driver Faults

Fault	Possible Cause	Recovery
Driver is not in correct position	Camera is obstructed	Remove the obstruction.
	Camera cable is loose or not connected	Secure cable to the camera body.
	Camera is misaligned	Adjust the camera.
	Camera is malfunctioning	Replace camera.
	Driver is obstructed	Remove the obstruction.
	Driver is misaligned	Adjust the driver.
	Rail is damaged or worn	Inspect rail for damage or wear, replace as needed.
	Motor is damaged or worn	Inspect motor for damage or wear, replace as needed.
The driver has no fasteners	Feeder system is depleted	Replenish feeder system.
	Fastener supply line is obstructed	Remove the obstruction.
	Fastener supply line is not connected	Secure fastener supply line to driver.
	The driver is jammed with a fastener.	Remove the obstruction.
Driver over or under torques fastener	Driver is not configured correctly	Consult OEM documentation regarding configuring driver.
	Driver is malfunctioning	Replace driver.
	Driver Bit is damaged or worn	Inspect driver bit for damage or wear, replace as needed.

6.4.5. Feeder System Faults

Fault	Possible Cause	Recovery
No fasteners supplied from system	Feeder system is depleted	Replenish feeder system.
	Fastener supply line is obstructed	Remove the obstruction.
	Fastener supply line is not connected	Secure fastener supply line to driver.
	Inadequate air supply	Ensure that air lines are secured and free of blockage. Ensure that the air preparation unit is functioning properly. Ensure facility air supply is functioning correctly.

REFERENCE ***For more information about fastener feed system equipment, refer to the equipment supplier documentation (Carlson S12 Technical Manual).***

6.4.6. Lift Assist Faults

Fault	Possible Cause	Recovery
Lift assist slow or no response from controls	Inadequate air supply	Ensure that air lines are secured and free of blockage. Ensure that the air preparation unit is functioning properly. Ensure facility air supply is functioning correctly.

6.4.7. RTV Dispense System Faults

REFERENCE ***For more information about the RTV Dispense System Controls troubleshooting, refer to the equipment supplier documentation (SCA HPS/PCU5000 Manual).***

6.4.8. RTV Pump System Faults

REFERENCE ***For more information about the RTV Dispense Pump troubleshooting, refer to the equipment supplier documentation (SCA Controller SYS6000 Manual).***

7. ASSEMBLY AND DISASSEMBLY

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7.1. PACK UNLOAD EOAT

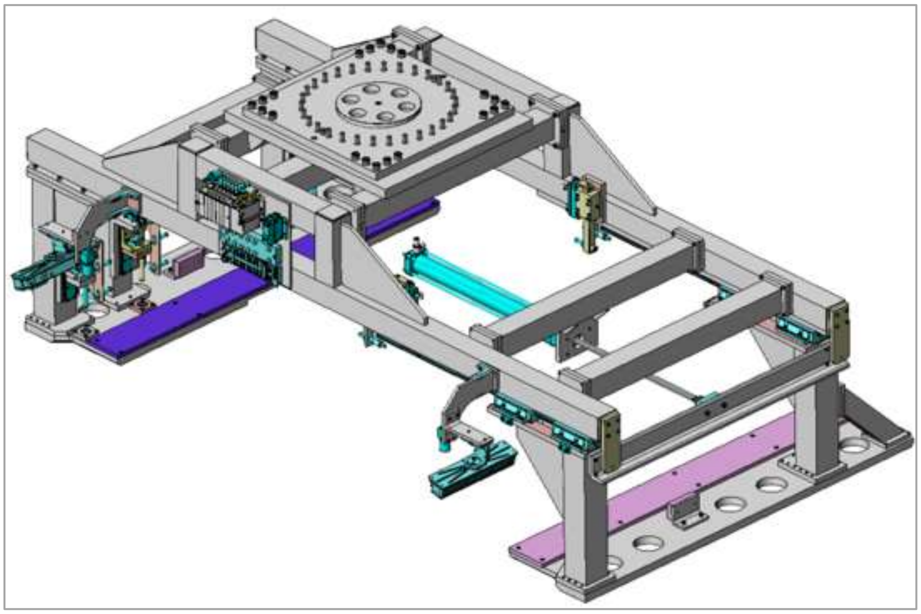

Figure 7-1. Pack Unload End Of Arm Tool

Before disassembling the EOAT, disconnect all air and electrical connections.

7.1.1. Removing the EOAT from Robot

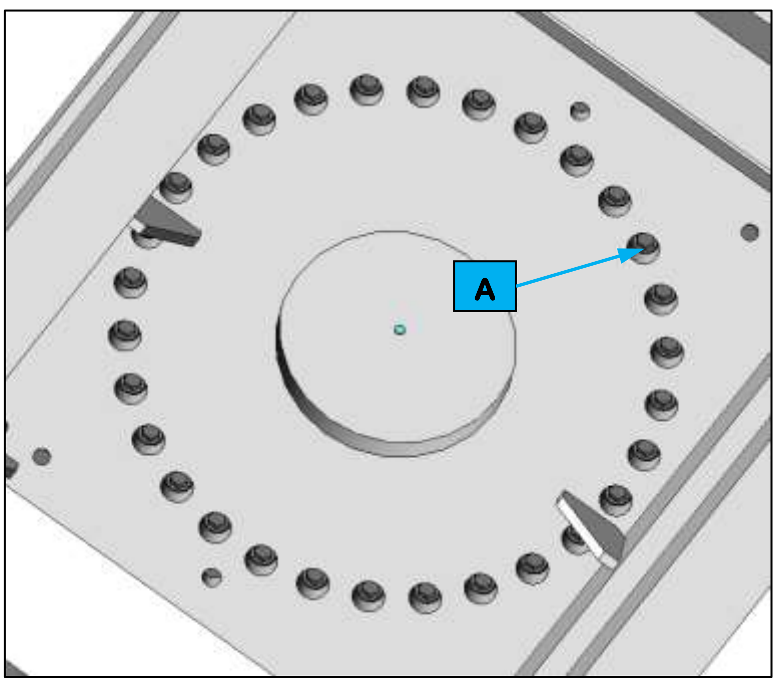

Figure 7-2. Removing the EOAT from Robot

While supporting the EOAT, remove the 30 M16 bolts (refer to callout **A** in ***Figure 7-2***) from the bottom of the frame. Remove EOAT from Robot.

7.2. TRAY EOAT

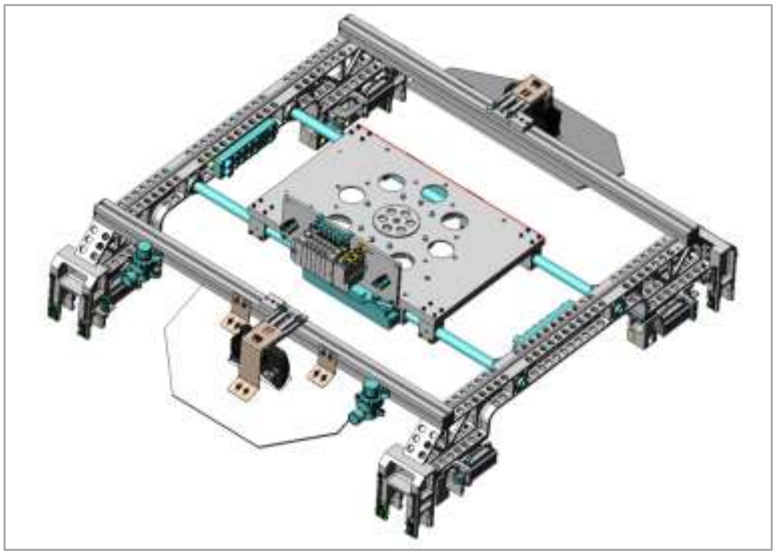

Figure 7-3. Tray End Of Arm Tool

Before disassembling the EOAT, disconnect all air and electrical connections.

7.2.1. Removing the EOAT from Robot

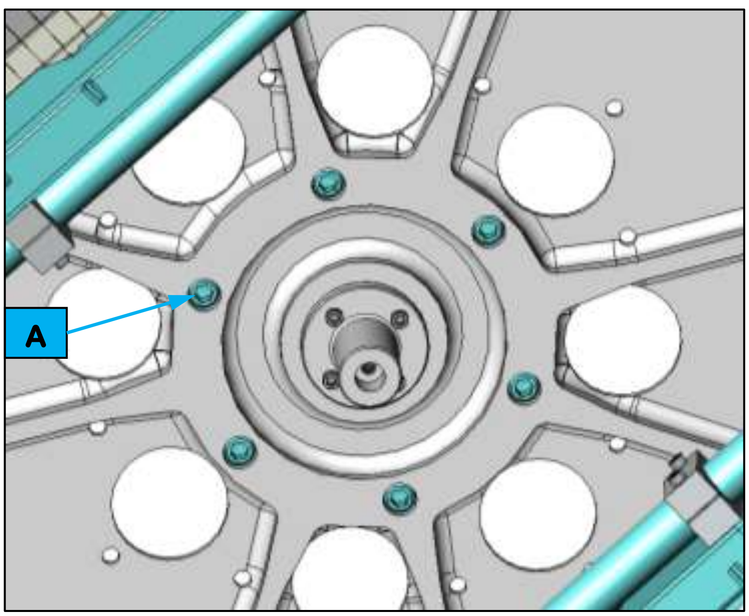

Figure 7-4. Removing the EOAT from Robot

While supporting the EOAT, remove the six (6) M12 bolts (refer to callout **A** in *Figure 7-4*) from the bottom of the frame. Remove EOAT from Robot.

7.3. SKID PLATE EOAT

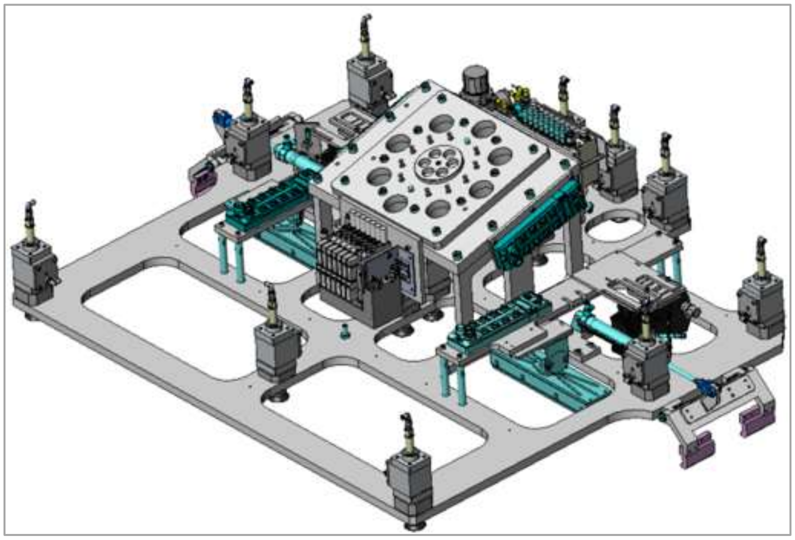

Figure 7-5. Skid Plate End Of Arm Tool

Before disassembling the EOAT, disconnect all air and electrical connections.

7.3.1. Removing the EOAT from Robot

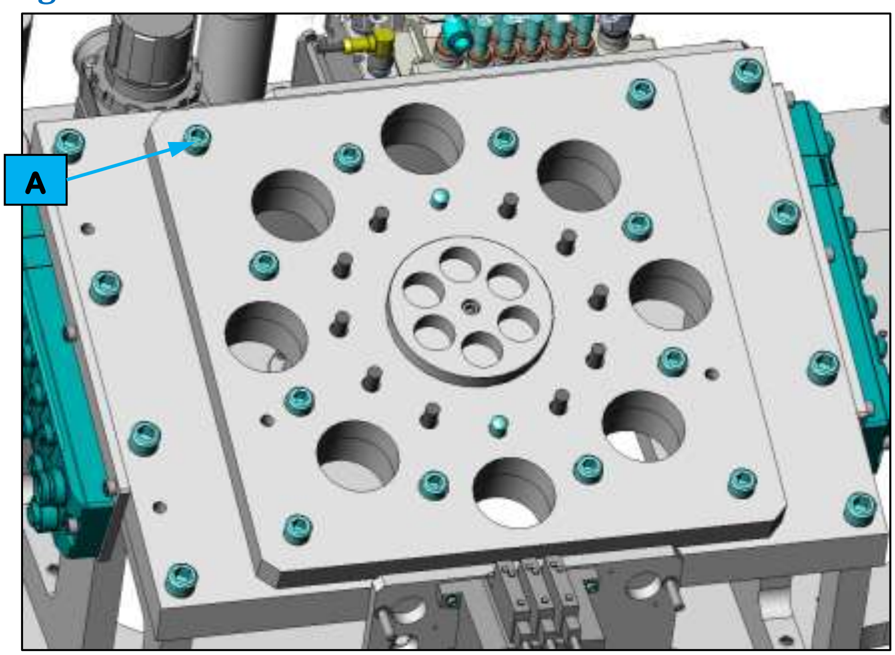

Figure 7-6. Removing the EOAT from Robot

While supporting the EOAT, remove the 12 M10 bolts (refer to callout **A** in ***Figure 7-6***) from the top of the frame. Remove EOAT from Robot.

7.4. TRAY/SKID PLATE ASSEMBLY EOAT

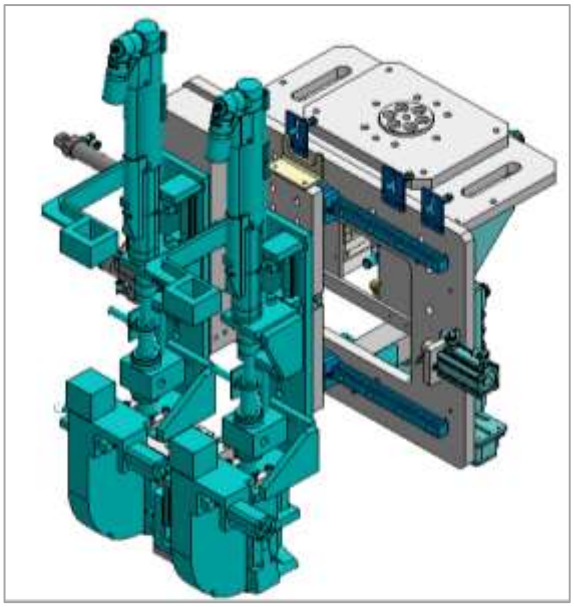

Figure 7-7. Tray/Skid Plate Assembly End Of Arm Tool

Before disassembling the EOAT, disconnect all air and electrical connections.

7.4.1. Removing the EOAT from Robot

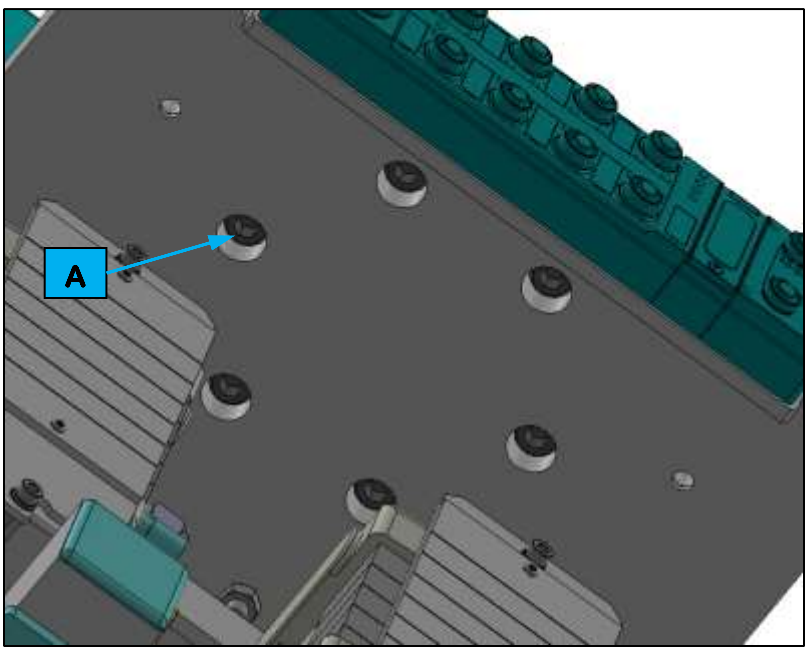

Figure 7-8. Removing the EOAT from Robot

While supporting the EOAT, remove the six (6) M10 bolts (refer to callout **A** in ***Figure 7-8***) from the bottom of the frame. Remove EOAT from Robot.

7.5. AGC LOAD EOAT

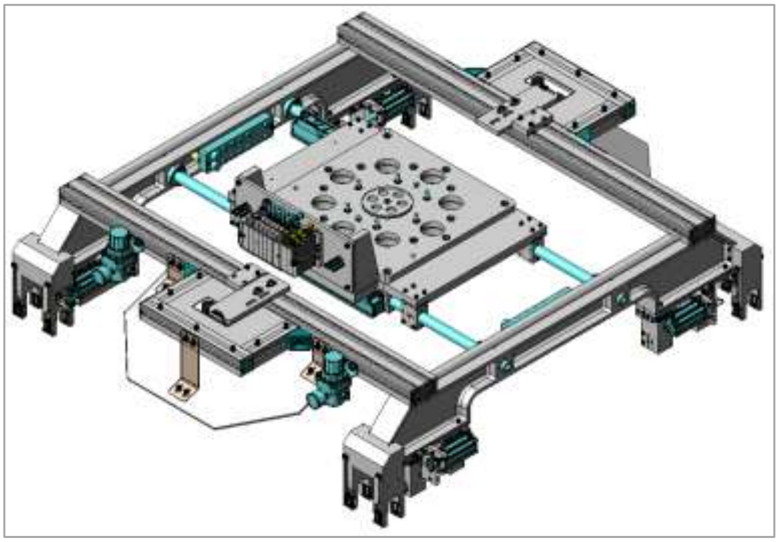

Figure 7-9. AGC Load End Of Arm Tool

Before disassembling the EOAT, disconnect all air and electrical connections

7.5.1. Removing the EOAT from Robot

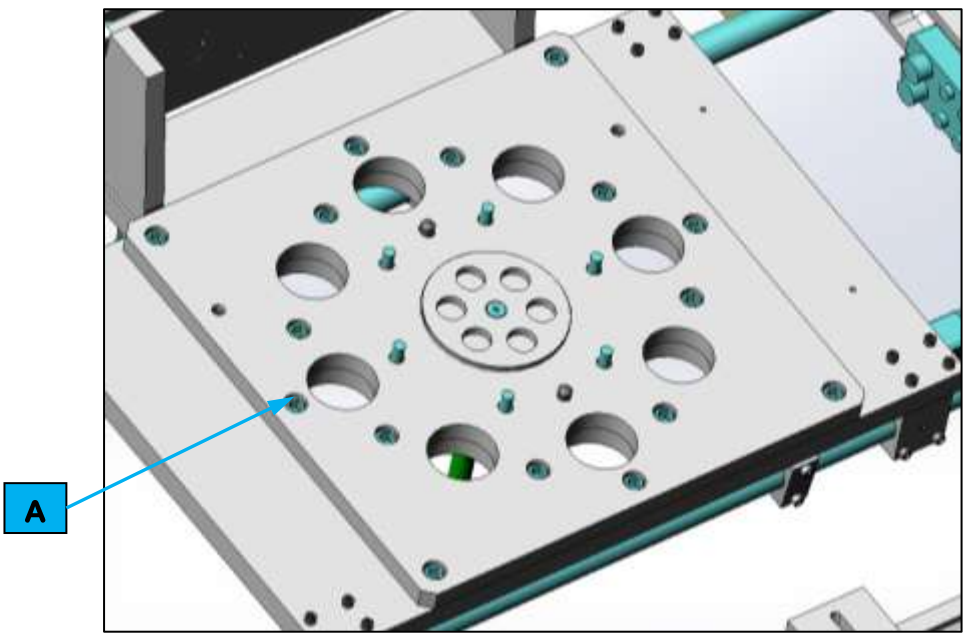

Figure 7-10. Removing the EOAT from Robot

While supporting the EOAT, remove the 16 M12 bolts (refer to callout **A** in ***Figure 7-10***) from the top of the frame. Remove EOAT from Robot and top plate.

7.6. LOAD MODULE EOAT

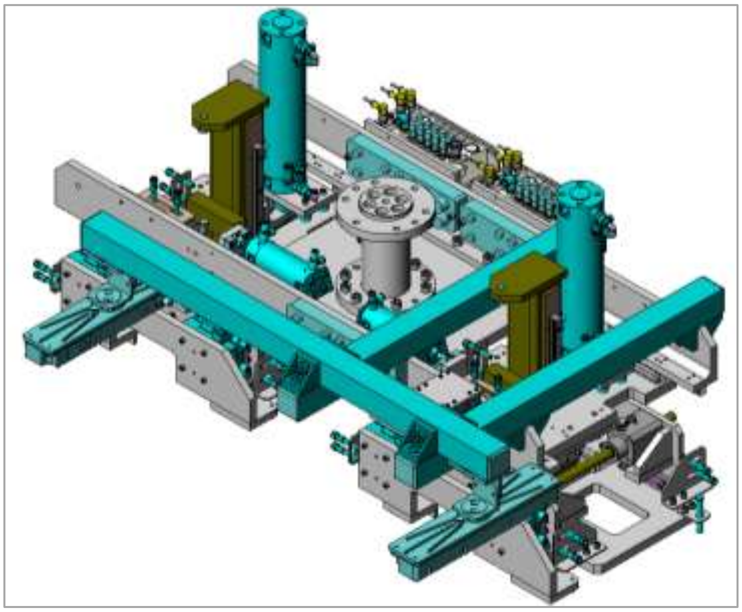

Figure 7-11. Load Module End Of Arm Tool

Before disassembling the EOAT, disconnect all air and electrical connections.

7.6.1. Removing the EOAT from Robot

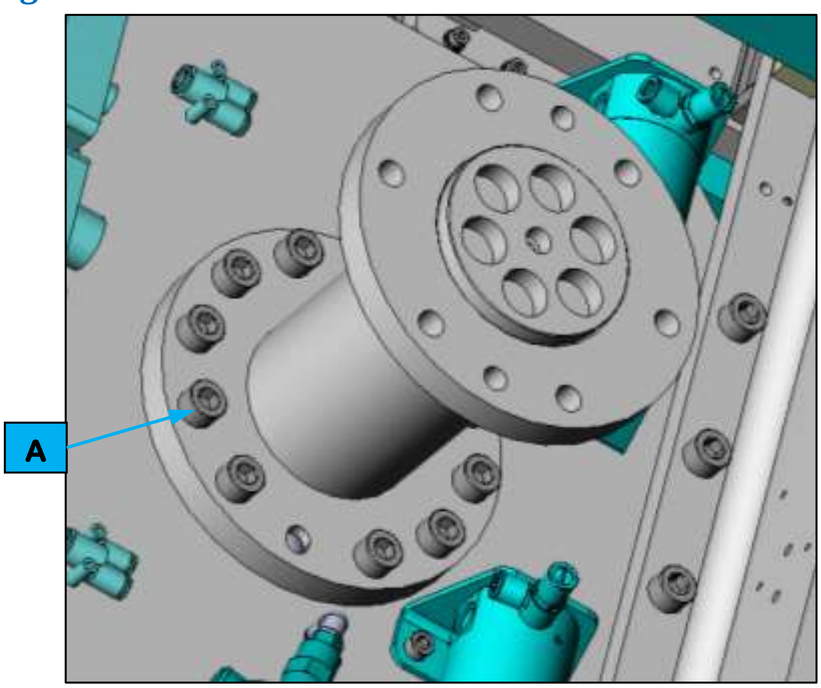

Figure 7-12. Removing the EOAT from Robot

While supporting the EOAT, remove the 10 M10 bolts (refer to callout **A** in *Figure 7-12*) from the top of the EOAT frame and Mounting Adapter Plate. Remove EOAT from Robot.

7.7. MODULE SECURE EOAT

Figure 7-13. Module Secure End Of Arm Tool

Before disassembling the EOAT, disconnect all air and electrical connections.

7.7.1. Removing the EOAT from Robot

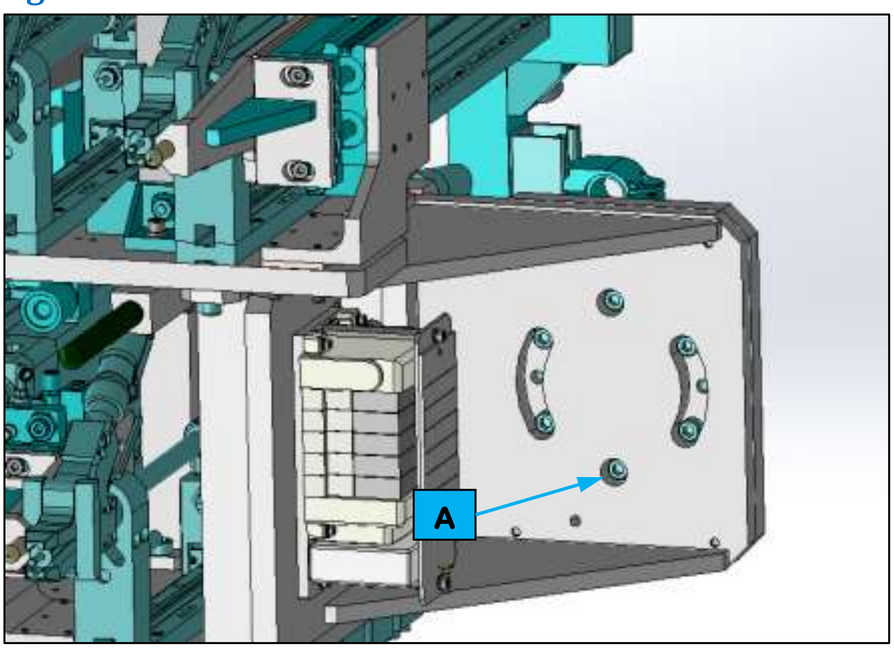

Figure 7-14. Removing the EOAT from Robot

While supporting the EOAT, remove the six (6) M10 bolts (refer to callout **A** in ***Figure 7-14***) from the bottom of the frame. Remove EOAT from Robot.

7.8. BUS BAR LOAD AND SECURE EOAT

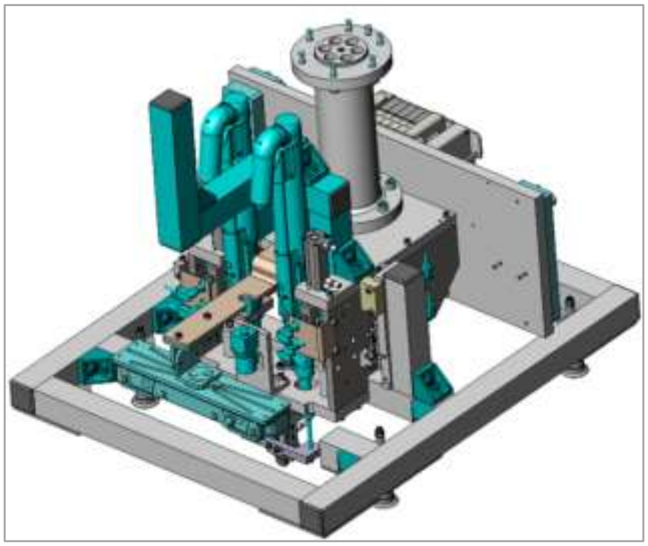

Figure 7-15. Bar Load and Secure End Of Arm Tool

Before disassembling the EOAT, disconnect all air and electrical connections.

7.8.1. Removing the EOAT from Robot

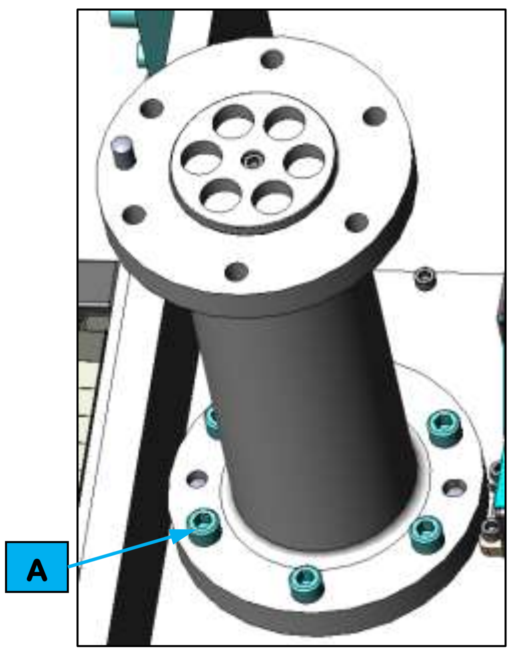

Figure 7-16. Removing the EOAT from Robot

While supporting the EOAT, remove the six (6) M10 bolts (refer to callout **A** in ***Figure 7-16***) from the top of the EOAT frame and Mounting Adapter Plate. Remove EOAT from Robot.

7.9. BUS BAR LOAD AND SECURE EOAT

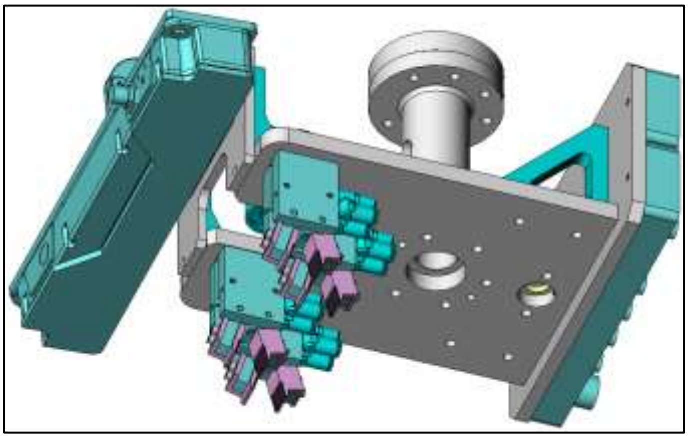

Figure 7-17. Bar Load and Secure End Of Arm Tool

Before disassembling the EOAT, disconnect all air and electrical connections.

7.9.1. Removing the EOAT from Robot

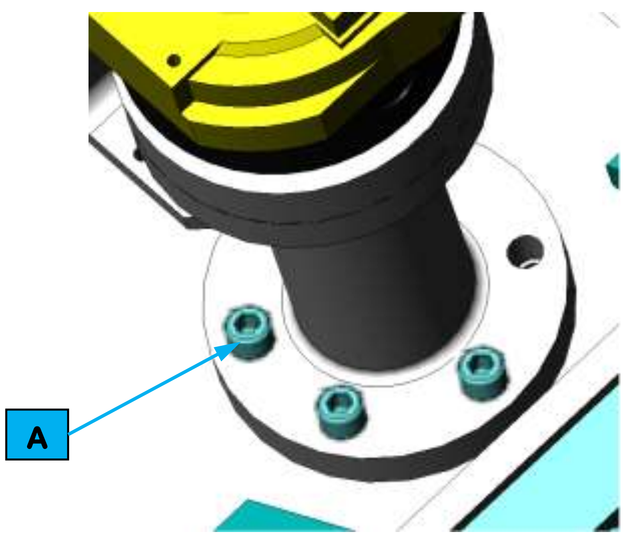

Figure 7-18. Removing the EOAT from Robot

While supporting the EOAT, remove the six (6) M10 bolts (refer to callout **A** in ***Figure 7-16***) from the top of the EOAT frame and Mounting Adapter Plate. Remove EOAT from Robot.

7.10. MIDPLATE LOAD EOAT

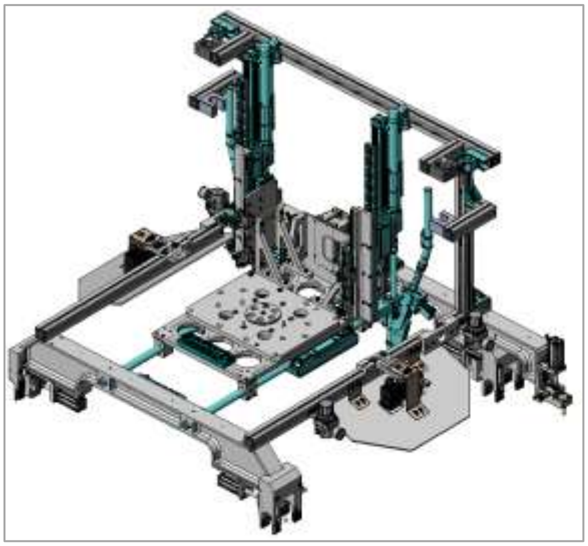

Figure 7-19. Midplate Load End Of Arm Tool

Before disassembling the EOAT, disconnect all air and electrical connections.

7.10.1. Removing the EOAT from Robot

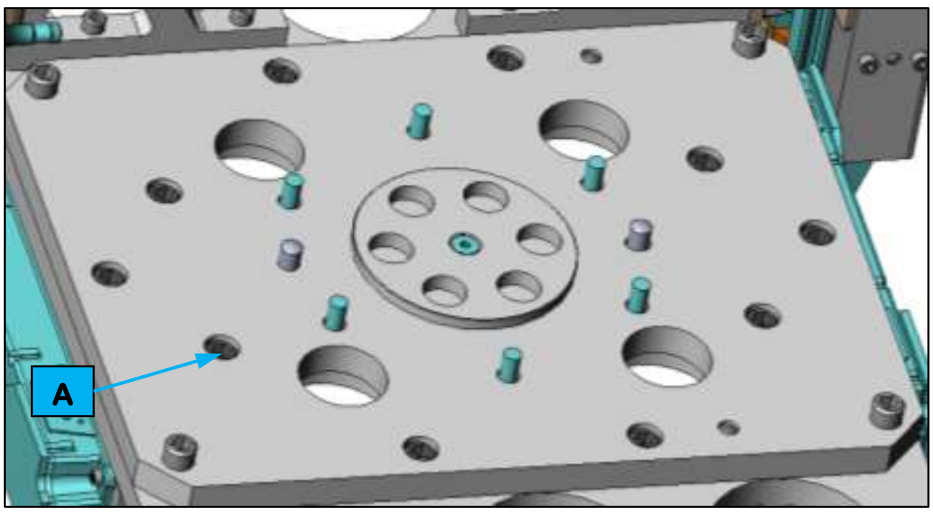

Figure 7-20. Removing the EOAT from Robot

While supporting the EOAT, remove the 10 M12 bolts (refer to callout **A** in ***Figure 7-20***) from the top of the EOAT frame and Mounting Adapter Plate. Remove EOAT from Robot.

7.11. MIDPLATE FASTEN EOAT

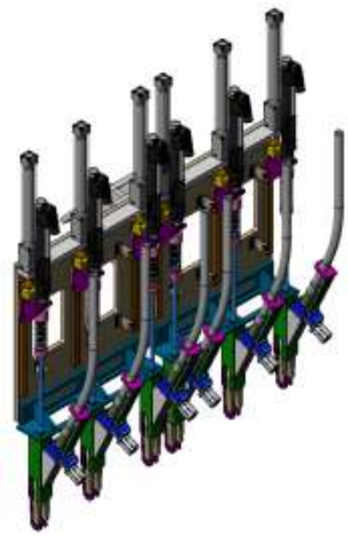

Figure 7-21. Midplate Fasten End Of Arm Tool

Before disassembling the EOAT, disconnect all air and electrical connections.

7.11.1. Removing the EOAT from Robot

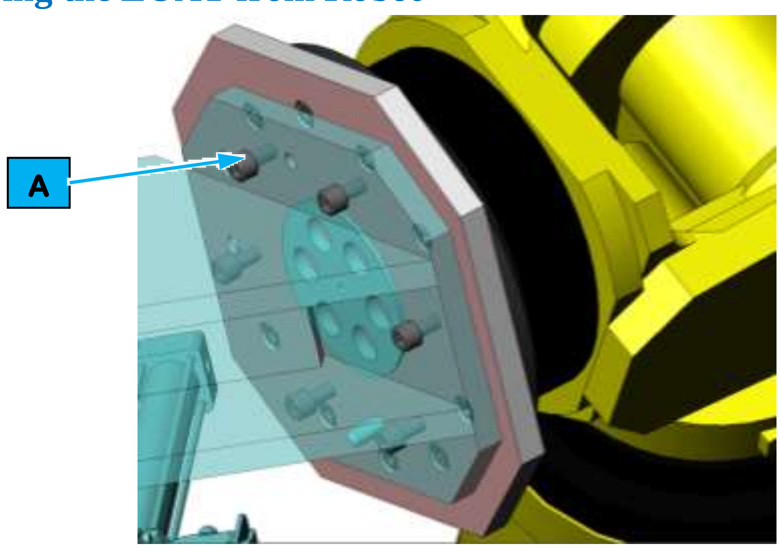

Figure 7-22. Removing the EOAT from Robot

While supporting the EOAT, remove the six (6) M10 bolts (refer to callout **A** in ***Figure 7-22***) from the bottom of the EOAT frame. Remove EOAT from Robot.

7.12. COVER LOAD EOAT

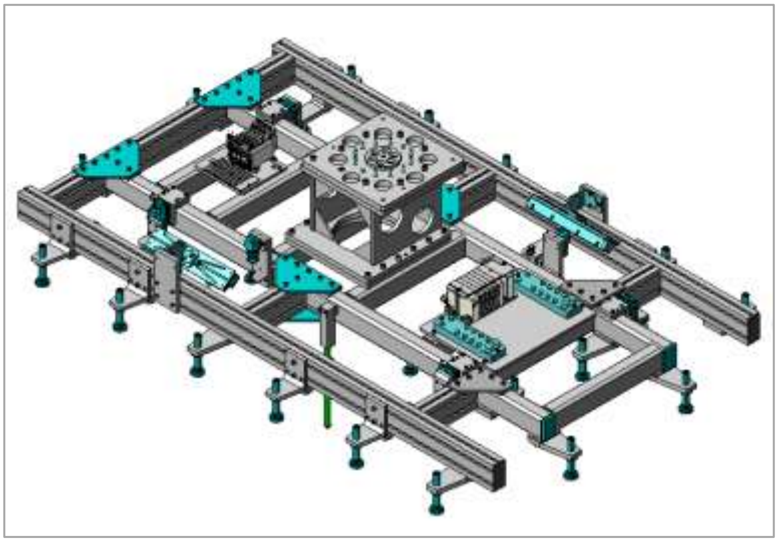

Figure 7-23. Cover Load End Of Arm Tool

Before disassembling the EOAT, disconnect all air and electrical connections.

7.12.1. Removing the EOAT from Robot

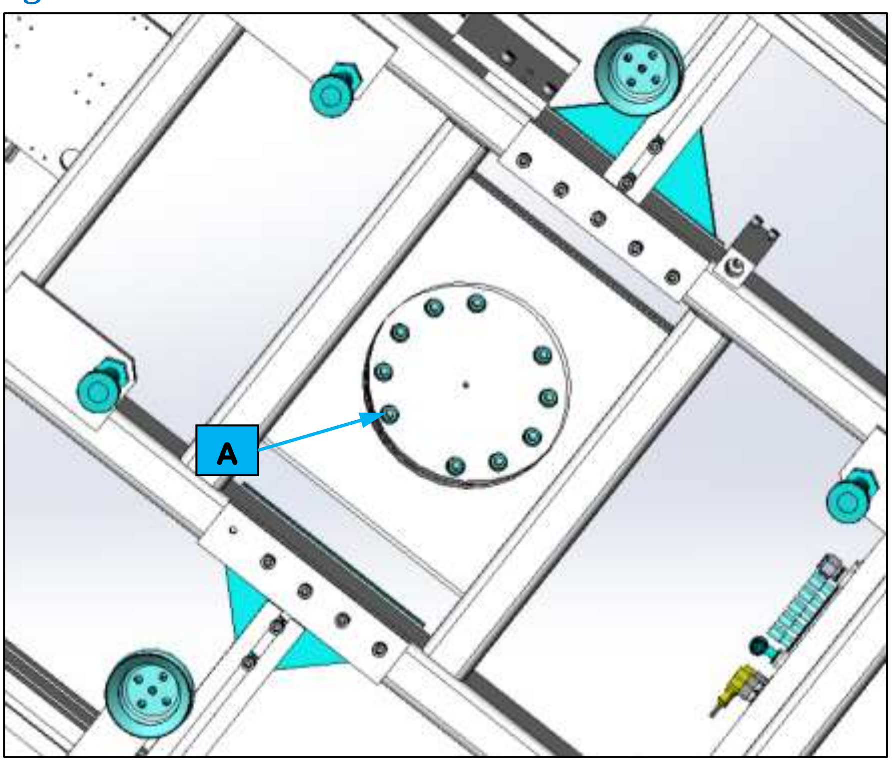

Figure 7-24. Remove EOAT from Robot

While supporting the EOAT, remove the ten (10) M10 bolts (refer to callout **A** in *Figure 7-24*) from the bottom of the EOAT support frame. Remove EOAT from Robot.

7.13. COVER SECURE EOAT

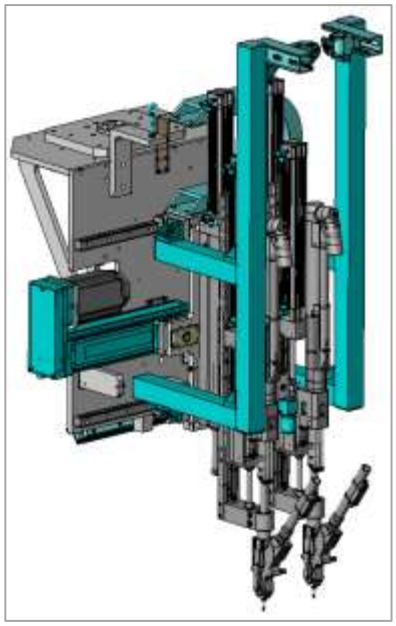

Figure 7-25. Cover Secure End Of Arm Tool

Before disassembling the EOAT, disconnect all air and electrical connections.

7.13.1. Removing the EOAT from Robot

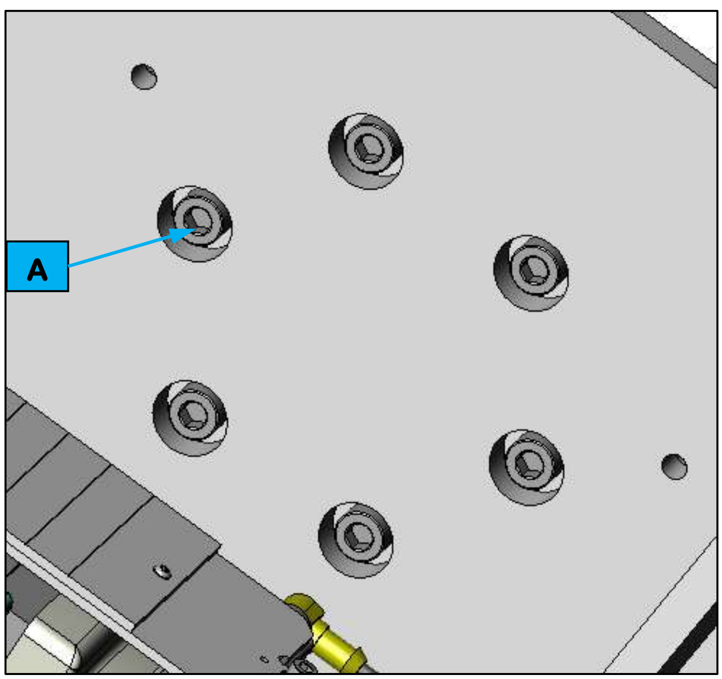

Figure 7-26. Remove EOAT from Robot

While supporting the EOAT, remove the six (6) M10 bolts (refer to callout **A** in *Figure 7-26*) from the back of the EOAT support frame. Remove EOAT from Robot.

7.14. COVER STANCHION SECURE EOAT

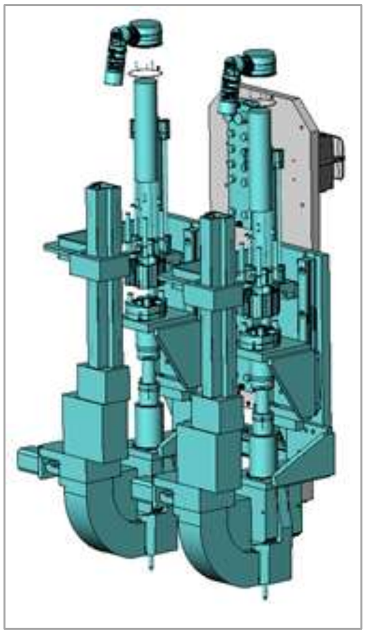

Figure 7-27. Cover Stanchion Secure End Of Arm Tool

Before disassembling the EOAT, disconnect all air and electrical connections.

7.14.1. Removing the EOAT from Robot

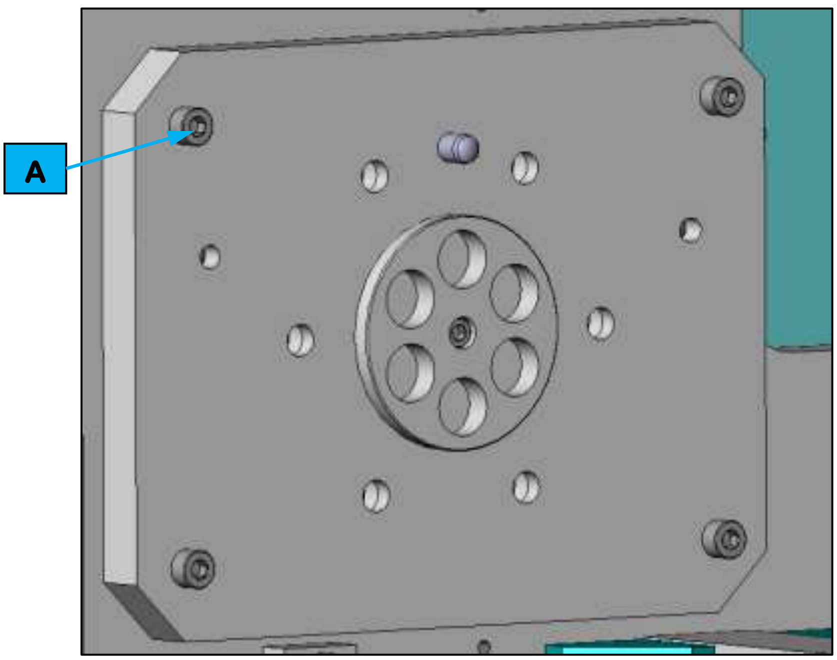

Figure 7-28. Remove EOAT from Robot

While supporting the EOAT, remove the four (4) M8 bolts (refer to callout **A** in ***Figure 7-28***) from the back of the EOAT support frame. Remove EOAT from Robot.

7.15. RTV DISPENSE EOAT

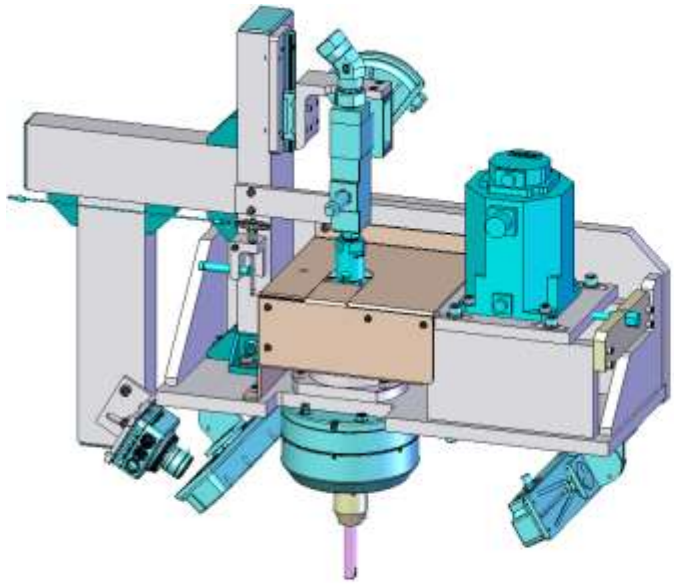

Figure 7-29. RTV dispense End Of Arm Tool

Before disassembling the EOAT, disconnect all air and electrical connections.

7.15.1. Removing the EOAT from Robot

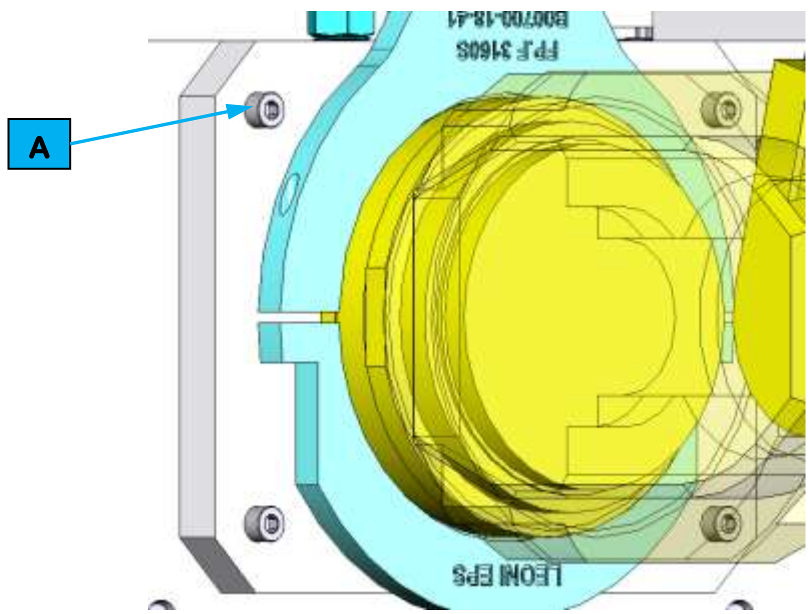

Figure 7-30. Remove EOAT from Robot

While supporting the EOAT, remove the four (4) M8 bolts (refer to callout **A** in ***Figure 7-30***) from the back of the EOAT support frame. Remove EOAT from Robot.

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.

If the shipping cover is removed the machine is not protected, the system must not be stored outside. Components that are not protected with long-term preservation against climatic influences can corrode and or wear down. Electrical cabinets and other electrical equipment are not rainproof.

8.2. COMMISSIONING

This section outlines procedures for installing the Pack Main 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 Pack Main Line. If the 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 Pack Main 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 Pack Main Line until the Line is fully assembled.

8.3. LIFTING POINTS

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

8.3.1. FANUC M-900 iB Robot Lifting

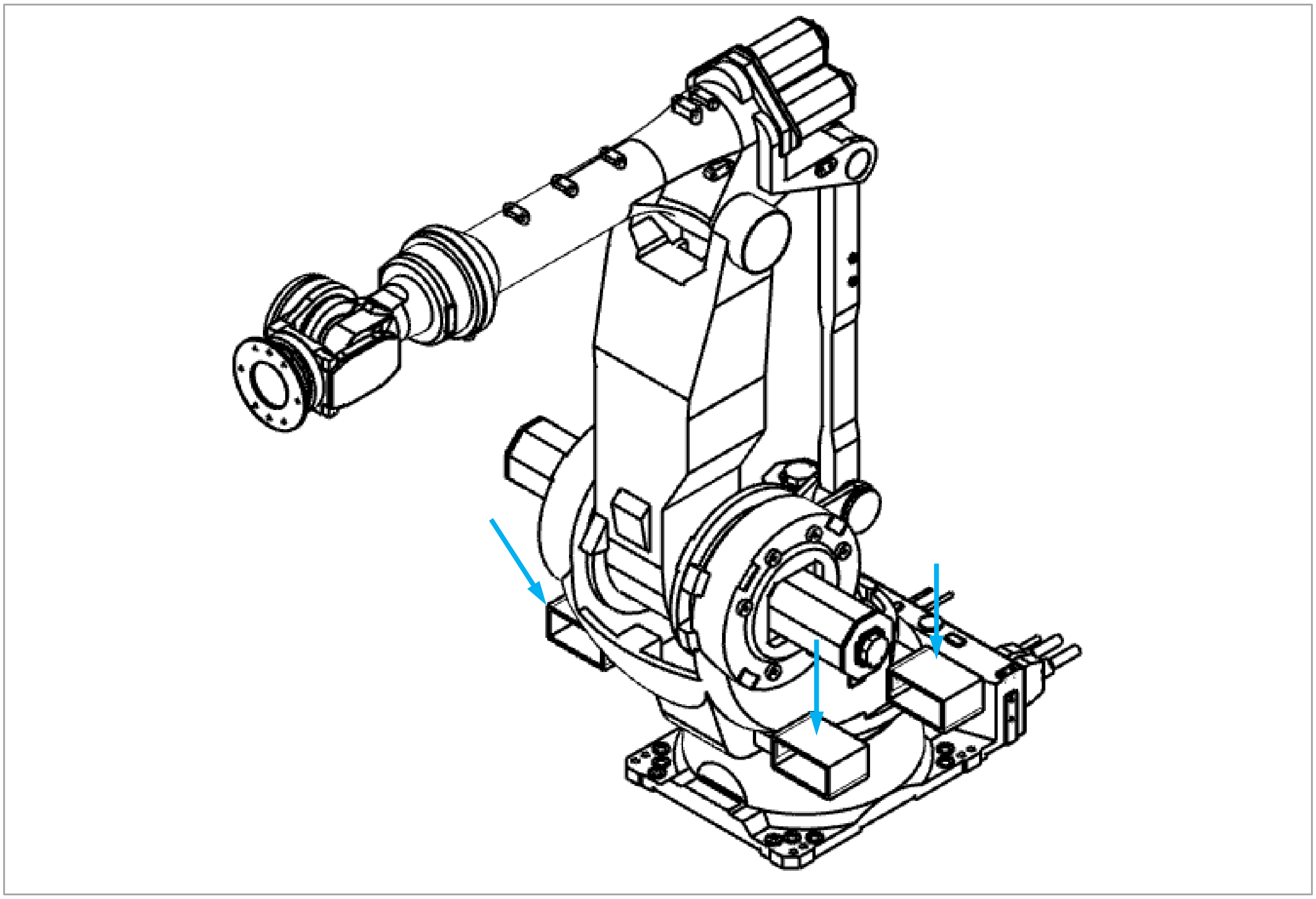

Figure 8-1. M-900 iB Lifting Points

REFERENCE	***For more information about lifting robot equipment, refer to the equipment supplier documentation (FANUC Robot M-900 iB Operator's Manual).***

8.3.2. FANUC M-2000iA Robot Lifting

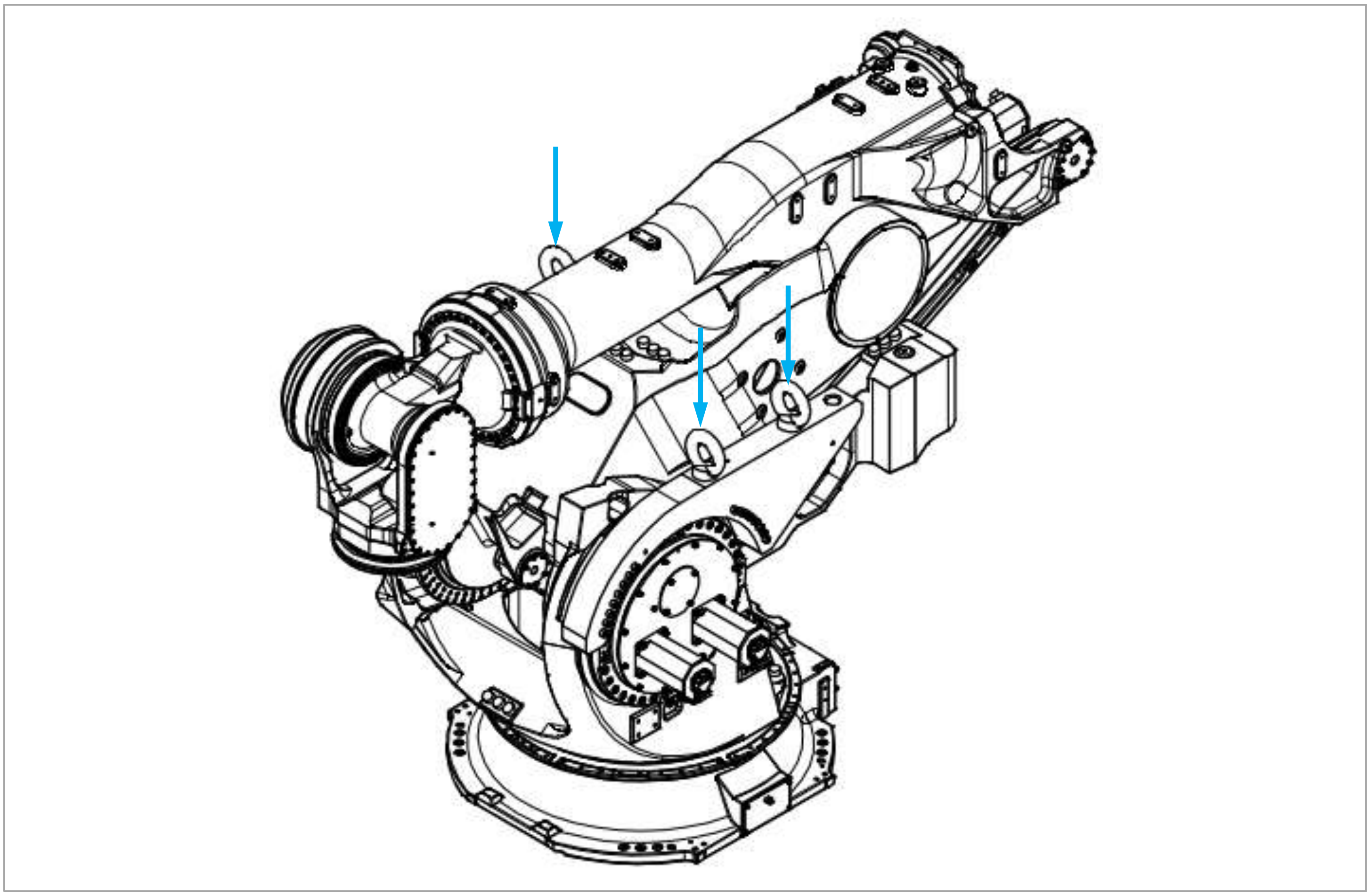

Figure 8-2. M-2000iA Lifting Points

REFERENCE

For more information about lifting robot equipment, refer to the equipment supplier documentation (FANUC Robot M-2000 iA Operator's Manual).

8.3.3. FANUC Robot R-2000 iC Robot Lifting

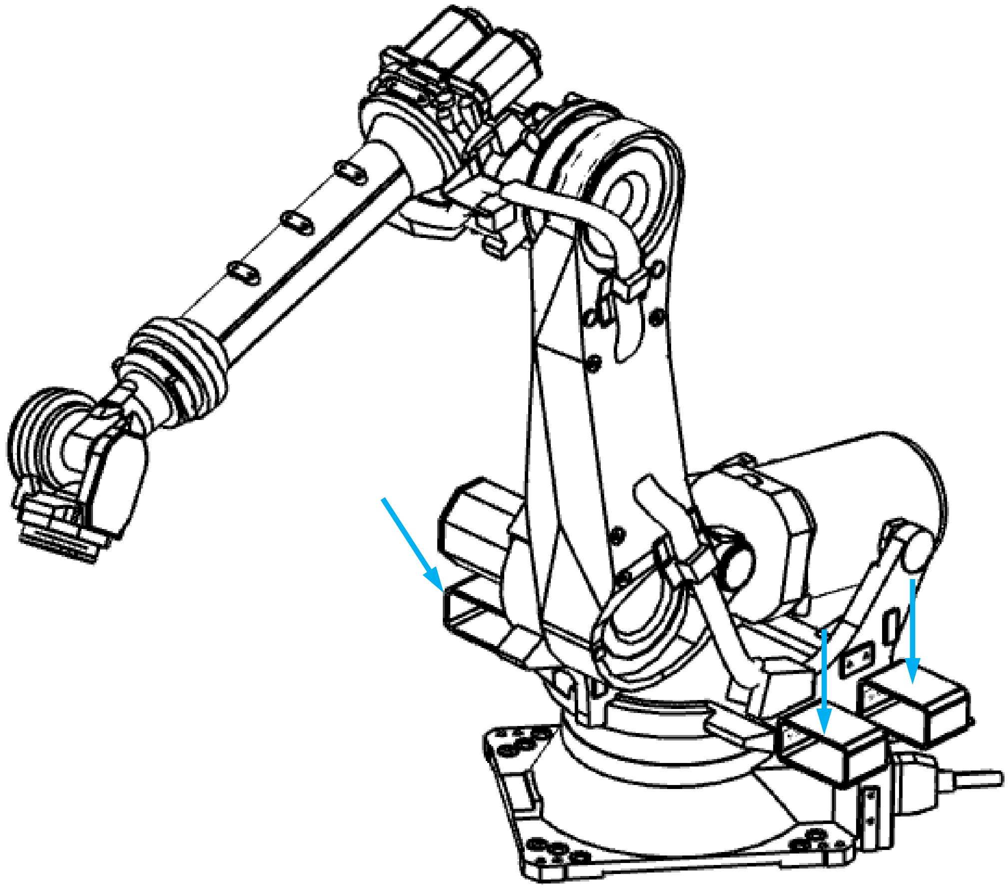

Figure 8-3. R-2000 iC Lifting Points

REFERENCE	***For more information about lifting robot equipment, refer to the equipment supplier documentation (FANUC Robot R-2000 iC Operator's Manual).***

8.3.1. PDP / Cabinet Lifting

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

Figure 8-4. PDP lifting points.

8.3.2. Programming Terminal Lifting

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

Figure 8-5. Programming terminal lifting points.

8.4. PACK MAIN LINE UTILITIES

The Pack Main Line has the following utility requirements:

8.4.1. Pack Main Line Utilities – Automated Stations

		020	100	120	230	300	320	380	400	480	620	630	640	720
Compressed Air Supply	Air Pressure (PSI)	60	60	60	60	60	60	60	60	60	60	60	60	60
	Max CFM	105	105	105	105	105	105	105	105	105	105	105	105	105
	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"	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	See cell 100	100	100	See cell 300	100	See cell 380	100	200	See Cell 620	See Cell 620	See Cell 620

8.4.2. Pack Main Line Utilities – Manual Stations

<table>
<tr><th colspan="2"></th><th>040</th><th>060</th><th>080</th><th>090</th><th>125</th><th>160</th><th>180</th><th>200</th><th>220</th><th>235</th><th>240</th><th>260</th><th>270</th><th>280</th><th>325</th><th>340</th><th>420</th><th>485</th><th>500</th><th>520</th><th>540</th><th>560</th><th>580</th><th>600</th><th>610</th><th>650</th><th>660</th><th>680</th><th>700</th><th>905</th></tr>
<tr><td rowspan="3">Compressed Air Supply</td><td>Air Pressure (PSI)</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td><td>60</td></tr>
<tr><td>Max CFM</td><td>105</td><td>105</td><td>105</td><td>105</td><td>105</td><td>105</td><td>105</td><td>105</td><td>105</td><td>105</td><td>105</td><td>105</td><td>105</td><td>105</td><td>105</td><td>105</td><td>105</td><td>105</td><td>105</td><td>105</td><td>105</td><td>105</td><td>105</td><td>105</td><td>105</td><td>105</td><td>105</td><td>105</td><td>105</td><td>105</td></tr>
<tr><td>Supply Pipe Size</td><td>1.5"</td><td>1.5"</td><td>1.5"</td><td>1.5"</td><td>1.5"</td><td>1.5"</td><td>1.5"</td><td>1.5"</td><td>1.5"</td><td>1.5"</td><td>1.5"</td><td>1.5"</td><td>1.5"</td><td>1.5"</td><td>1.5"</td><td>1.5"</td><td>1.5"</td><td>1.5"</td><td>1.5"</td><td>1.5"</td><td>1.5"</td><td>1.5"</td><td>1.5"</td><td>1.5"</td><td>1.5"</td><td>1.5"</td><td>1.5"</td><td>1.5"</td><td>1.5"</td><td>1.5"</td></tr>
<tr><td rowspan="3">Electrical Supply</td><td>Equipment Volts</td><td>480</td><td>480</td><td>480</td><td>480</td><td>480</td><td>480</td><td>480</td><td>480</td><td>480</td><td>480</td><td>480</td><td>480</td><td>480</td><td>480</td><td>480</td><td>480</td><td>480</td><td>480</td><td>480</td><td>480</td><td>480</td><td>480</td><td>480</td><td>480</td><td>480</td><td>480</td><td>480</td><td>480</td><td>480</td><td>480</td></tr>
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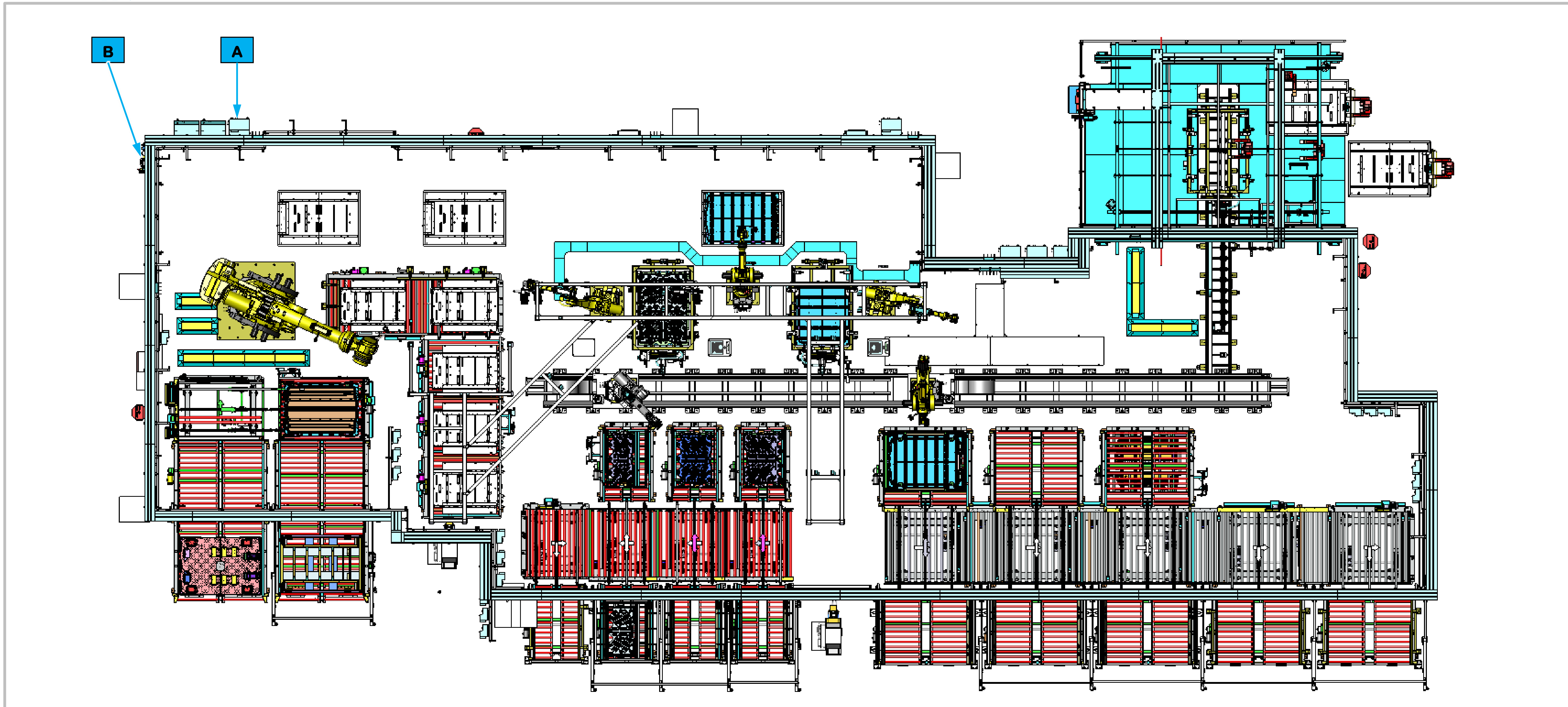
8.5. PACK MAIN LINE CONNECTION POINTS

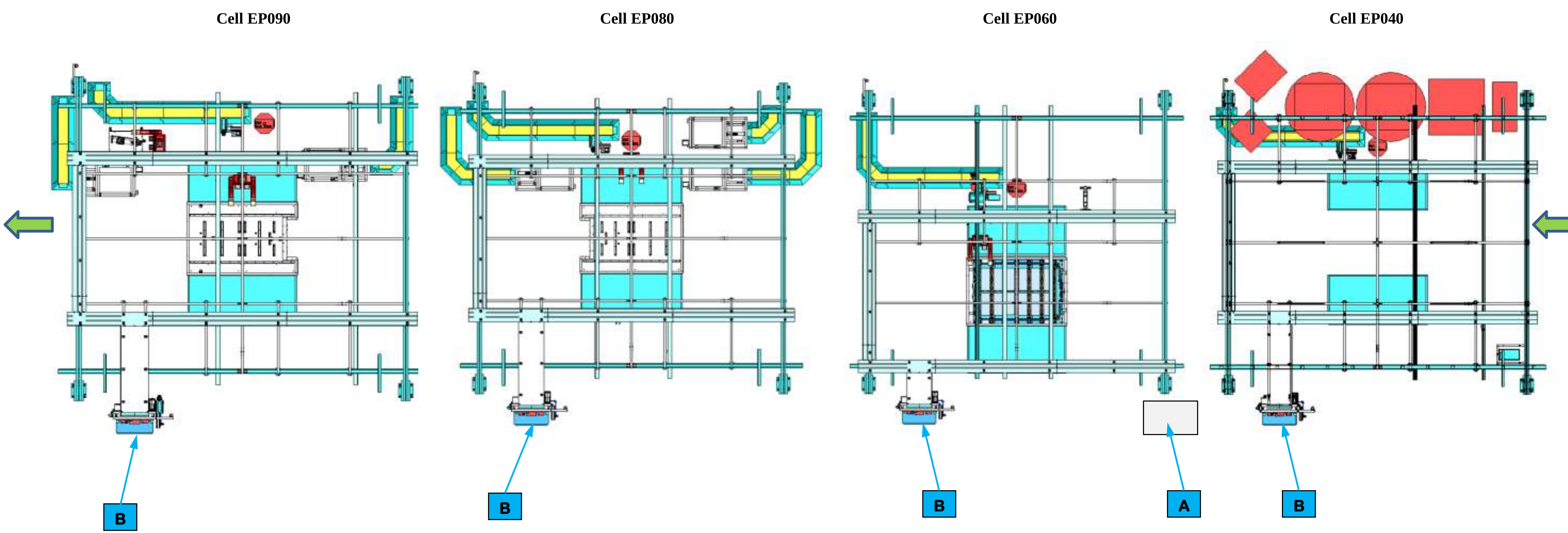
8.5.1. Supply Connection Points for Cells EP020 and EP720



Supply Connection Callouts in Figure 8-6					
A	Electrical Supply	480 Volt 3 Phase AC 100 Amps	B	Compressed Air Supply	60 PSI 105 Max CFM

Figure 8-6. Cells EP020 and EP720 Supply Connection Locations.

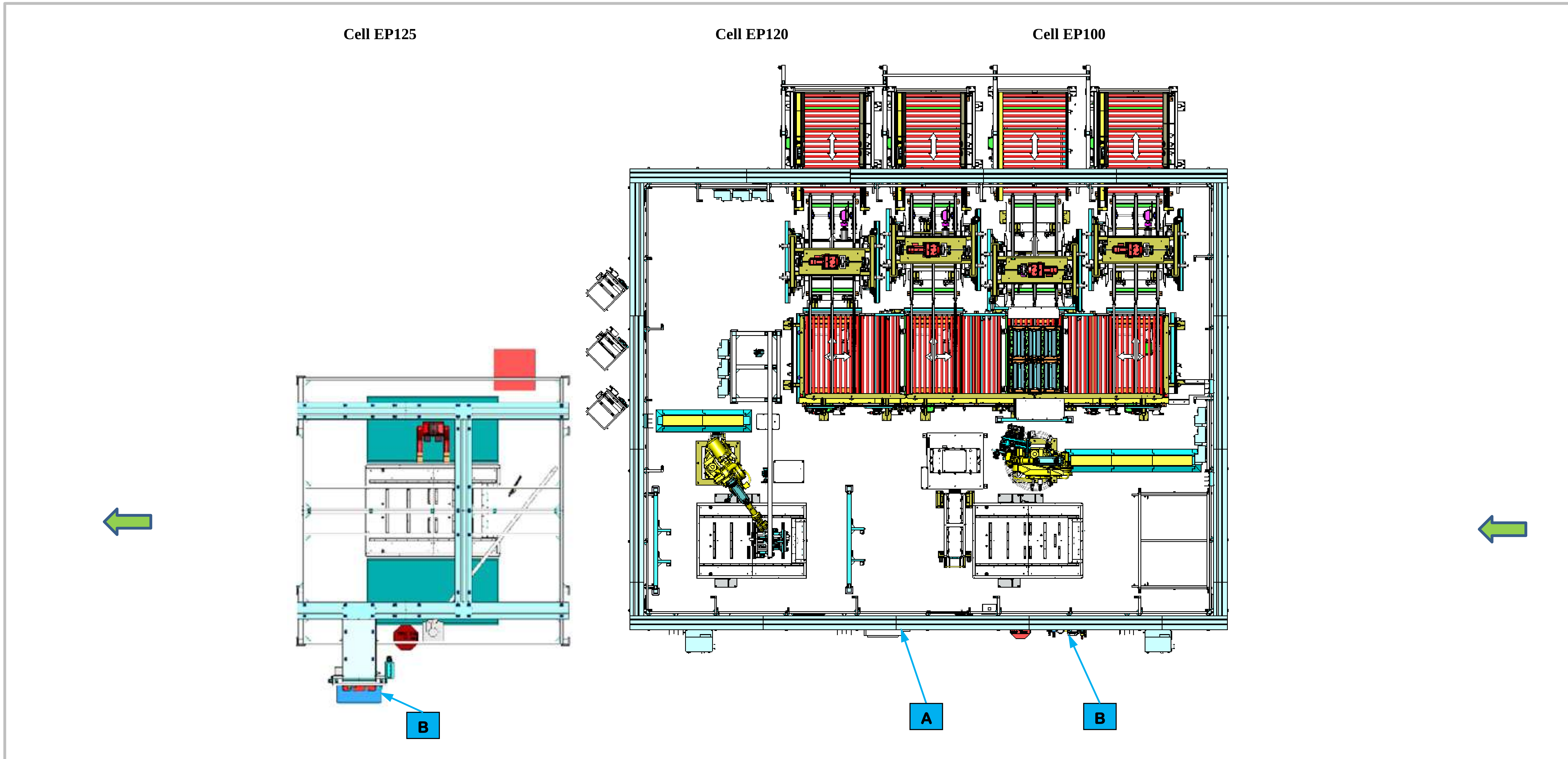
8.5.2. Supply Connection Points for Cells EP040, EP060, and EP080



Supply Connection Callouts in Figure 8-7					
A	Electrical Supply	480 Volt 3 Phase AC 100 Amps	B	Compressed Air Supply	60 PSI 105 Max CFM

Figure 8-7. Cells EP040, EP060, and EP080 Supply Connection Locations.

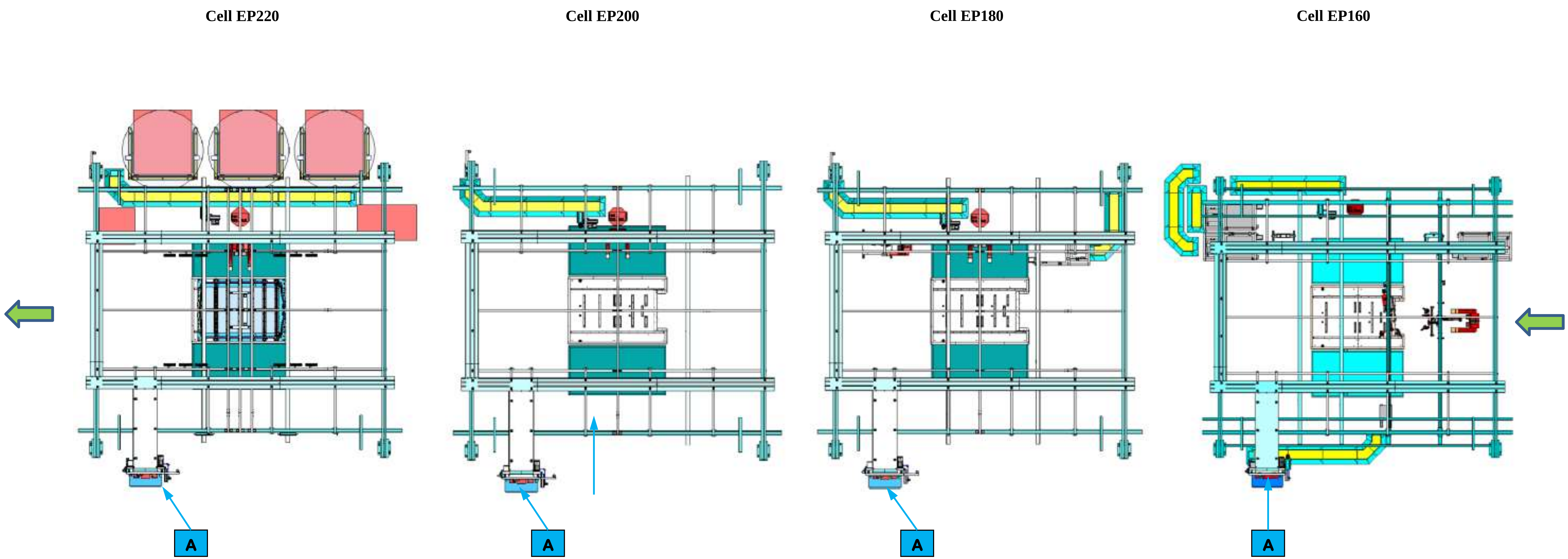
8.5.3. Supply Connection Points for Cells EP100, EP120, and EP125



Supply Connection Callouts in Figure 8-8					
A	Electrical Supply	480 Volt 3 Phase AC 100 Amps	B	Compressed Air Supply	60 PSI 105 Max CFM

Figure 8-8. Cells EP100, EP120, and EP125 Supply Connection Locations.

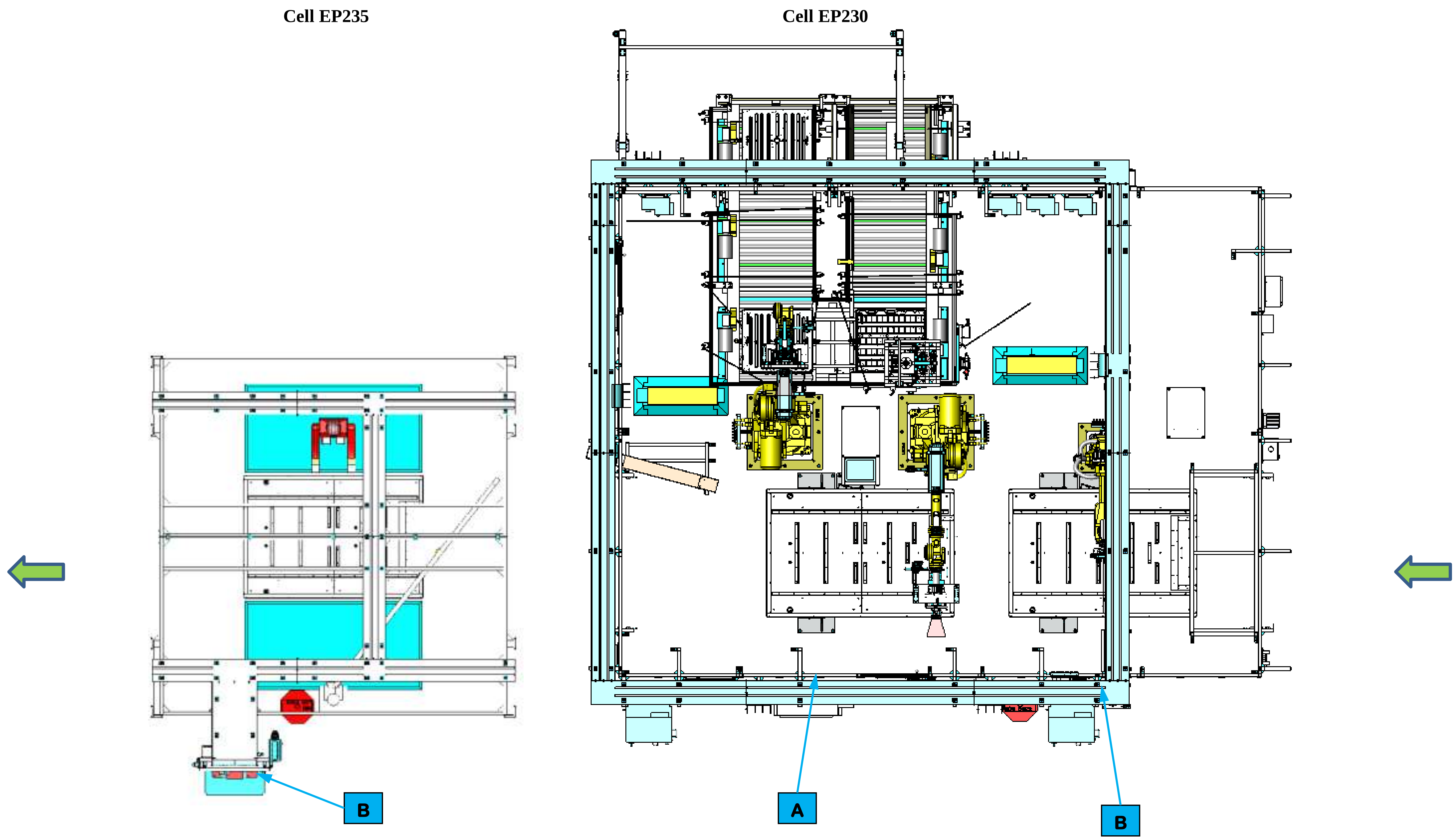
8.5.4. Supply Connection Points for Cells EP160, EP180, EP200, and EP220



Supply Connection Callouts in Figure 8-9		
A	Compressed Air Supply	60 PSI 105 Max CFM

Figure 8-9. Cells EP160, EP180, EP200, and EP220 Supply Connection Locations.

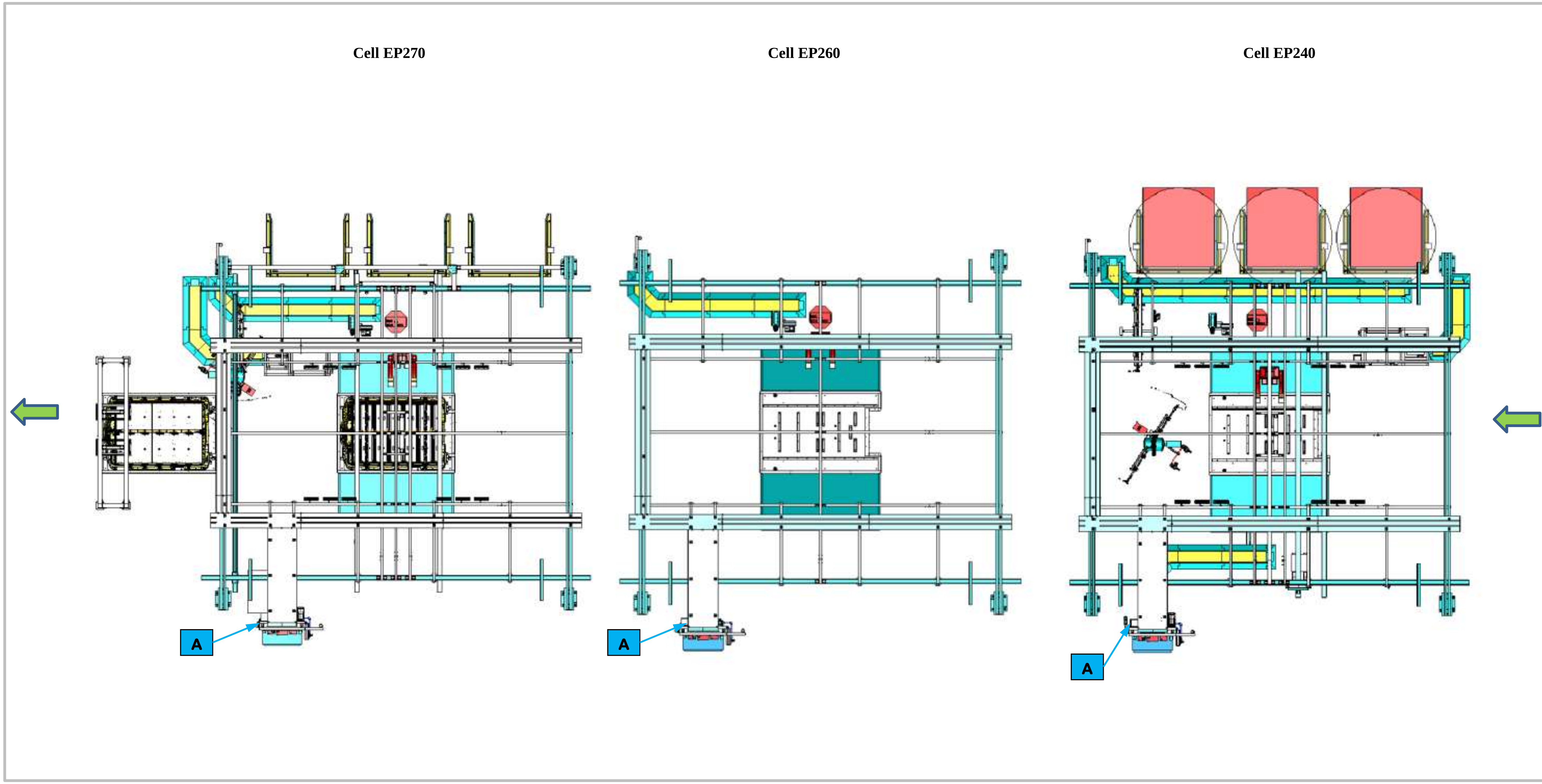
8.5.5. Supply Connection Points for Cells EP230 and EP235



Supply Connection Callouts in Figure 8-10					
A	Electrical Supply	480 Volt 3 Phase AC 100 Amps	B	Compressed Air Supply	60 PSI 105 Max CFM

Figure 8-10. Cells EP230 and EP235 Supply Connection Locations.

8.5.6. Supply Connection Points for Cells EP240 and EP260

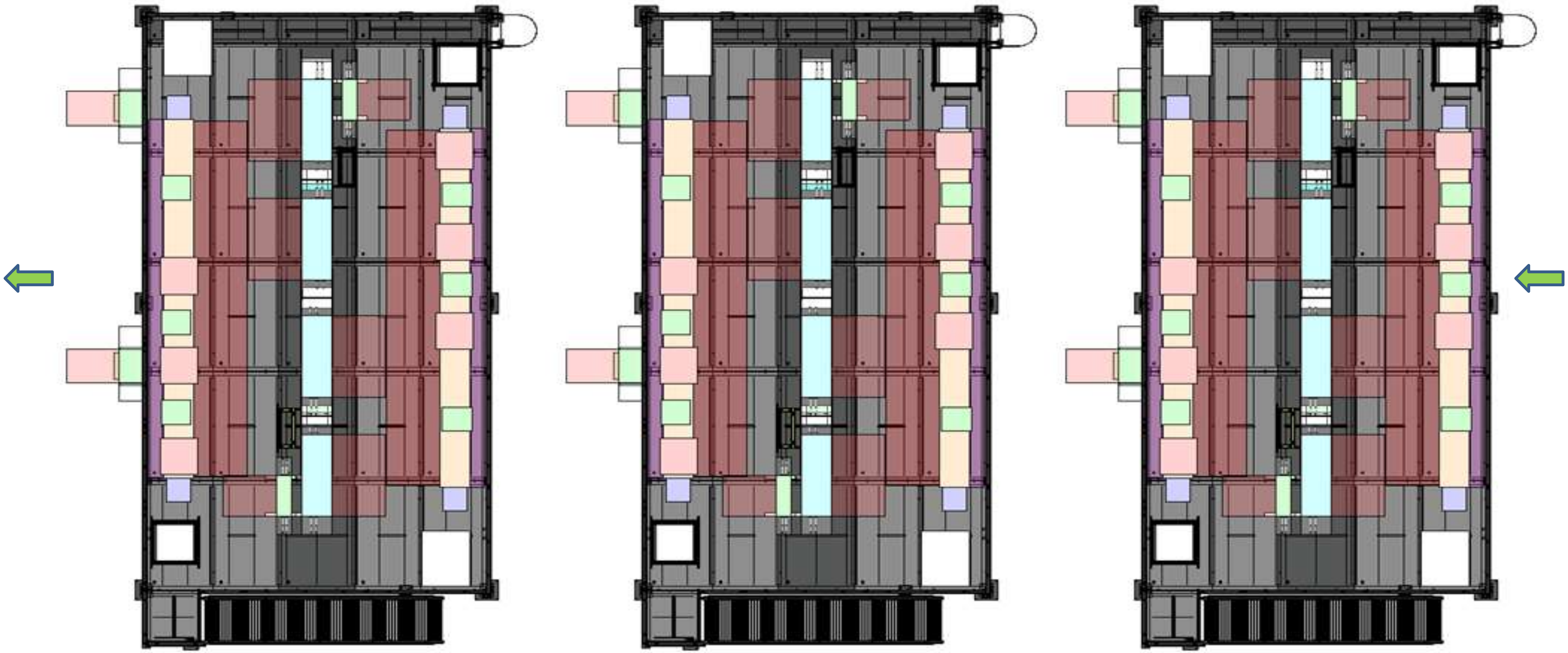


Supply Connection Callouts in Figure 8-11		
A	Compressed Air Supply	60 PSI 105 Max CFM

Figure 8-11. Cells EP240 and EP260 Supply Connection Locations.

8.5.7. Supply Connection Points for Cell EP280

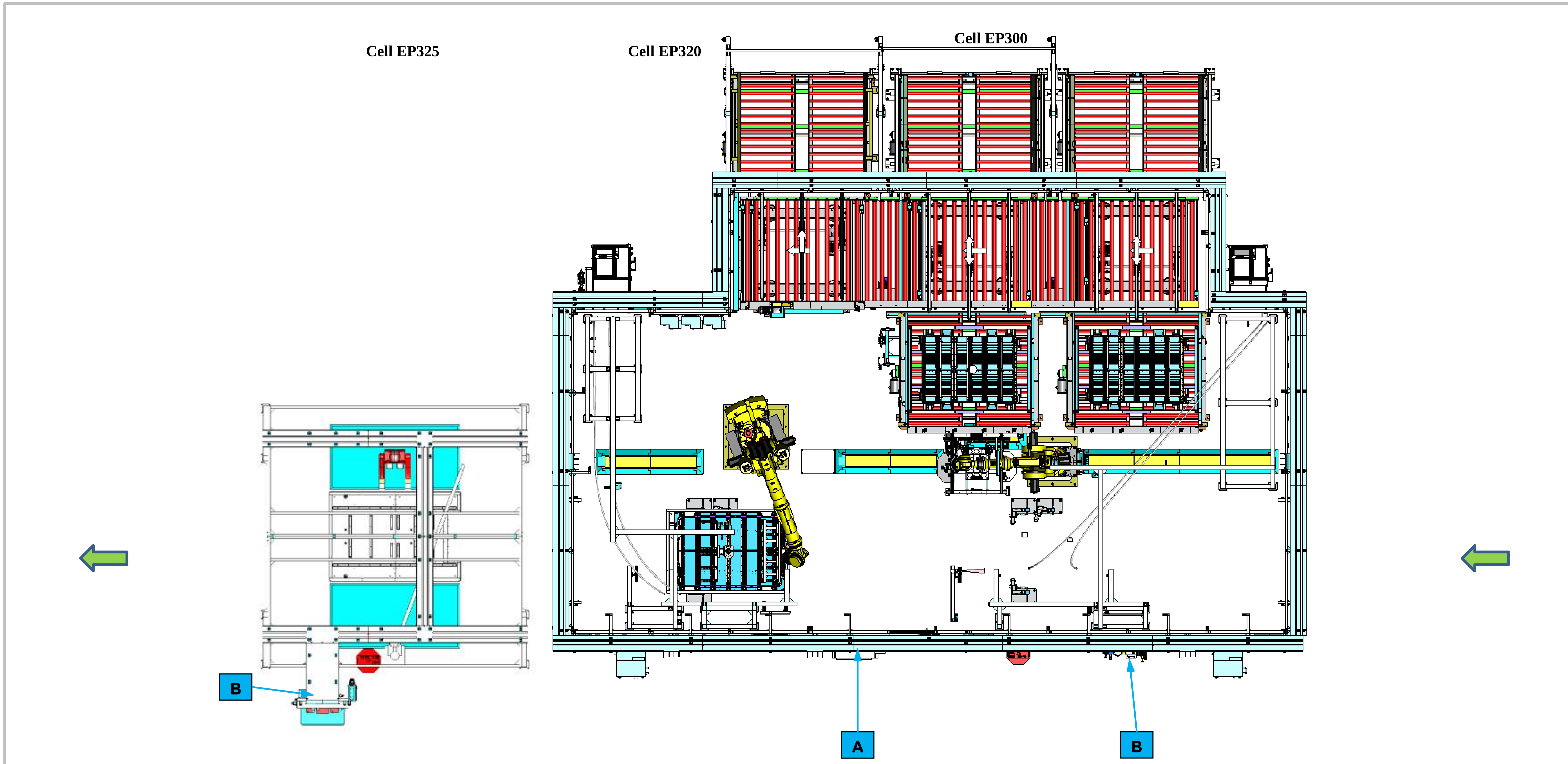
Cell EP280



For information regarding supply connections located in Cell 280, refer to *Battery Pack Test and Cover Leak Test Operation and Maintenance Manual*

Figure 8-12. Cell EP280 Supply Connection Locations.

8.5.8. Supply Connection Points for Cells EP300, EP320, and EP325

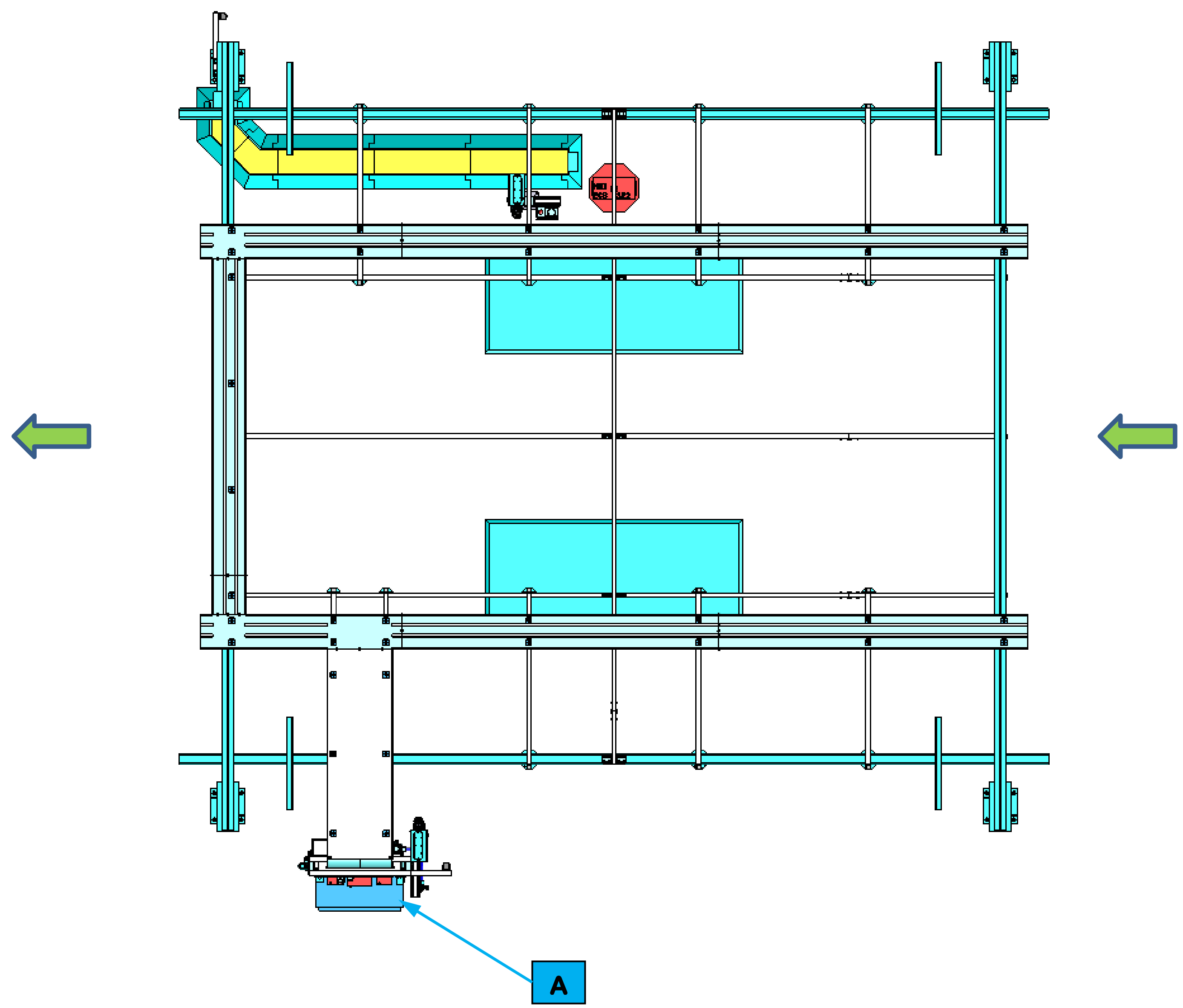


Supply Connection Callouts in Figure 8-13					
A	Electrical Supply	480 Volt 3 Phase AC 100 Amps	B	Compressed Air Supply	60 PSI 105 Max CFM

Figure 8-13. Cells EP300, EP320, and EP325 Supply Connection Locations.

Supply Connection Points for Cell EP340

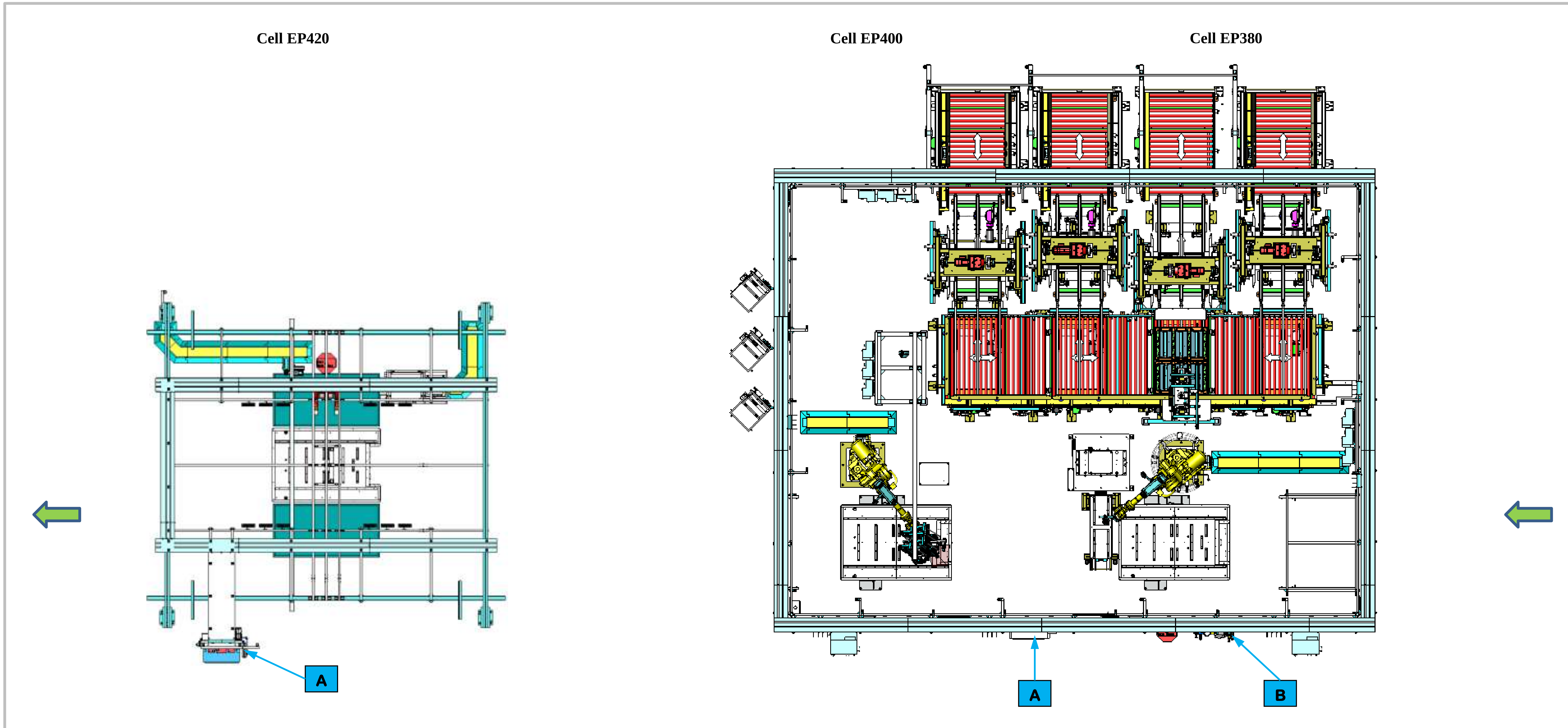
Cell EP340



Supply Connection Callouts in Figure 8-14		
A	Compressed Air Supply	60 PSI 105 Max CFM

Figure 8-14. Cell EP340 Supply Connection Locations.

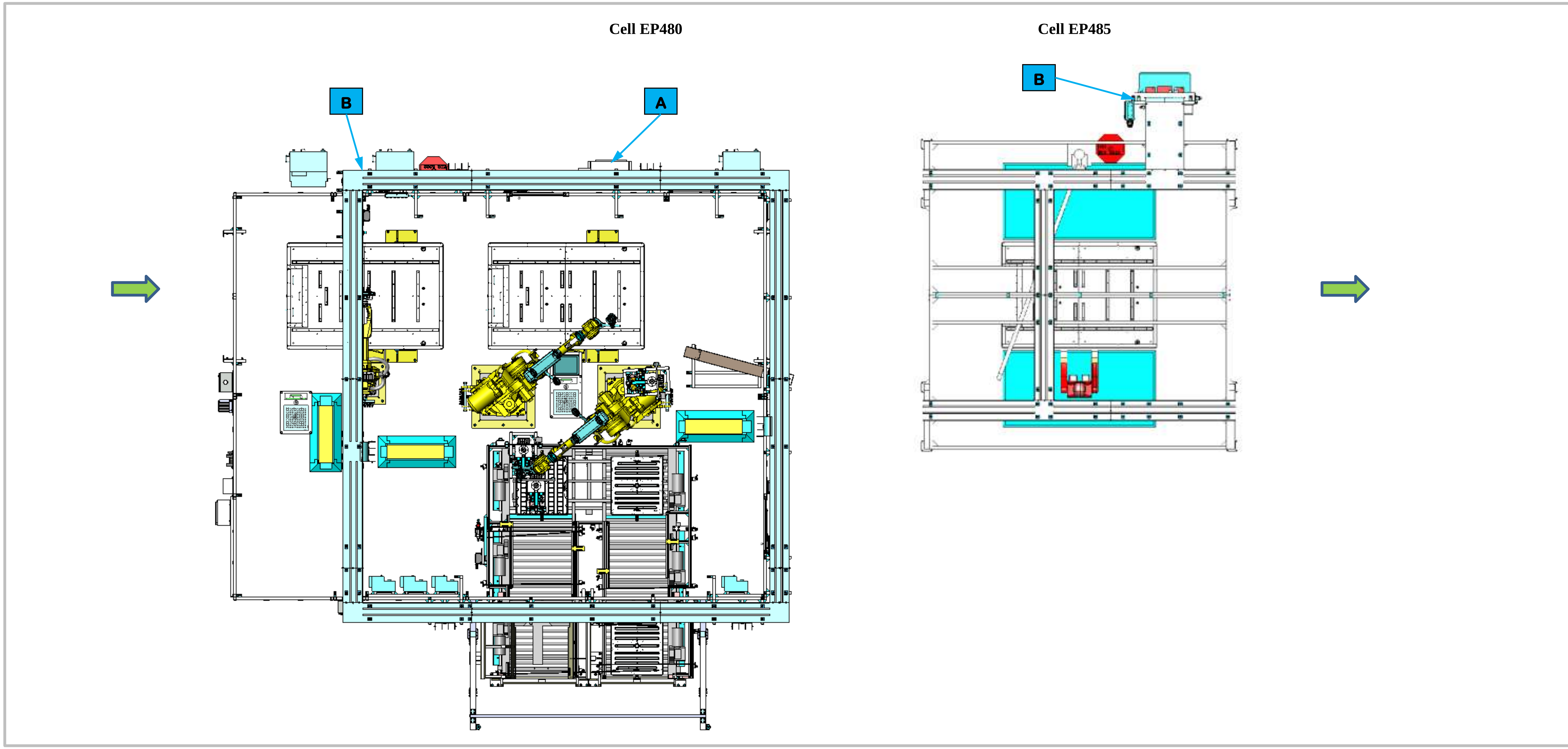
8.5.9. Supply Connection Points for Cells EP380, EP400, and EP420



Supply Connection Callouts in Figure 8-15					
A	Electrical Supply	480 Volt 3 Phase AC 100 Amps	B	Compressed Air Supply	60 PSI 105 Max CFM

Figure 8-15. Cells EP380, EP400, and EP420 Supply Connection Locations.

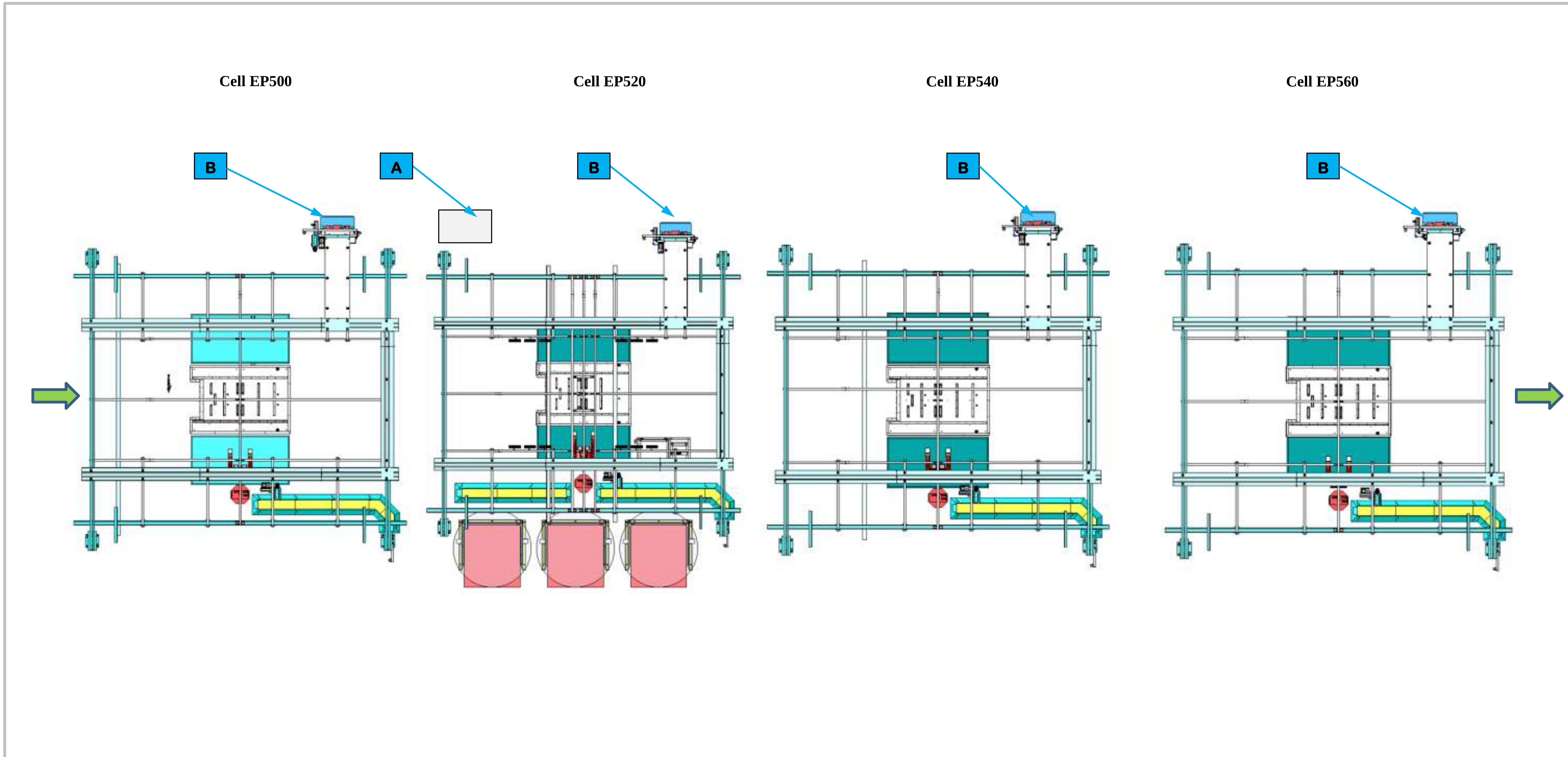
8.5.10. Supply Connection Points for Cells EP480 and EP485



Supply Connection Callouts in Figure 8-16					
A	Electrical Supply	480 Volt 3 Phase AC 100 Amps	B	Compressed Air Supply	60 PSI 105 Max CFM

Figure 8-16. Cells EP480 and EP485 Supply Connection Locations.

8.5.11. Supply Connection Points for Cells EP500, EP520, EP540, and EP560

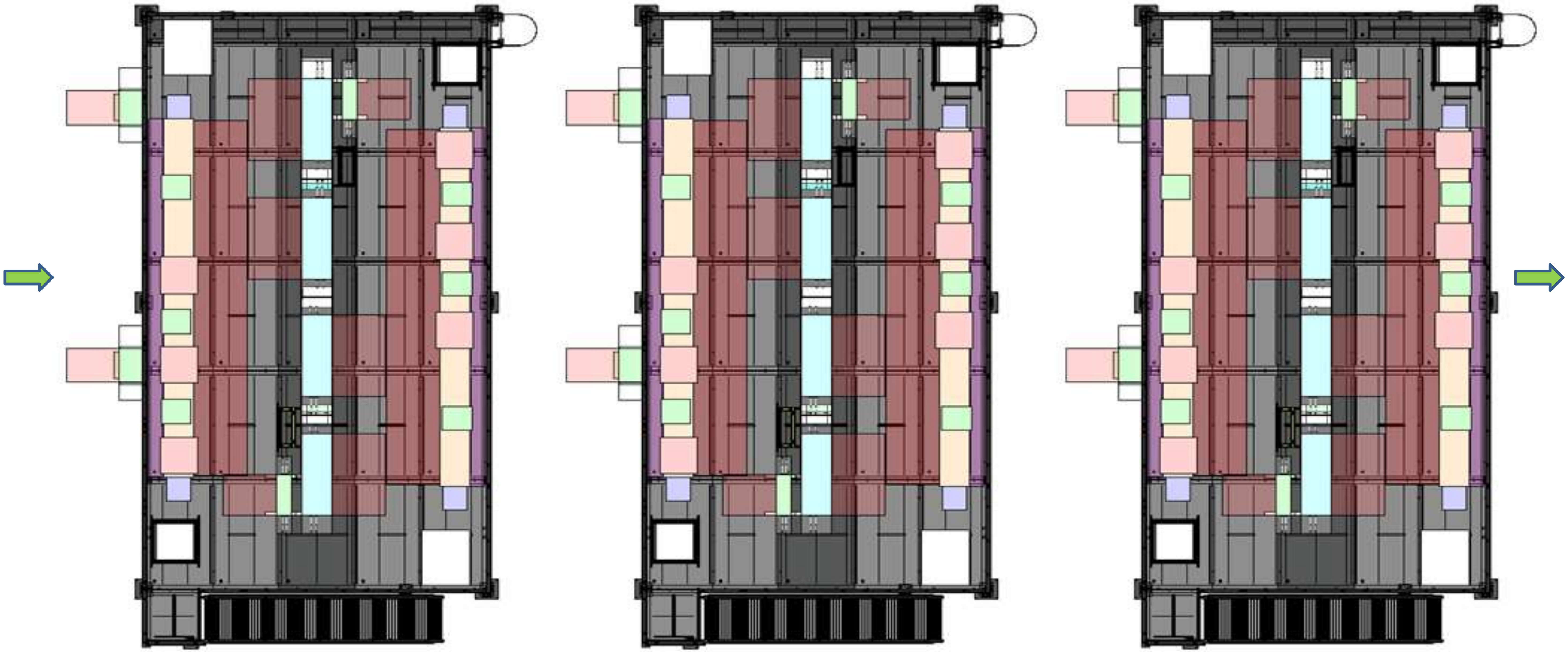


Supply Connection Callouts in Figure 8-7					
A	Electrical Supply	480 Volt 3 Phase AC 100 Amps	B	Compressed Air Supply	60 PSI 105 Max CFM

Figure 8-17. Cells EP500, EP520, EP540, and EP560 Supply Connection Locations.

8.5.12. Supply Connection Points for Cell EP580

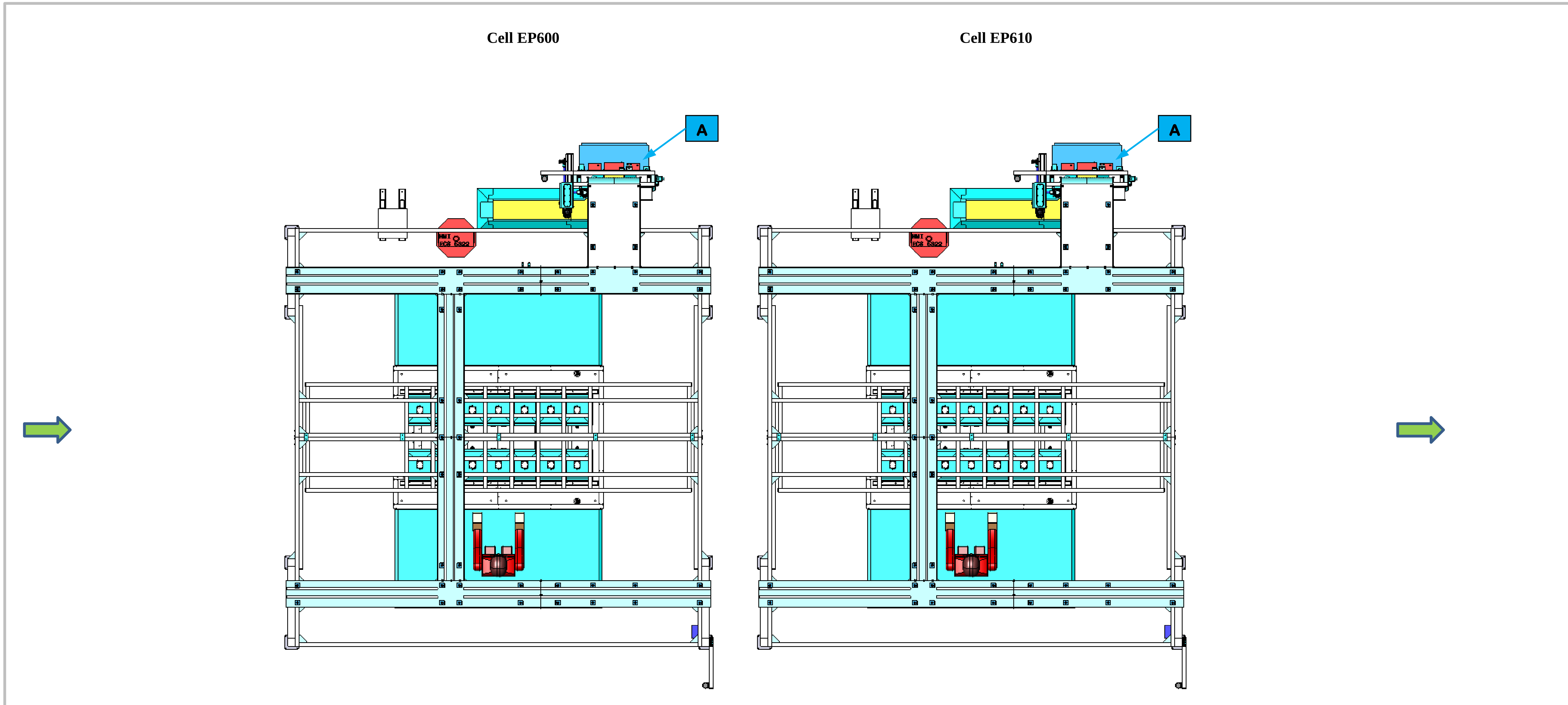
Cell EP580



For information regarding supply connections located in Cell 580, refer to *Battery Pack Test and Cover Leak Test Operation and Maintenance Manual*

Figure 8-18. Cell EP580 Supply Connection Locations.

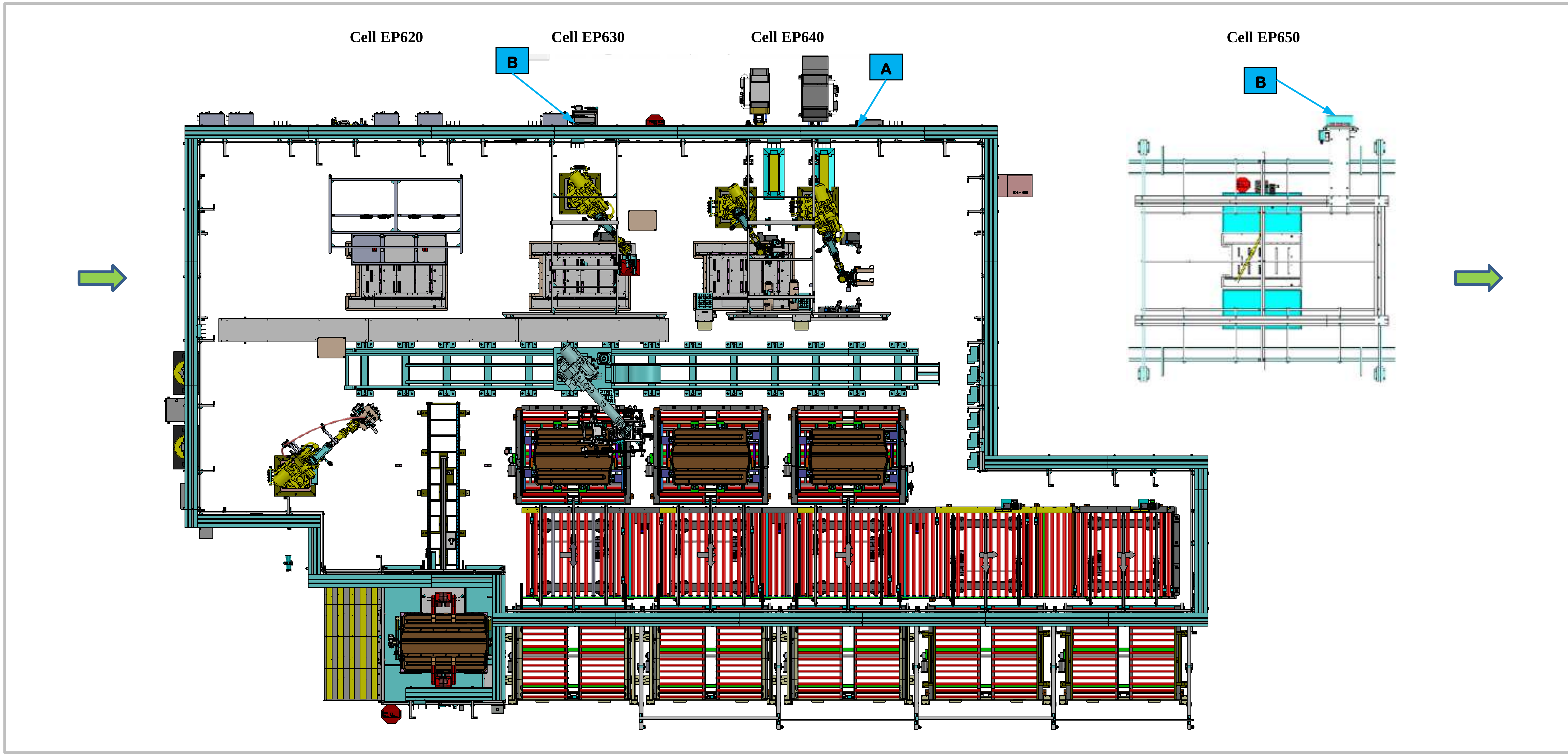
8.5.13. Supply Connection Points for Cells EP600, and EP610



Supply Connection Callouts in Figure 8-19		
A	Compressed Air Supply	60 PSI 105 Max CFM

Figure 8-19. Cells EP600, and EP610 Supply Connection Locations.

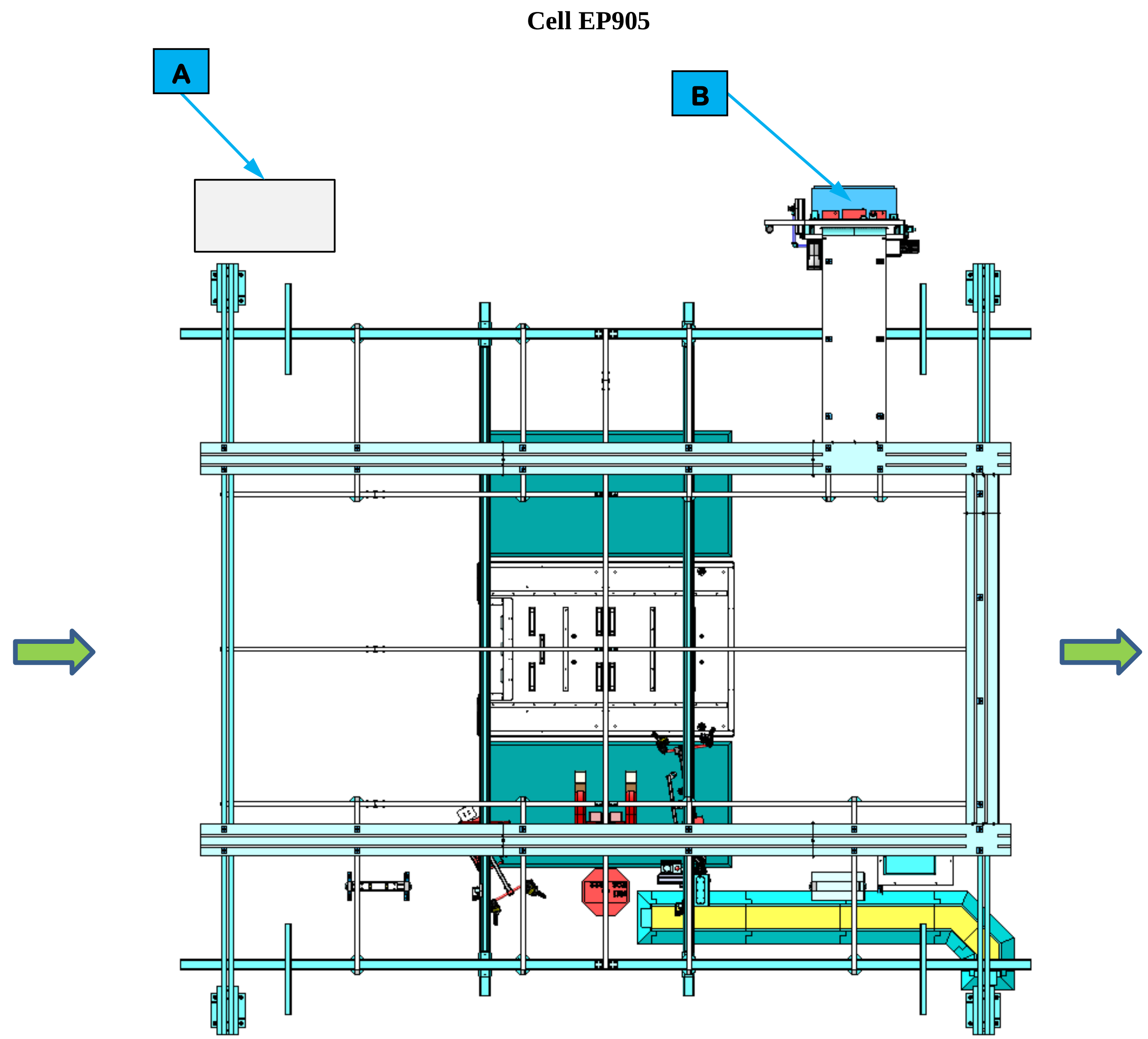
8.5.14. Supply Connection Points for Cells EP620, EP630, EP640, and EP650



Supply Connection Callouts in Figure 8-20					
A	Electrical Supply	480 Volt 3 Phase AC 200 Amps	B	Compressed Air Supply	60 PSI 105 Max CFM

Figure 8-20. Cells EP620, EP630, EP640, and EP650 Supply Connection Locations.

8.5.15. Supply Connection Points for Cell EP660

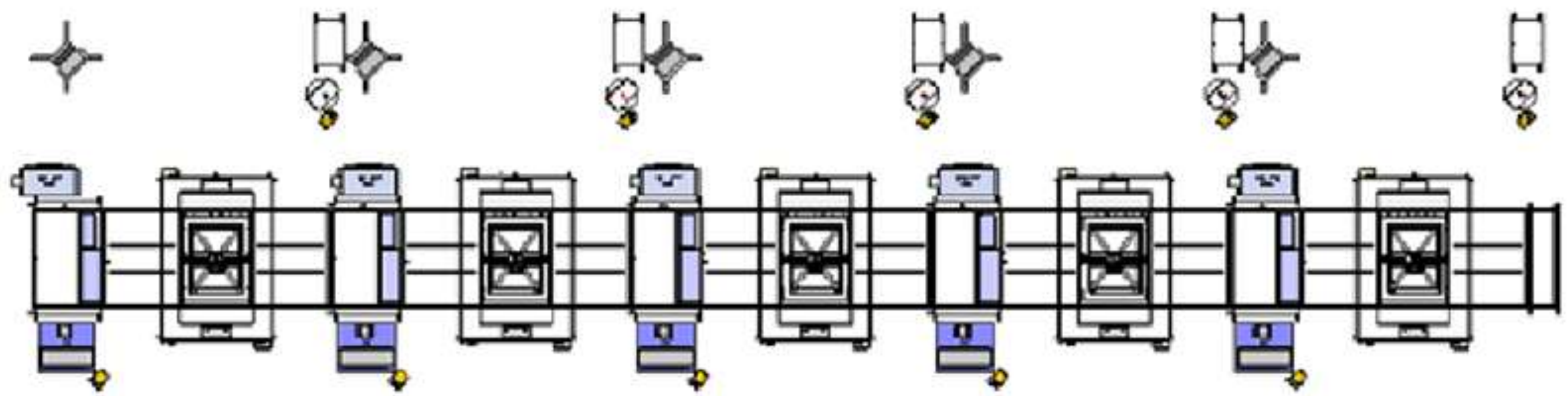


Supply Connection Callouts in Figure 8-21					
A	Electrical Supply	480 Volt 3 Phase AC 60 Amps	B	Compressed Air Supply	60 PSI 105 Max CFM

Figure 8-21. Cell EP660 Supply Connection Locations.

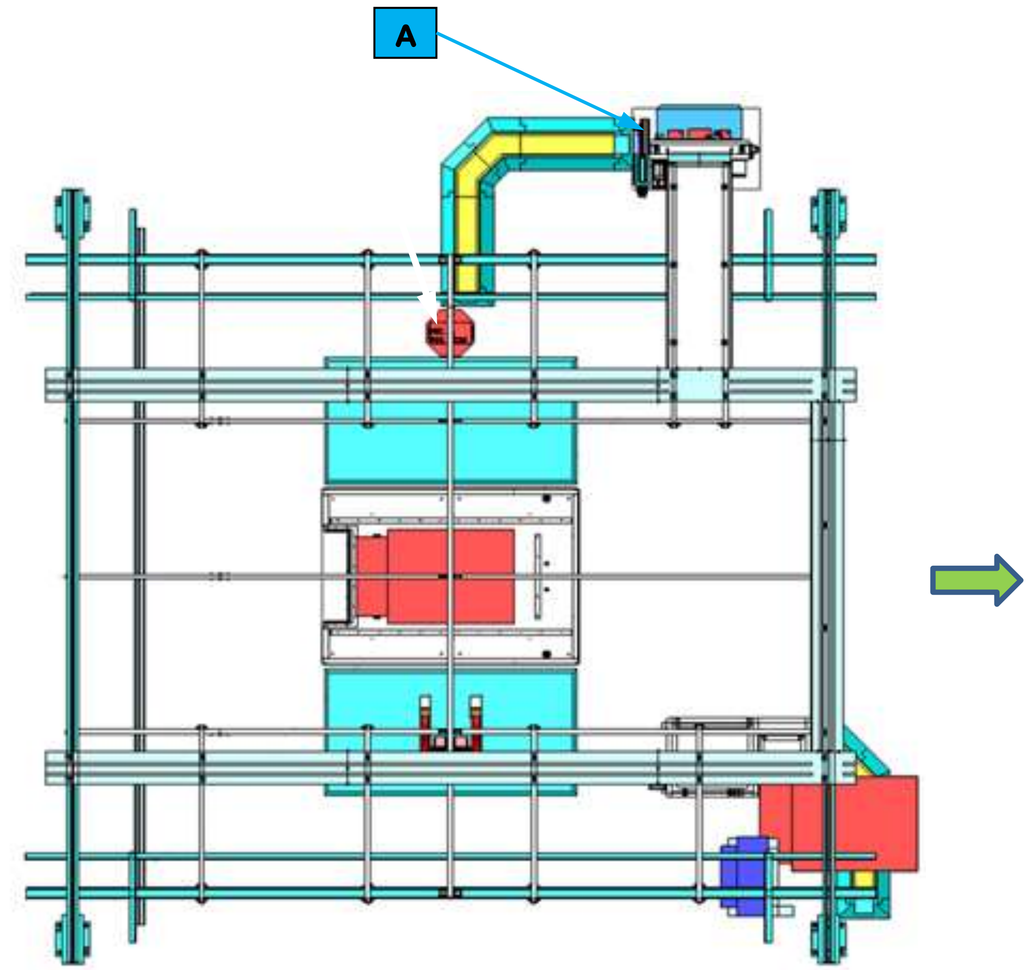
8.5.16. Supply Connection Points for Cells EP680 and EP700

Cell EP680



For information regarding supply connections located in EPCell 680, refer to *Battery Pack Test and Cover Leak Test Operation and Maintenance Manual*

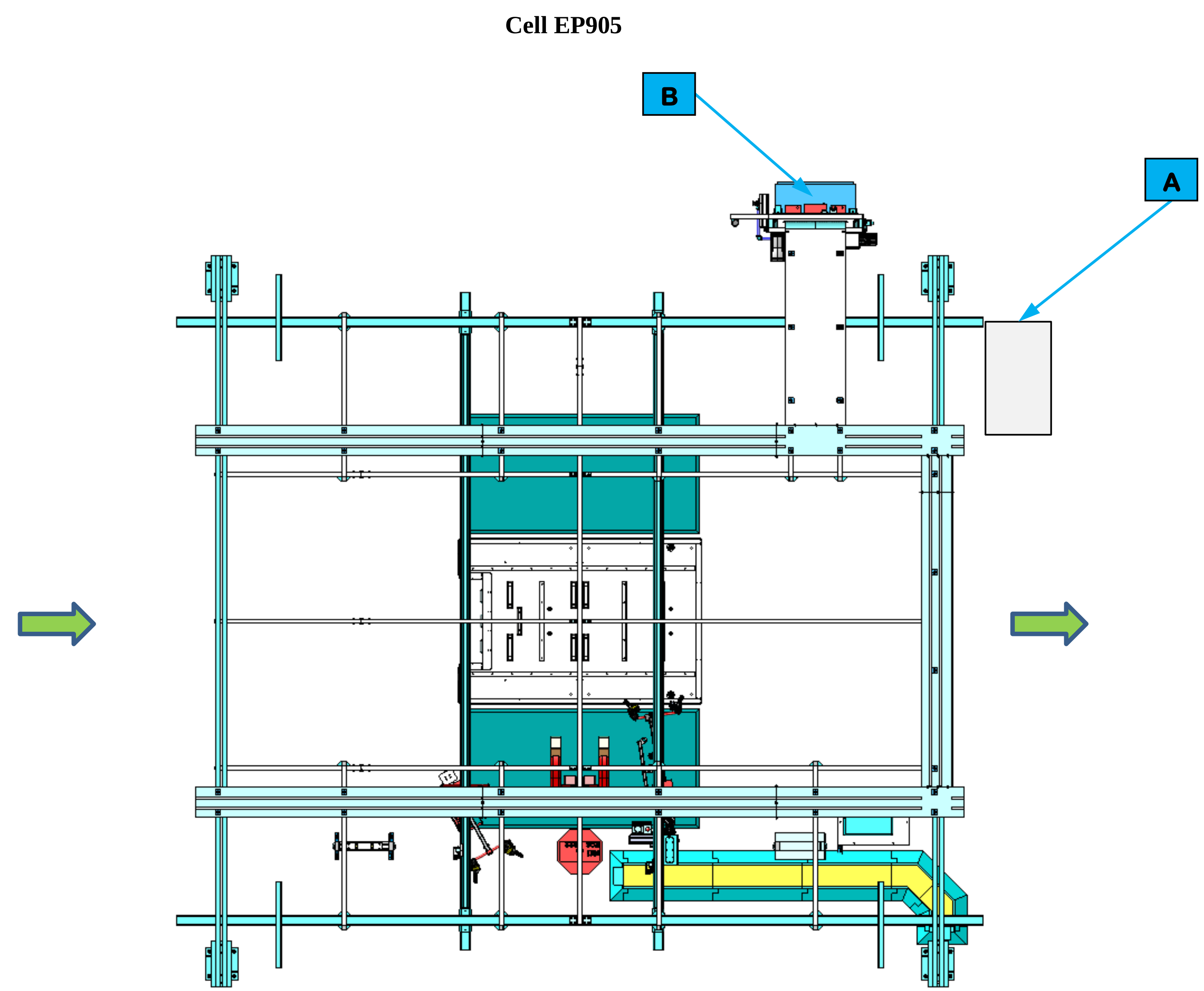
Cell EP700



Supply Connection Callouts in Figure 8-22		
A	Compressed Air Supply	60 PSI 105 Max CFM

Figure 8-22. Cells EP680 and EP700 Supply Connection Locations.

8.5.17. Supply Connection Points for Cell EP905



Supply Connection Callouts in Figure 8-23					
A	Electrical Supply	480 Volt 3 Phase AC 60 Amps	B	Compressed Air Supply	60 PSI 105 Max CFM

Figure 8-23. Cell EP905 Supply Connection Locations.

8.6. DECOMMISSIONING

This section outlines procedures for disassembling for moving or removal of Pack Main Line along with a section disposing of the Line if necessary.

In General, ATS personnel are ready to disassemble, reconfigure, and assist in moving the Pack Main Line. If the 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, jib cranes, and other tooling systems from the cell.

8.6.2.8. Disassemble and Remove Conveyor Systems

Disconnect and remove all conveyor system from the cell.

8.6.2.9. Disassemble and Remove Main Structure

Disassemble and remove the main structure for the Cell.

8.7. DISPOSAL

The Pack Main Line has a product life cycle of 10 million cycles and 10 calendar years. If the entire Main Pack 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 will be done either through 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 the 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

Table of Contents

9.1. EP020 TRAY AND SKID PLATE STATION PARAMETERS

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET/BEV	All	Air Preparation Unit	Air Pressure Regulator	60 PSI
BET	Secure Skid Plates to Tray	Driver	Torque	D: 22.0 +/- 3.0 Nm S: 19.0 - 25.0 Nm
			Torque Angle	TBD.
		Feeder	Bolt Quantity	BET 24 LWB Offroad: 32 BET 20 LWB Offroad: 32 BET 20 SWB Offroad: 28

9.2. EP040 BIN LABEL AND RPIM INSTALL DESCRIPTION

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BEV	All	Air Preparation Unit	Air Pressure Regulator	60 PSI
	Secure Coolant Inlet assembly	Atlas Copco Nutrunner	Torque	4.7 +/- 0.9 Nm
			Torque Angle	TBD.
		Bin Pick	Bolt Quantity	2
	Print, Install, and Scan BIN label	BIN Label Printer	Print Quantity	BET: 2 BEV: 1
BET	Front Ground Strap Secure	Atlas Copco Nutrunner	Torque	22.0 +/- 3.0 Nm
	RPIM Header Secure		Torque	6.0 +/- 0.9 Nm
	SWB Jumper Bus Bar		Torque	9.0 +/- 1.5 Nm

9.3. EP060 LPIM HEADERS INSTALL STATION DESCRIPTION

<table>
<tr><th>Battery Pack Variant</th><th>Process Step</th><th>Device</th><th>Parameter Setting</th><th>Parameter Value</th></tr>
<tr><td>BET/BEV</td><td>ALL</td><td>Air Preparation Unit</td><td>Air Pressure Regulator</td><td>60 PSI</td></tr>
<tr><td rowspan="5">BET</td><td rowspan="3">Secure LV harness to Tray</td><td rowspan="2">Atlas Copco Nutrunner</td><td>Torque</td><td>8.0 +/- 1.0 Nm</td></tr>
<tr><td>Torque Angle</td><td>TBD</td></tr>
<tr><td>Bin Pick</td><td>Bolt Quantity</td><td>TBD</td></tr>
<tr><td>LPIM Header Secure</td><td rowspan="2">Atlas Copco Nutrunner</td><td rowspan="2">Torque</td><td>6.0 +/- 0.9 Nm</td></tr>
<tr><td>SWB Jumper Bus Bar Secure</td><td>9.0 +/- 1.5 Nm</td></tr>
<tr><td>BEV</td><td>RDU Header Secure</td><td>Atlas Copco Nutrunner</td><td>Torque</td><td>6.0 +/- 0.9 Nm</td></tr>
</table>

9.4. EP080 DCFC STATION PARAMETERS

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET/BEV	ALL	Air Preparation Unit	Air Pressure Regulator	60 PSI
BEV	IPE Header Secure	Atlas Copco Nutrunner	Torque	6.0 +/- 0.9 Nm.
	DCFC Header Secure			
BET	FPIM Secure	Atlas Copco Nutrunner	Torque	6.0 +/- 0.9 Nm
	IPE Header Secure			
	SWB Jumper Bus Bar			9.0 +/- 1.5 Nm

9.5. EP090 DCFC HEADER INSTALL STATION DESCRIPTION

<table>
<tr><th>Battery Pack Variant</th><th>Process Step</th><th>Device</th><th>Parameter Setting</th><th>Parameter Value</th></tr>
<tr><td>BET/BEV</td><td>ALL</td><td>Air Preparation Unit</td><td>Air Pressure Regulator</td><td>60 PSI</td></tr>
<tr><td rowspan="3">BEV</td><td>Double-Ended Stud Secure</td><td rowspan="3">Atlas Copco Nutrunner</td><td rowspan="3">Torque</td><td rowspan="3">9.0 +/- 1.5 Nm</td></tr>
<tr><td>BRFM Secure to Bracket</td></tr>
<tr><td>BRFM Sub Secure to Tray</td></tr>
<tr><td rowspan="2">BET</td><td>DCFC Header Secure</td><td rowspan="2">Atlas Copco Nutrunner</td><td rowspan="2">Torque</td><td>6.0 +/- 0.9 Nm</td></tr>
<tr><td>SWB Jumper Bus Bar</td><td>9.0 +/- 1.5 Nm</td></tr>
</table>

9.6. EP100 LOWER MODULE LOAD STATION PARAMETERS

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET/BEV	All	Air Preparation Unit	Air Pressure Regulator	60 PSI
BET/BEV	Install 3P Modules to Tray	Pick and Place	Module Quantity	BET 24 LWB Offroad: 12 BET 24 LWB: 12 BET 20 LWB Offroad: 10 BET 20 LWB: 10 BET 10 LWB: 10 BET 20 SWB Offroad: 10 BET 20 SWB: 10 BET 12 SWB: 10 BEV 12 RWD: 12 BEV 12 AWD: 12 BEV 10 RWD: 10
BET	Install 2P Modules to Tray	Pick and Place	Module Quantity	BET 16 LWB: 8 BET 16 SWB: 8

9.7. EP120 LOWER MODULE SECURE STATION PARAMETERS

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET/BEV	All	Air Preparation Unit	Air Pressure Regulator	60 PSI
BET/BEV	Secure Modules to Tray	Driver	Torque	9.0 +/- 1.5 Nm
			Torque Angle	TBD.
		Feeder	Bolt Quantity	BET 24 LWB Offroad: 72 BET 24 LWB: 72 BET 20 LWB Offroad: 60 BET 20 LWB: 60 BET 16 LWB: 48 BET 10 LWB: 60 BET 20 SWB Offroad: 60 BET 20 SWB: 60 BET 16 SWB: 48 BET 12 SWB: 60 BEV 12 RWD: 72 BEV 12 AWD: 72 BEV 10 RWD: 60

9.8. EP160 COOLANT INLET INSTALL STATION DESCRIPTION

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET/BEV	All	Air Preparation Unit	Air Pressure Regulator	60 PSI
BET	Coolant Inlet Secure	Atlas Copco Nutrunner	Torque	8.0 +/- 1.0 Nm
	Coolant Inlet to Tray Cross-Rail			9.0 +/- 1.5 Nm
	String B Bus Bar Mod Side			8.0 +/- 1.0 Nm

9.9. EP180 BDU INSTALL STATION DESCRIPTION

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET/BEV	All	Air Preparation Unit	Air Pressure Regulator	60 PSI
BEV	Diode Bracket Asm Secure	Atlas Copco Nutrunner	Torque	9.0 +/- 1.5 Nm
	Pos/Neg Bus (POA Diode) BDU Side			
	Pos/Neg Bus (POA Diode) Mod Side			8.0 +/- 1.0 Nm
BET	String B Bus Bar BDU Side	Atlas Copco Nutrunner	Torque	9.0 +/- 1.5 Nm
	Periscope Bus Bar Secure			8.0 +/- 1.0 Nm

9.10. EP200 COOLANT OUTLET INSTALL STATION DESCRIPTION

<table>
<tr><th>Battery Pack Variant</th><th>Process Step</th><th>Device</th><th>Parameter Setting</th><th>Parameter Value</th></tr>
<tr><td>BET/BEV</td><td>All</td><td>Air Preparation Unit</td><td>Air Pressure Regulator</td><td>60 PSI</td></tr>
<tr><td rowspan="3">BEV</td><td>BEV BDU Secure to Headers</td><td rowspan="3">Atlas Copco Nutrunner</td><td rowspan="3">Torque</td><td rowspan="2">9.0 +/- 1.5 Nm</td></tr>
<tr><td>BEV BDU Secure to Tray Nuts</td></tr>
<tr><td>BEV LV Harness Secure</td><td>8.0 +/- 1.0 Nm</td></tr>
<tr><td rowspan="3">BET</td><td>BET BDU Secure to Headers</td><td rowspan="3">Atlas Copco Nutrunner</td><td rowspan="3">Torque</td><td rowspan="2">9.0 +/- 1.5 Nm</td></tr>
<tr><td>BET BDU Secure to Tray</td></tr>
<tr><td>BET Coolant Outlet Secure</td><td>8.0 +/- 1.0 Nm</td></tr>
</table>

9.11. EP220 BRFM AND BDU AWNING INSTALL STATION DESCRIPTION

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET/BEV	All	Air Preparation Unit	Air Pressure Regulator	60 PSI
BEV	BDU Secure to Tray Bolts	Atlas Copco Nutrunner	Torque	9.0 +/- 1.5 Nm
	Midpack Bus Bar Secure			8.0 +/- 1.0 Nm
	Midpack Bus Bar to Tray Bolt Secure			9.0 +/- 1.5 Nm
BET	BET BRFM Secure	Atlas Copco Nutrunner	Torque	9.0 +/- 1.5 Nm
	BET BDU Awning Secure			

9.12. EP230 LOWER BUS BAR INSTALL AND SECURE STATION PARAMETERS

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET/BEV	All	Air Preparation Unit	Air Pressure Regulator	60 PSI
BET/BEV	Secure Module to Module Bus Bar	Driver	Torque	9.0 +/- 1.5 Nm
			Torque Angle	TBD.
		Pick and Place	Bus Bar Quantity	BET 24 LWB Offroad: 10 BET 24 LWB: 10 BET 20 LWB Offroad: 8 BET 20 LWB: 8 BET 16 LWB: 6 BET 10 LWB: 8 BET 20 SWB Offroad: 8 BET 20 SWB: 8 BET 16 SWB: 6 BET 12 SWB: 8 BEV 12 RWD: 10 BEV 12 AWD: 10 BEV 10 RWD: 8

9.13. EP240 RH & LH OUTBOARD INSTALL STATION DESCRIPTION

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET/BEV	All	Air Preparation Unit	Air Pressure Regulator	60 PSI
BEV	RH Outboard Hose Secure	Atlas Copco Nutrunner	Torque	9.0 +/- 1.5 Nm
	LH Outboard Hose Secure			
BET	RH Outboard Hose Secure	Atlas Copco Nutrunner	Torque	9.0 +/- 1.5 Nm
	LH Outboard Hose Secure			

9.14. EP260 COOLANT OUTLET, SFM, SFM GROUND STRAP STATION DESCRIPTION

<table>
<tr><th>Battery Pack Variant</th><th>Process Step</th><th>Device</th><th>Parameter Setting</th><th>Parameter Value</th></tr>
<tr><td>BET/BEV</td><td>All</td><td>Air Preparation Unit</td><td>Air Pressure Regulator</td><td>60 PSI</td></tr>
<tr><td>BEV</td><td>Coolant Outlet Secure</td><td>Atlas Copco Nutrunner</td><td>Torque</td><td>8.0 +/- 1.0 Nm</td></tr>
<tr><td rowspan="2">BET</td><td>SFM Secure</td><td rowspan="2">Atlas Copco Nutrunner</td><td rowspan="2">Torque</td><td>6.0 +/- 0.9 Nm</td></tr>
<tr><td>SFM Ground Strap Secure</td><td>9.0 +/- 1.5 Nm</td></tr>
</table>

9.15. EP270 RDU, THERMAL BARRIER, AND MCP1 INSTALL DESCRIPTION

<table>
<tr><th>Battery Pack Variant</th><th>Process Step</th><th>Device</th><th>Parameter Setting</th><th>Parameter Value</th></tr>
<tr><td>BET/BEV</td><td>All</td><td>Air Preparation Unit</td><td>Air Pressure Regulator</td><td>60 PSI</td></tr>
<tr><td rowspan="3">BEV</td><td>RDU Cable Secure to BDU</td><td rowspan="3">Atlas Copco Nutrunner</td><td rowspan="3">Torque</td><td rowspan="3">9.0 +/- 1.5 Nm</td></tr>
<tr><td>RDU Cable Secure to RDU</td></tr>
<tr><td>RDU Cable Secure to Tray</td></tr>
<tr><td rowspan="2">BET</td><td>Rear Ground Strap Secure</td><td rowspan="2">Atlas Copco Nutrunner</td><td rowspan="2">Torque</td><td>22.0 +/- 3.0 Nm</td></tr>
<tr><td>MCP1 Module Bracket Bolt Secure</td><td>9.0 +/- 1.5 Nm</td></tr>
</table>

9.16. EP280 ELECTRICAL LEAK TEST STATION PARAMETERS

For information regarding equipment located in Cell EP280, refer to *Battery Pack Test and Cover Leak Test Operation and Maintenance Manual*.

9.17. EP300 MIDPLATE LOAD STATION PARAMETERS

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET	All	Air Preparation Unit	Air Pressure Regulator	60 PSI
BET	Secure Midplate	Driver	Torque	22.0 +/- 3.0 Nm
			Torque Angle	TBD.
		Feeder	Bolt Quantity	16

9.18. EP320 MIDPLATE SECURE STATION PARAMETERS

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET	All	Air Preparation Unit	Air Pressure Regulator	60 PSI
BET	Secure Midplate	Driver	Torque	22.0 +/- 3.0 Nm
			Torque Angle	TBD.
		Feeder	Bolt Quantity	BET 24 LWB Offroad: 26 BET 24 LWB: 26 BET 20 LWB Offroad: 26 BET 20 LWB: 26 BET 16 LWB: 26 BET 10 LWB: 26 BET 20 SWB Offroad: 20 BET 20 SWB: 20 BET 16 SWB: 20 BET 12 SWB: 20

9.19. EP380 UPPER MODULE LOAD STATION PARAMETERS

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET	All	Air Preparation Unit	Air Pressure Regulator	60 PSI
BET	Install 3P Modules to Tray	Pick and Place	Module Quantity	BET 24 LWB Offroad: 12 BET 24 LWB: 12 BET 20 LWB Offroad: 10 BET 20 LWB: 10 BET 20 SWB Offroad: 10 BET 20 SWB: 10 BET 12 SWB: 2
BET	Install 2P Modules to Tray	Pick and Place	Module Quantity	BET 16 LWB: 8 BET 16 SWB: 8

9.20. EP400 UPPER MODULE SECURE STATION PARAMETERS

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET	All	Air Preparation Unit	Air Pressure Regulator	60 PSI
BET	Secure Modules to Tray	Driver	Torque	9.0 +/- 1.5 Nm
			Torque Angle	TBD.
		Feeder	Bolt Quantity	BET 24 LWB Offroad: 72 BET 24 LWB: 72 BET 20 LWB Offroad: 60 BET 20 LWB: 60 BET 16 LWB: 48 BET 20 SWB Offroad: 60 BET 20 SWB: 60 BET 16 SWB: 48 BET 12 SWB: 12

9.21. EP420 Z-BLOCKER INSTALL STATION PARAMETERS

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET	All	Air Preparation Unit	Air Pressure Regulator	60 PSI
	String A Bus Bar Secure BDU Side	Atlas Copco Nutrunner	Torque	9.0 +/- 1.5 Nm
	String A Bus Bar Secure Mod Side			8.0 +/- 1.0 Nm
	Midpack Bus Bar Secure			8.0 +/- 1.0 Nm
	BDU Bracket Secure			9.0 +/- 1.5 Nm

9.22. EP480 UPPER BUS BAR INSTALL AND SECURE STATION PARAMETERS

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET	All	Air Preparation Unit	Air Pressure Regulator	60 PSI
BET	Secure Module to Module Bus Bar	Driver	Torque	9.0 +/- 1.5 Nm
			Torque Angle	TBD.
		Pick and Place	Bus Bar Quantity	BET 24 LWB Offroad: 10 BET 24 LWB: 10 BET 20 LWB Offroad: 8 BET 20 LWB: 8 BET 16 LWB: 6 BET 20 SWB Offroad: 8 BET 20 SWB: 8 BET 16 SWB: 6

9.23. EP500 BET RH AND LH OUTBOARD HOSE INSTALL STATION DESCRIPTION

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET	All	Air Preparation Unit	Air Pressure Regulator	60 PSI
	RH Outboard Hose Secure	Atlas Copco Nutrunner	Torque	9.0 +/- 1.5 Nm
	LH Outboard Hose Secure			

9.24. EP520 LH & RH OUTER Z-BLOCKER INSTALL STATION DESCRIPTION

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET	All	Air Preparation Unit	Air Pressure Regulator	60 PSI
	BET Bus Bar Z-Blocker Secure	Atlas Copco Nutrunner	Torque	9.0 +/- 1.5 Nm
	BET LH Outer Z-Blocker Secure			
	BET RH Outer Z-Blocker Secure			

9.25. EP540 MCP1, THERMAL BARRIER INSTALL STATION DESCRIPTION

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET	All	Air Preparation Unit	Air Pressure Regulator	60 PSI
	MCP1 Module Bracket Bolt Secure	Atlas Copco Nutrunner	Torque	9.0 +/- 1.5 Nm
	Front-to-Rear Hose Secure to Tray			
	BDU Bracket Secure			

9.26. EP560 FRONT TO REAR BUS BAR INSTALL STATION DESCRIPTION

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET	All	Air Preparation Unit	Air Pressure Regulator	60 PSI
	Front-to-Rear Bus Bar Secure	Atlas Copco Nutrunner	Torque	9.0 +/- 1.5 Nm

9.27. EP580 UPPER DECK ELECTRICAL LEAK TEST STATION PARAMETERS

For information regarding equipment located in Cell EP580, refer to *Battery Pack Test and Cover Leak Test Operation and Maintenance Manual*.

9.28. EP600 O-RING INSTALL STATION PARAMETERS

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET/BEV	All	Air Preparation Unit	Air Pressure Regulator	60 PSI
BET/BEV	Get and Install O-rings	Bin Pick	O-Ring Quantity	BET 24 LWB Offroad: 14 BET 24 LWB: 14 BET 20 LWB Offroad: 14 BET 20 LWB: 14 BET 16 LWB: 14 BET 10 LWB: 14 BET 20 SWB Offroad: 12 BET 20 SWB: 12 BET 16 SWB: 12 BET 12 SWB: 12 BEV 12 RWD: 12 BEV 12 AWD: 12 BEV 10 RWD: 12

9.29. EP620 RTV AND COVER LOAD STATION PARAMETERS

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET/BEV	All	Air Preparation Unit	Air Pressure Regulator	60 PSI
	RTV Dispense	RTV Dispense Vision Inspection	Bead Position	±2 mm (0.0787 In)
			Bead Height	15 mm / ±2 mm(0.59 ±0.0787 In)
			Bead Width	9 mm / ±2 mm(0.354 ±0.0787 In)

9.30. EP630 COVER SECURE STATION PARAMETERS

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET/BEV	All	Air Preparation Unit	Air Pressure Regulator	60 PSI
BET/BEV	Secure Cover to Tray	Driver	Torque	9.0 +/- 1.5 Nm
			Torque Angle	TBD.
		Feeder	Bolt Quantity	BET 24 LWB Offroad: 25 BET 24 LWB: 25 BET 20 LWB Offroad: 25 BET 20 LWB: 25 BET 16 LWB: 25 BET 10 LWB: 25 BET 20 SWB Offroad: 23 BET 20 SWB: 23 BET 16 SWB: 23 BET 12 SWB: 23 BEV 12 RWD: 22 BEV 12 AWD: 22 BEV 10 RWD: 22

9.31. EP640 COVER STANCHION SECURE STATION PARAMETERS

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET/BEV	All	Air Preparation Unit	Air Pressure Regulator	60 PSI
BET/BEV	Secure Cover to Stanchions	Driver	Torque	58.0 +/- 9.0 Nm
			Torque Angle	TBD.
		Feeder	Nut Quantity	BET 24 LWB Offroad: 14 BET 24 LWB: 14 BET 20 LWB Offroad: 14 BET 20 LWB: 14 BET 16 LWB: 14 BET 10 LWB: 14 BET 20 SWB Offroad: 14 BET 20 SWB: 12 BET 16 SWB: 12 BET 12 SWB: 12 BEV 12 RWD: 12 BEV 12 AWD: 12 BEV 10 RWD: 12

9.32. EP660 BURST VALVE INSTALL STATION PARAMETERS

Battery Pack Variant	Process Step	Device	Parameter Setting	Parameter Value
BET/BEV	All	Air Preparation Unit	Air Pressure Regulator	60 PSI
BET/BEV	Install Side 1 Burst Valves to Cover	Atlas Copco Nutrunner	Torque	9.0 +/- 1.5 Nm
			Torque Angle	TBD.
		Feeder	Bolt Quantity	6
	Install Side 2 Burst Valves to Cover	Atlas Copco Nutrunner	Torque	9.0 +/- 1.5 Nm
			Torque Angle	TBD.
		Feeder	Bolt Quantity	6

9.33. EP680 COVER LEAK TEST STATION PARAMETERS

For information regarding equipment located in Cell EP680, refer to *Battery Pack Test and Cover Leak Test Operation and Maintenance Manual*.

9.34. EP700 CONTINUITY TEST STATION PARAMETERS

<table>
<tr><th>Battery Pack Variant</th><th>Process Step</th><th>Device</th><th>Parameter Setting</th><th>Parameter Value</th></tr>
<tr><td>BET/BEV</td><td>ALL</td><td>Air Preparation Unit</td><td>Air Pressure Regulator</td><td>60 PSI</td></tr>
<tr><td rowspan="3">BET/BEV</td><td rowspan="3">Secure Multi-Purpose Valve</td><td rowspan="2">Atlas Copco Nutrunner</td><td>Torque</td><td>9.0 +/- 1.5 Nm</td></tr>
<tr><td>Torque Angle</td><td>TBD.</td></tr>
<tr><td>Feeder</td><td>Bolt Quantity</td><td>BET: 8
BEV: 4</td></tr>
</table>