

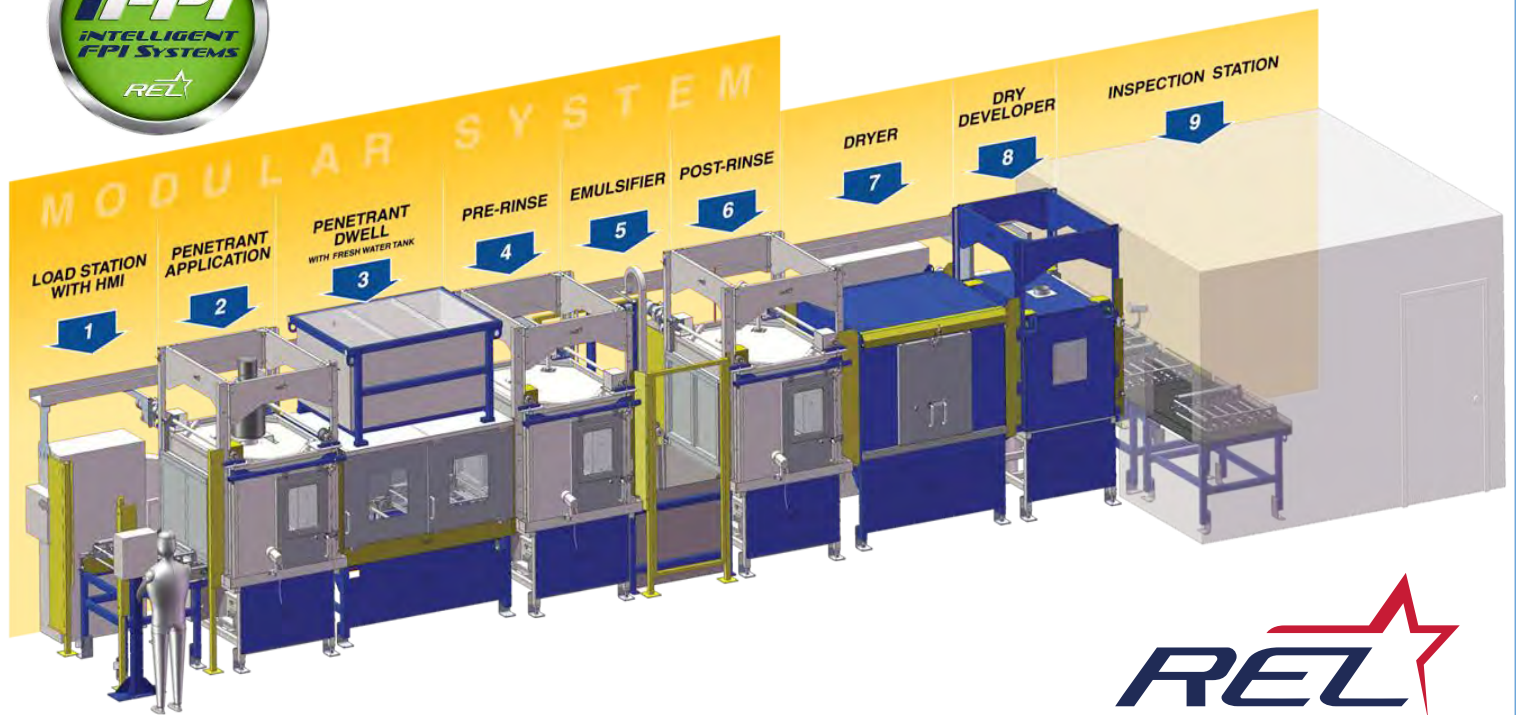
iFPI

Fluorescent Penetrant Application Equipment



System Information

REL, Inc.
57640 North Eleventh Street
Calumet, MI 49913
Phone: (906) 337-3018
Fax: (906) 337-2930
www.relinc.com



RECIPE
SCREEN

PROCESS VARIABLE
DISPLAY & LOGGING

LINE STATUS

SYSTEM INITIATE



intelligent Fluorescent Penetrant Inspection (iFPI) Systems



Glo-Black LED UV-A Lamps

Tested to comply with both

ASTM
E3022
Standard

Rolls-Royce
RRES 90061
Requirements



C4 Magnum & Magnum-GO
120V Plug-in



C4 Nomad & Nomad-GO
18V Portable



Profusion
Booth Lighting

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\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\ LED UV-A Lamps \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\

REL's Glo-Black LED UV-A Inspection Lamps utilize the latest in safe high output UV-A LED technology for Fluorescent Penetrant Inspection (FPI) and Magnetic Particle Inspection (MPI). Each light module contains a high flux UV-A LED emitter that is mounted in a military grade aluminum alloy housing to allow the light to perform in all harsh environments regardless of ambient conditions.

American. Brilliance.



REL System Controls

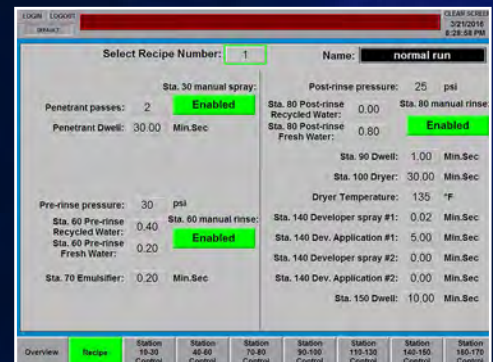
SMART HMI
ROBUST iFPI



1. Full Operation Controls



2. System Control Panel



3. Touch Screen Interaction

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PLC Controls

iFPI (intelligent Fluorescent Penetrant Inspection) systems and *iREL* equipment are provided with the control systems that integrate into the customers control scheme. Whether the plant has a central DCS or the equipment needs to be controlled locally, REL has a control solution for the application. UL Listing of complete panels is also available.



Loading Station

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Select Recipe Number: 1		Name: normal run	
Sta. 30 manual spray:	Post-rinse pressure: 25 psi	Sta. 80 manual rinse:	
Penetrant passes: 2 Enabled	Sta. 80 Post-rinse Recycled Water: 0.00	Sta. 80 manual rinse:	
Penetrant Dwell: 30.00 Min.Sec	Sta. 80 Post-rinse Fresh Water: 0.80	Sta. 80 manual rinse:	
Pre-rinse pressure: 30 psi	Sta. 90 Dwell: 1.00 Min.Sec	Sta. 100 Dryer: 30.00 Min.Sec	
Sta. 60 Pre-rinse Recycled Water: 0.40	Sta. 140 Developer spray #1: 0.02 Min.Sec	Dryer Temperature: 135 °F	
Sta. 60 Pre-rinse Fresh Water: 0.20	Sta. 140 Dev. Application #1: 5.00 Min.Sec	Sta. 140 Developer spray #2: 0.00 Min.Sec	
Sta. 70 Emulsifier: 0.20 Min.Sec	Sta. 140 Dev. Application #2: 0.00 Min.Sec	Sta. 150 Dwell: 10.00 Min.Sec	

1. Recipe selection



2. Load carrier

STATION 10 - LOAD		STATION 20 - ELEVATOR		DOOR SAFETY PK. 10000 CLOSED LIGHT CURTAIN NOT DETECTED		STATION 30 - PENETRANT STATION	
PK 1002	PK 1001	PK 1002	PK 1001	PK 1002	PK 1001	PK 1002	PK 1001
LOADING	ENTRY	LOADING	ENTRY	LOADING	ENTRY	LOADING	ENTRY
UP 30.00	UP 30.00	UP 30.00	UP 30.00	UP 30.00	UP 30.00	UP 30.00	UP 30.00
DOWN	DOWN	DOWN	DOWN	DOWN	DOWN	DOWN	DOWN
INITIATE BASKET	SYSTEM ON	INITIATE BASKET	SYSTEM ON	INITIATE BASKET	SYSTEM ON	INITIATE BASKET	SYSTEM ON
Select Recipe Number: 1	START	Select Recipe Number: 1	START	Select Recipe Number: 1	START	Select Recipe Number: 1	START
STOP	STOP	STOP	STOP	STOP	STOP	STOP	STOP
RESET SELECT	RESET SELECT	RESET SELECT	RESET SELECT	RESET SELECT	RESET SELECT	RESET SELECT	RESET SELECT

3. Start cycle

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Loading Station

The Load Station aligns the carrier to the Automated Material Handling System (AMHS). Carriers with parts are manually set onto the load station to begin the process. The loaded parts must not protrude outside the processing size envelope of the FPI line.

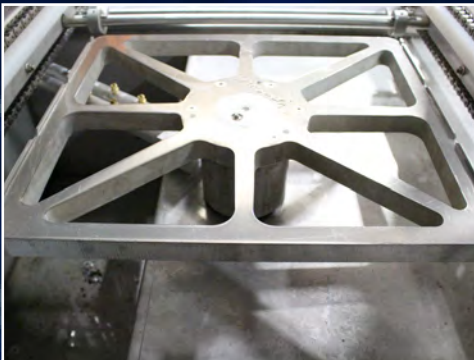


Penetrant Station

SMART HMI
ROBUST iFPI



Made in
U.S.A.



\ 1. \
Pop-up turn table
rotates parts



\ 2. \
Electrostatic spray applied to
top and bottom of carrier



\ 3. \
Touch up/
convey basket

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\\\\\\\\\\\\\\\\ Penetrant Spray Station \\\\\\\\\\\\\\\

The Penetrant Application Station utilizes electrostatic spray application. Separate guns are used for top and bottom spray application, as well as penetrant type/level of penetrant. This station will allow operator interaction through an access door on the front. When needed, the operator can stop the process and open the access doors to inspect the parts for complete coverage. The station incorporates a turntable that rotates the carrier 360° to allow complete coverage from the electrostatic spray and visual inspection of all four sides of the carrier. There is typically a handheld electrostatic spray gun for use in touching-up areas on the parts, and a HEPA filtration system, controlled by the PLC to remove the spray mist from the enclosure.



Dwell Station

SMART HMI
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1. \
Convey basket
into Dwell Station



2. \
Timer set according
to daily throughput



3. \
Basket conveyed
to next station

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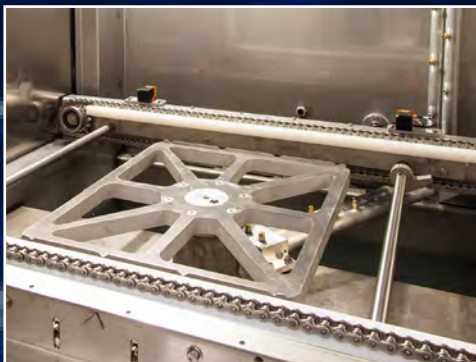
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\ Dwell Station \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\

The Penetrant Dwell Station controls the time required for the carrier to sit while the penetrant is 'wetting' the part surface area. The dwell allows for multiple carrier staging between the Penetrant Application and Pre-Rinse Stations.



Pre-Rinse Station

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\ 1. \
Pop-up turn table
lifts and turns basket



\ 2. \
Fresh water
pre-rinse



\ 3. \
Touch up/
convey basket

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\\\\\\\\\\\\\\\\\\\\ Pre-Rinse Station \\\\\\\\\\\\\\\\\\\

Rinsing is accomplished by a pressure controlled spray header. This spray header stays stationary while the carrier pops up and rotates through the spray streams. The rinse water supply pump utilizes recycled water for the initial part rinsing followed by a freshwater supplied rinse.



Emulsifier Station

SMART HMI
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\\ 1. \\

Robust lowerator
for immersion



\\ 2. \\

Emulsifier agitation



\\ 3. \\

Raise up/
convey basket

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\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\ Emulsifier Station \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\

This dip system is pneumatically or electrically powered and controlled to allow for smooth accelerations and consistent processing time during transit to ensure that the process specifications called out by ASTM 1417 are met. For this station the control system doesn't allow parts to dip if there is a basket in the post rinse station. This is to ensure that the parts are being rinsed within the specified 2 minute window after emulsification.

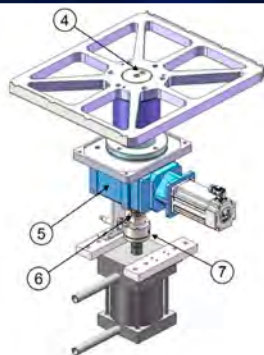


Post Rinse Station

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**1. **
Pop-up turn table
lifts and rotates basket



**2. **
Full 360° rinse with
turn-table



**3. **
Touch up /
convey basket

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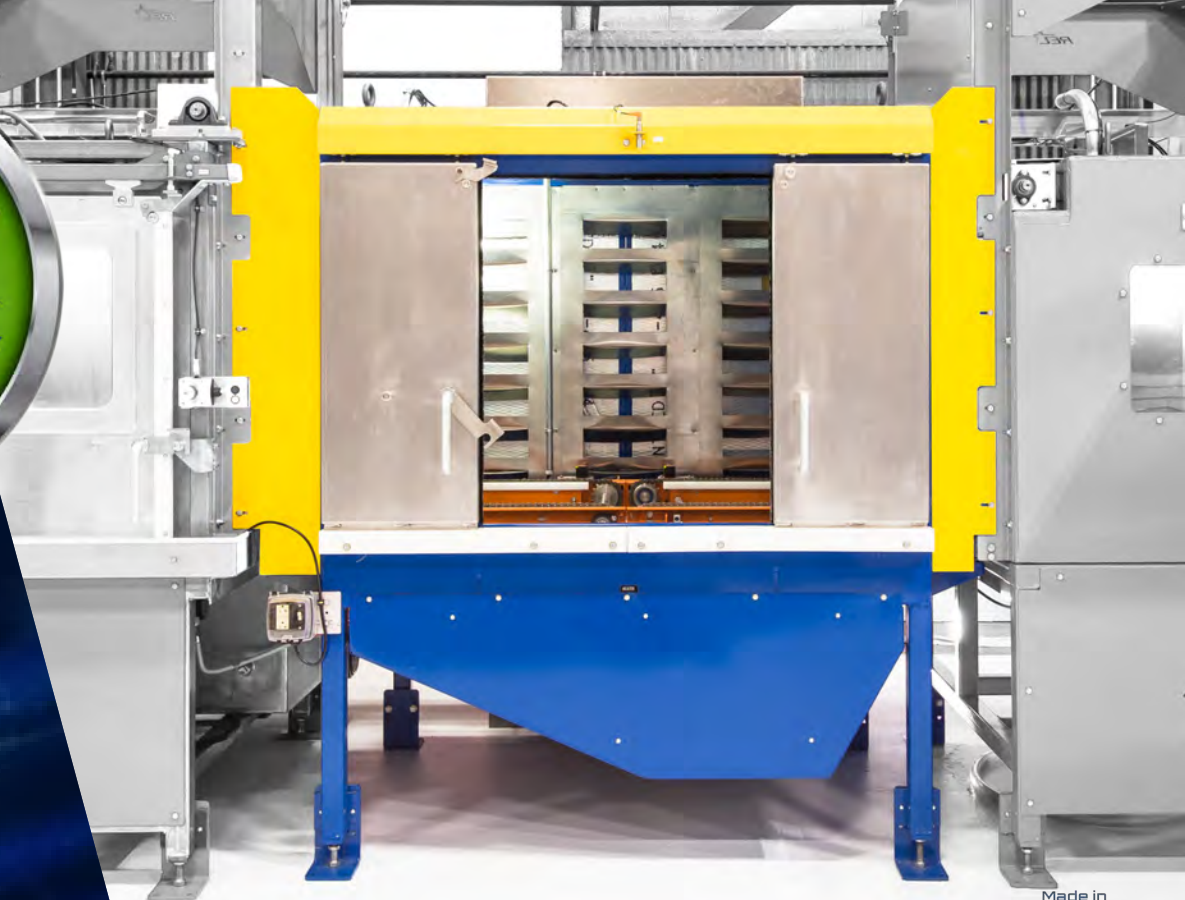
\\\\\\\\\\\\\\\\\\\\ Post Rinse Station \\\\\\\\\\\\\\\\\\\

Rinsing is accomplished by a pressure controlled spray header. This spray header stays stationary while the carrier pops up and rotates through the spray streams. The rinse water supply pump utilizes recycled water for the initial part rinsing followed by a freshwater supplied rinse.



Dryer Station

SMART HMI
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1.
Convey basket
into Dryer



2.
Temperature controlled
Dryer



3.
Convey basket

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\\ Dryer Station \\\

This station can be powered by electricity, gas, or steam. REL puts a heating coil in the duct that is circulating the air in the station. Temperature control in the oven chamber is accomplished through the PLC. REL ovens come with a customer specified calibration port for oven temperature verification.



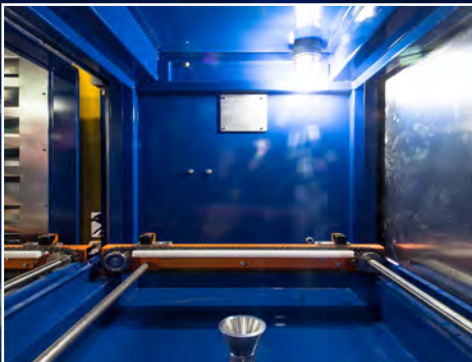
Dry Developer Station

SMART HMI
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\ 1. \
Convey basket
into Dry Developer



\ 2. \
Cloud dry developer applied
(not actual powder in image)



\ 3. \
Basket conveyed
into unloading area

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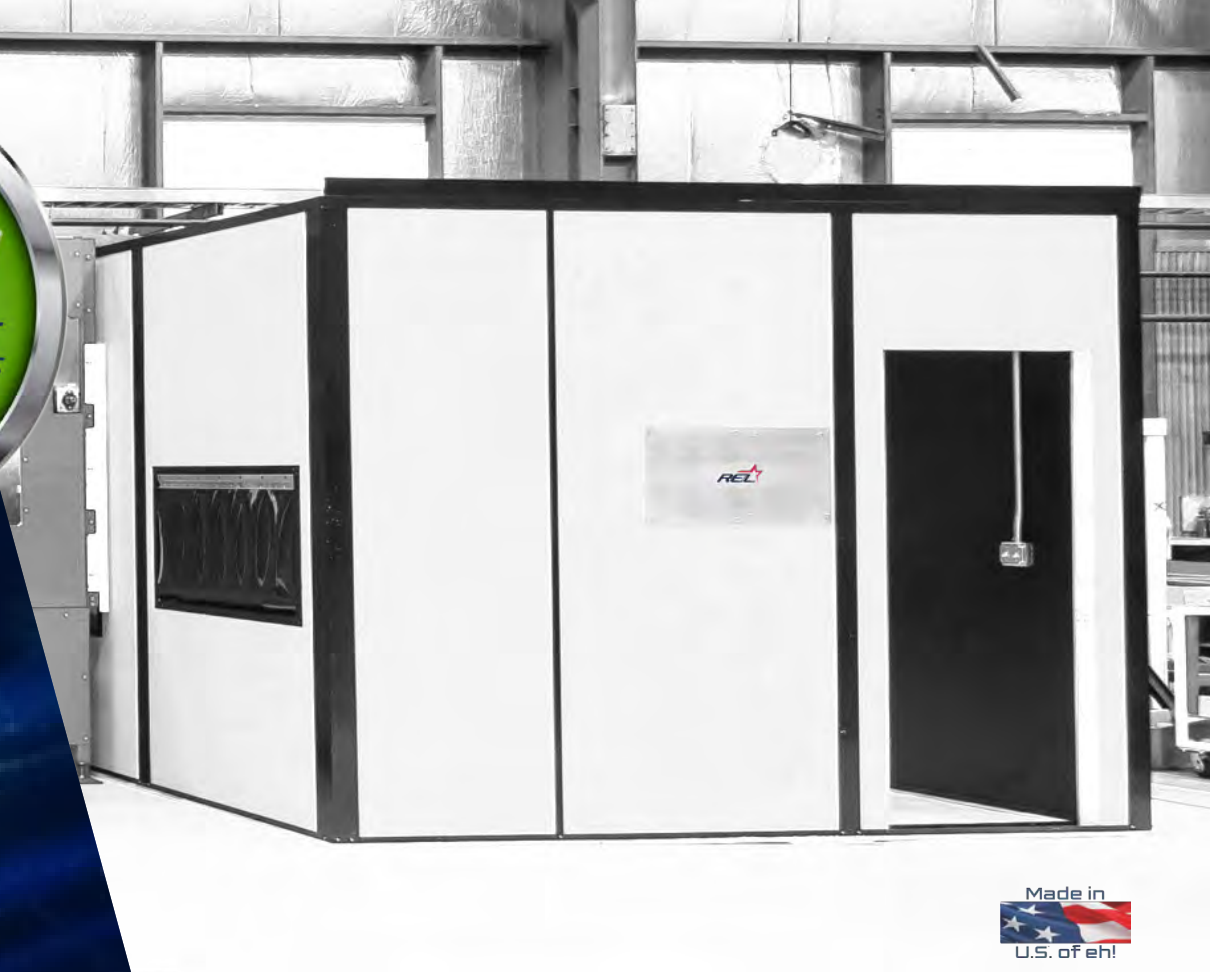
\\\\\\\\\\\\\\\\ Dry Developer Station \\\\\\\\\\\\\\\

This station applies dry developer to part surfaces by the use of a cloud. Electrostatic spray is available also. A Dust Collector with a HEPA filter keeps dust from migrating outside of the station area.



Inspection and Unloading

SMART HMI
ROBUST iFPI



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\ 1. \

Parts conveyed
into inspection area



\ 2. \

Basket emptied and
sent to loading station



\ 3. \

Multiple inspection
stations

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\\\\\\\\\\\\\\\\ Inspection \ Unloading \\\\\\\\\\\\\\\

Parts are inspected with blacklight in this climate controlled multi-station inspection area. Fire suppression systems & process monitoring can also be included with the system.

EFFICIENT

- ✓ **Electrostatic penetrant spray uses 90% less penetrant than immersion dipping**
- ✓ **Process control reduces water usage, chemical consumption and disposal costs**
- ✓ **Automated systems increase throughput and reduces manpower and maintenance**
- ✓ **Greater processing efficiencies lower material and utility costs**

REL's ultra-efficient NDT systems can be engineered for use with specific types of penetrants, developers and removal methods



FLEXIBLE

- ✓ **REL's FPI systems are modular in design to maximize plant floor space usage**
- ✓ **Station layouts are adaptable to allow for large part envelopes**
- ✓ **Straight line, L-shaped and U-shaped layouts for diverse array of part geometries and sizes**
- ✓ **Full suite of add-on features and options for tailored system configurations**

Modular, U-shaped Fluorescent Penetrant Inspection System with two 90° turns reduces equipment footprint



ACCURATE

- ✓ **PLC with Human Machine Interface (HMI) controls processes and different recipes**
- ✓ **Automated processing results in consistent, reliable and dependable flaw detection**
- ✓ **Precisely timed wet/dwell/dry stations vastly improves throughput and part outcomes**
- ✓ **REL's FPI systems eliminate damage from manual processing and improve inspections**

Sensors track movement of parts along the conveyor and relay positions to either HMI at the Load Station or Inspection Station

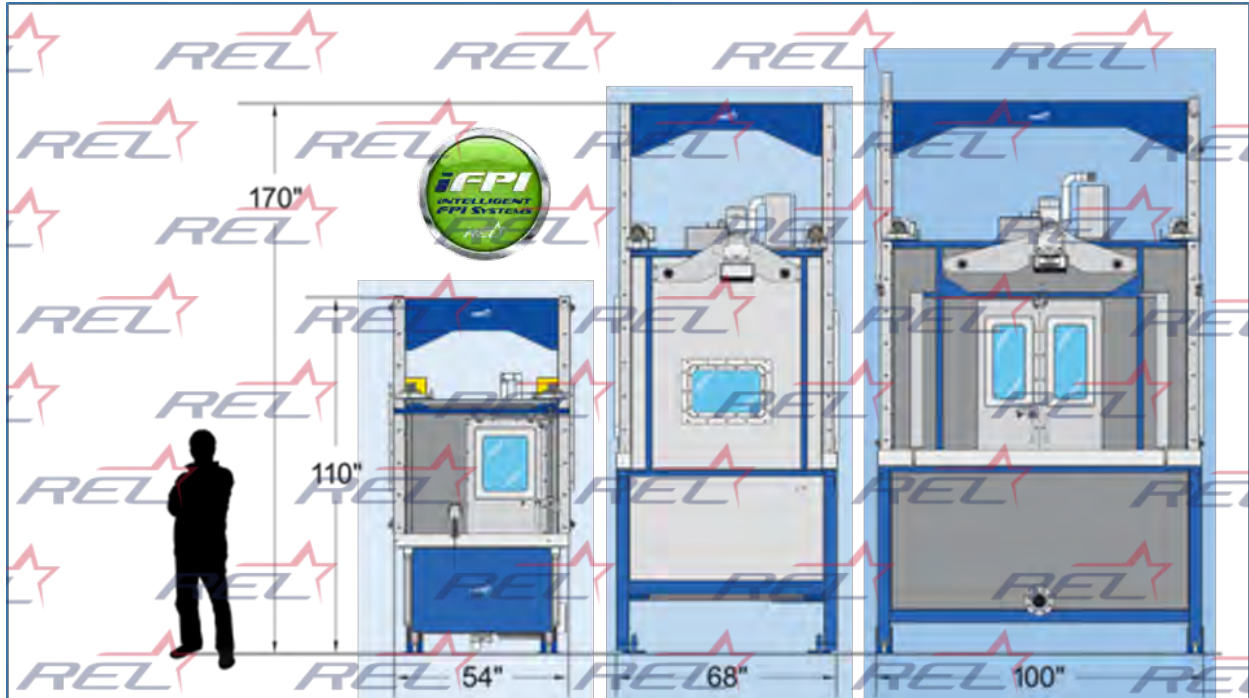


ECO-CLEAN

- ✓ **REL FPI systems use dedicated tank farms to reclaim wastewater for parts processing**
- ✓ **Electrostatic penetrant spray reduces chemical usage (penetrant, emulsifier and developer)**
- ✓ **Computer controlled pre-rinse and post-rinse stations reduce water usage and cost**
- ✓ **REL's Near-Zero effluent filtration systems can provide low contaminant levels in wastewater**

Rinsing is accomplished using a spray header that creates a curtain of water to cover hard-to-reach areas on parts





The diagram illustrates three iFPI systems: MSF (Model Size Factor), MBF (Medium Batch Factor), and RBF (Rack Batch Factor). A person is shown for scale. Dimensions are provided for each system.

Model Name:	MSF	MBF	RBF
Part Envelope:	30x30x30	36x60x36	48x78x42
System Weight:	18,500#	50,500#	67,500#
Carriers/Hour:	Up to 6 carriers per hour* <i>Based on 30 minutes Penetrant Dwell & 20 minutes Drying Time</i>		
Max. Part Weight:	400#	1,500#	2,000#

**Note: Throughput can be increased with more Dwell & Dry Stations*

Estimates based on Turn-Key, Installed: Type 1, Method D, iFPI Systems



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Introduction: iFPI Systems

Description

The **iFPI** Fluorescent Penetrant Application Machine is comprised of automated stations to perform fluorescent penetrant processes and inspection of parts. REL can tailor the line to any penetrant type and level that is needed in a single system! The system is scalable to fit your part envelopes. REL has built three 'Standard Sizes'. These sizes are:

1. 30X30X30
2. 36X60X36
3. 48X78X42

REL can manufacture an FPI cell to accommodate your every part and shop space. The part carrier is conveyed through the system using driven chain conveyors at each station. The entire process is controlled by a PLC with HMI. As each carrier is loaded on the load station, the operator must choose the parameters or recipe required for the particular parts that will be processed. Each carrier can have different parameters or recipe. The operator can choose a standard recipe from the menu and make changes to the standard recipe for a particular carrier. Once the recipe has been selected at the load station for the carrier, the process will run automatically.

Following is a general layout map and description of each station.

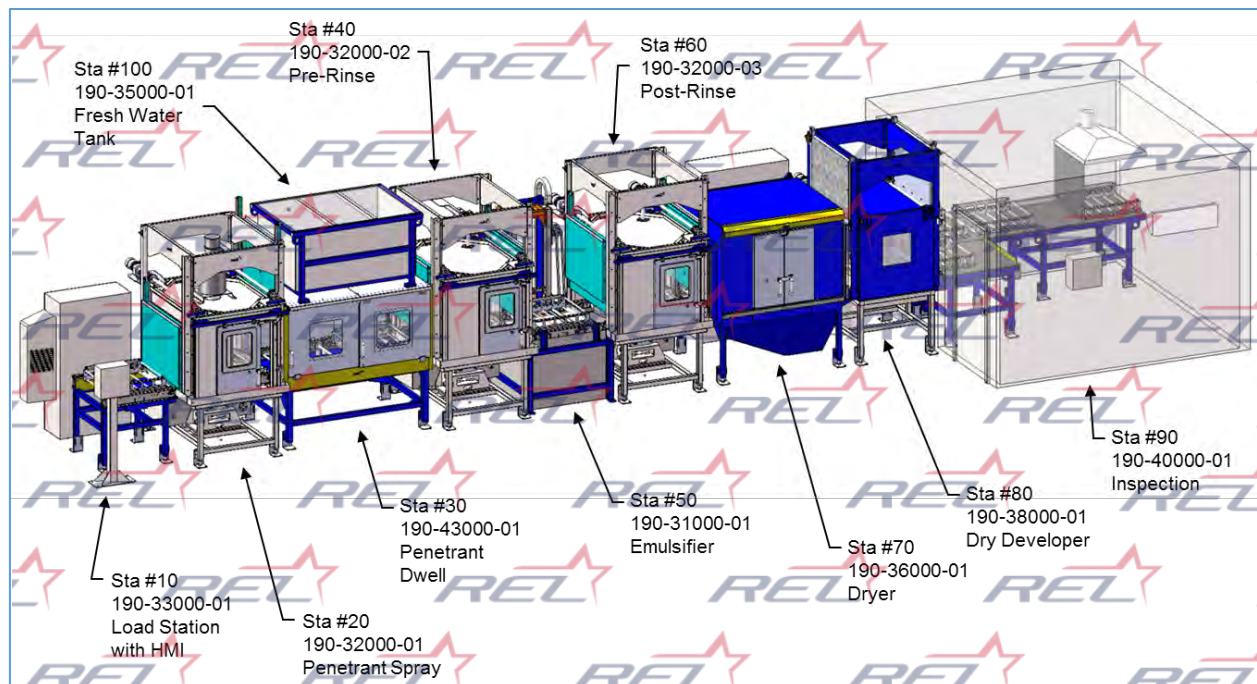


Figure 1: Typical Model MSF Overall Automated Line Layout

**Automated Material Handling System (AMHS):**

The automated material handling system (AMHS) is comprised of two parallel chain conveyor rails to handle the carrier. The AMHS is comprised of individually driven chain conveyors. The gear motors are coupled to the conveyor with either chain drives or shaft couplings with polymer packing. In the wet stations the components are manufactured of 304 stainless steel. In the dry stations the components are painted carbon steel. The motor speed is controlled over Ethernet through a variable frequency drive and managed Ethernet switch. The chain runs over a UHMW wear surface integral with the frame rails. Operator Safety is considered at the Operator Interaction Points (OIP) on the line. These areas are protected with safety rated devices such as Safety Light Curtains and/or Safety Rated Switches.

Load Station:

The Load Station aligns the carrier to the AMHS. Carriers are manually set onto the load station to begin the process. The parts loaded onto the carrier must not protrude outside the processing size envelope of the FPI line. As the carrier advances into the Penetrant Application Station, the PLC will timeout and alert the operator if the carrier is outside of the processing size envelope of the system and needs to be repackaged.

Penetrant Application Station:

The Penetrant Application Station uses electrostatic spray application with electrostatic spray guns. The penetrant application is controlled from the PLC. Separate guns are used for top and bottom spray application, as well as penetrant type/level of penetrant. This station will allow operator interaction through an access door on the front. When needed, the operator can stop the process and open the access doors to inspect the parts for complete coverage. The station incorporates a turntable that rotates the carrier 360° to allow complete coverage from the electrostatic spray and visual inspection of all four sides of the carrier. There is typically a handheld electrostatic spray gun for use in touching-up areas on the parts, and a HEPA filtration system, controlled by the PLC to remove the spray mist from the enclosure.

Penetrant Dwell Station:

The Penetrant Dwell Station controls the time required for the carrier to sit while the penetrant is 'wetting' the part surface area. The dwell allows for staging and independent control of two carriers between the Penetrant Application and Pre-Rinse Stations.

Pre-Rinse Station:

The Pre-Rinse Station allows for the rinsing of complex shaped parts using a two-stage operation. Its multi-functional design has the option to utilize both recycled rinse water from previous cycles as well as freshwater for final rinsing. The rinse header interacts with both the freshwater tank, and the sump integral with the station. The rinsing is accomplished with a spray header that increases the pump water flow effectiveness by creating a curtain of water that encompasses surface details and covers hard-to-reach areas. The station incorporates a turntable that



rotates the carrier 360° to allow complete coverage from the spray header and visual inspection of all four sides of the carrier. This station will allow operator interaction through an access door on the front. When needed the operator can stop the process and open the access doors to inspect the parts for a complete rinse. There is a handheld rinse wand for use in touching-up areas on the parts. There are electrically powered overhead doors on both ends of the station controlled by the PLC to contain the rinse water in the station.

The first rinse stage has the option to utilize fresh water or recycled water to initially wash down the parts. The recycled water will be contained in a tank within the rinse cabinet. This holding tank has an overflow, which can be pumped to the filtration system.

The second rinse stage is activated by an electrically powered butterfly valve such that the post rinse cycle is flushed with 'clean water' from the fresh water holding tank. This stage of the rinse cycle allows for further cleaning of the parts with higher water purity.

The operator can control the process in two ways. The operator can select a pause on the HMI which will cause the carrier to pause automatically to allow inspection and touch-up rinsing. Or, if desired, the operator can choose to bypass the touch-up portion and proceed automatically.

Emulsifier Application Station:

The Emulsifier Station uses an air cylinder, or an electric motor depending on the size of the station, to lower the conveyor carriage and parts carrier, into the emulsifier tank. The operator can program the required immersion time and emulsifier level at the HMI. An air bubbler header provides agitation of the emulsifier fluid. When the conveyor is in the Up position, a pan mounted below the conveyor acts as the cover for the emulsifier tank. A metering system is provided to control the emulsifier concentration when filling the system. This station will not start its process unless the Post-Rinse station is ready to receive a carrier.

Post-Rinse Station:

The Post-Rinse Station allows for the rinsing of complex shaped parts using a two-stage operation. Its multi-functional design has the option to utilize both recycled rinse water from previous cycles as well as freshwater for final rinsing. This station interacts directly with the freshwater tank. The rinsing is accomplished with a spray header that increases the pump water flow effectiveness by creating a curtain of water that encompasses surface details and covers hard-to-reach areas. The station incorporates a turntable that rotates the carrier 360° to allow complete coverage from the spray header and visual inspection of all four sides of the carrier. This station will allow operator interaction through an access door on the front. When needed, the operator can stop the process and open the access door to inspect the parts for a complete rinse. There is a handheld rinse wand for use in touching-up areas on the parts. There are electrically powered overhead doors on both ends of the station controlled by the PLC to contain the rinse water in the station.



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The operator can control the process in two ways. The operator can select a pause on the HMI which will cause the carrier to pause automatically to allow inspection and touch-up rinsing. Or, if desired, the operator can choose to bypass the touch up portion and proceed automatically.

Dryer Station:

This is an insulated enclosure, electrically powered convection dryer, designed to dry the parts in the fluorescent penetrant application process. The Dryer will be held at a selectable temperature between 120° and 160° Fahrenheit controlled through the HMI. The Dryer station will utilize the overhead door on the exit side of the post-rinse station and the entrance door on the dry developer station to close the dryer enclosure to maximize efficiency. The Dryer will have a fan to move air through the drying chamber to maintain a uniform temperature. The dryer station can accommodate and independently control two carriers at one time. An access door located on the front of the station allows operator intervention as needed.

Dry Developer Station:

This station will apply developer powder to the parts with an auxiliary air accelerator, or electrostatically. This system includes a refrigerated air dryer to ensure the developer powder maintains a dry state during application. A Torit dust collector with HEPA filtration will evacuate the chamber before the electrically actuated entry and exit doors open. A viewing window is provided on the front of the station.

Inspection Station:

The Inspection Station allows for two part carriers to be inspected at the same time. The automated material handling system (AMHS) in the Dry Developer station will convey the carrier onto a UHMW surfaced table inside the Inspection booth. From this point the carriers can be moved by hand to either of the two inspection areas. A safety photo eye will prevent the exit door of the Dry Developer from closing if the light beam is broken by an object. A self contained fume hood can be used to apply additional non-aqueous developer, if required. The inspection booth has both white and black lighting. Each inspection area will have the use of a handheld blacklight.

Fresh Water Tank:

The Fresh Water Tank handles the flow and storage of the rinse water used in the system processes. The tank can be provided with an immersion heater to control the water temperature which can be set in the HMI.



Safety

Hazardous Materials

This equipment does not contain any mercury or mercury compounds. There are fluorescent light bulbs used in this equipment. This equipment does not contain any asbestos or materials containing asbestos. This equipment does not have materials containing any polychlorinated biphenyl (PCB). This equipment does not contain any Class 1 Ozone Depleting Substances.

General Safety

Machine owners, operators, maintenance personnel, and service personnel must know that safety practices are a vital part of the job. Whenever maintenance or repair is performed on any part of the **iFPI** Line ALL equipment must be in a zero energy state and proper lockout/tagout procedures must be performed.

When putting equipment in a zero energy state, the operator may encounter the following energy sources:

- Electrical power
- Pressurized air
- Pressurized process piping
- Hot surfaces
- Components that can fall
- Other potential hazards not listed here

Lockout / Tagout Procedures

Follow these steps before performing any maintenance or repair work on the equipment:

1. To disconnect and lockout electrical power to the Fluorescent Penetrant Application Machine (FPAM), turn off the disconnect mounted on side behind Panel **CP-1000**. This will disconnect all system power **except** the maintenance lights and receptacles.
2. To shut off and lockout the freshwater to the FPAM, close and lock the 1" ball valve located behind the Emulsifier Station.
3. To shut off and lockout the compressed air supply to the FPAM, close and lock the shut-off valve located behind the Dry Developer station.



HMI: Operation & Control

General Overview

This FPI line is controlled from two HMI (Human-Machine Interface) screens, one installed near the Load Station at the beginning of the line and one inside the Inspection Room.

The Overview screen will show where carriers are currently located on the line along with the recipe number for the carrier at that particular station and time remaining at the station. This screen will also indicate when a carrier is Advancing from one station and Loading at the next station. The Recipe screen shows all of the parameters for each recipe. To access the recipe screen you must be logged-in with additional security. Once you are logged-in, you can then make changes to the recipe. The control screens show more information for each station than is displayed on the Overview screen. Motors and valves can be put in Manual Mode and temperature and pressure displays are shown.

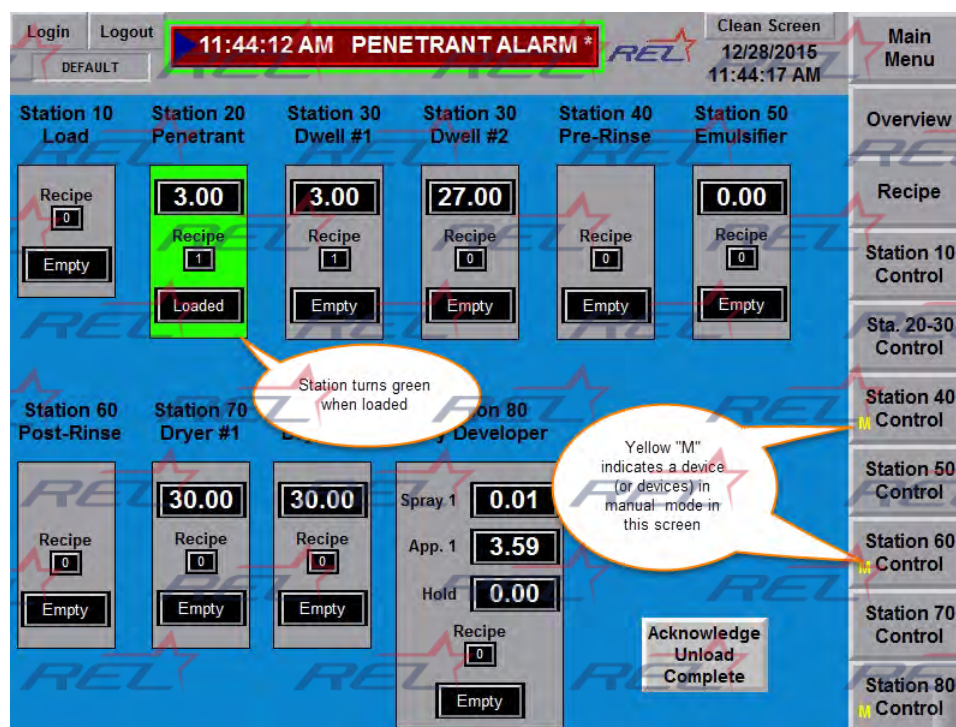


Figure 2: Overview Screen

Individual Device Modes & Indication

System Color Code

Purple-Auto Mode
Green-Device is On

Yellow-Manual Mode
Red-Fault

When the system is turned On and motors start, the motors will turn green and will have a purple indicator to show that the motor is running in Auto mode. In the motor pop-up the “Auto” will be purple whenever the motor is in Auto mode. The “On” indication in the top right of the pop-up will turn green when the motor is on.

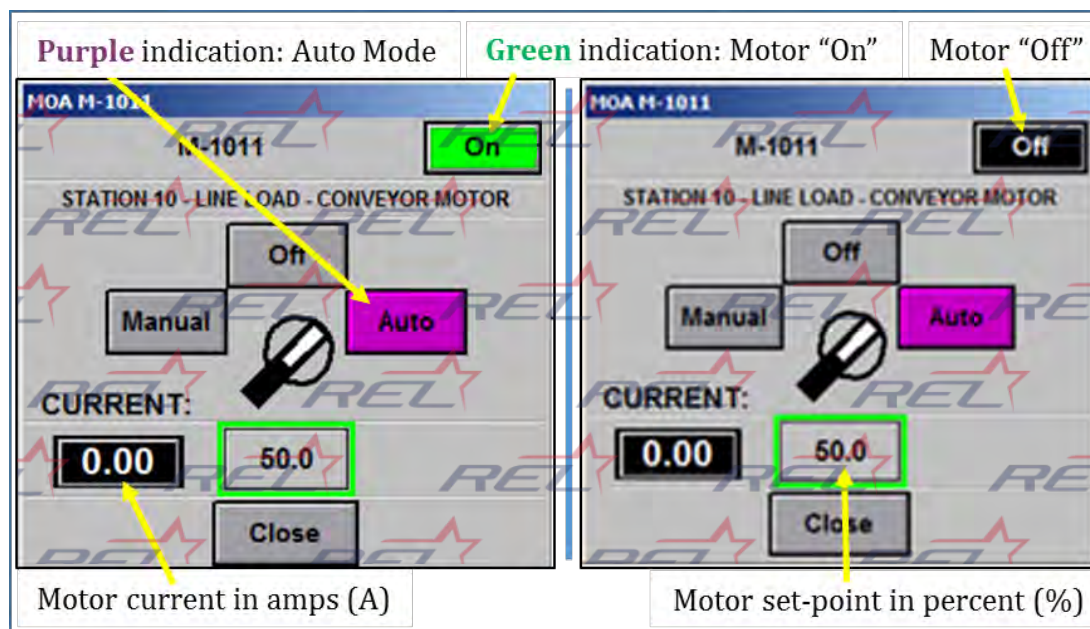


Figure 3: Motor “On” in Auto Mode (left); Motor “Off” in Auto Mode (right)

Figure 4 shows an example of a motor that has been turned on manually. When a motor is pressed, the pop-up displays and the operator has the option to manually turn the motor on, manually turn the motor off, or put the motor in Auto mode. When manually turned on, the “Manual” button will turn yellow. The “On” indication in the top right will turn green, just as it would if the motor is on in Auto mode. When the motor is manually turned off (Figure 5), the “Off” button will turn yellow and the “Off” display will then appear in the top right of the pop-up window. If a motor is manually turned off, it will not start in Auto mode. The motor must be put back in Auto before running any carriers.

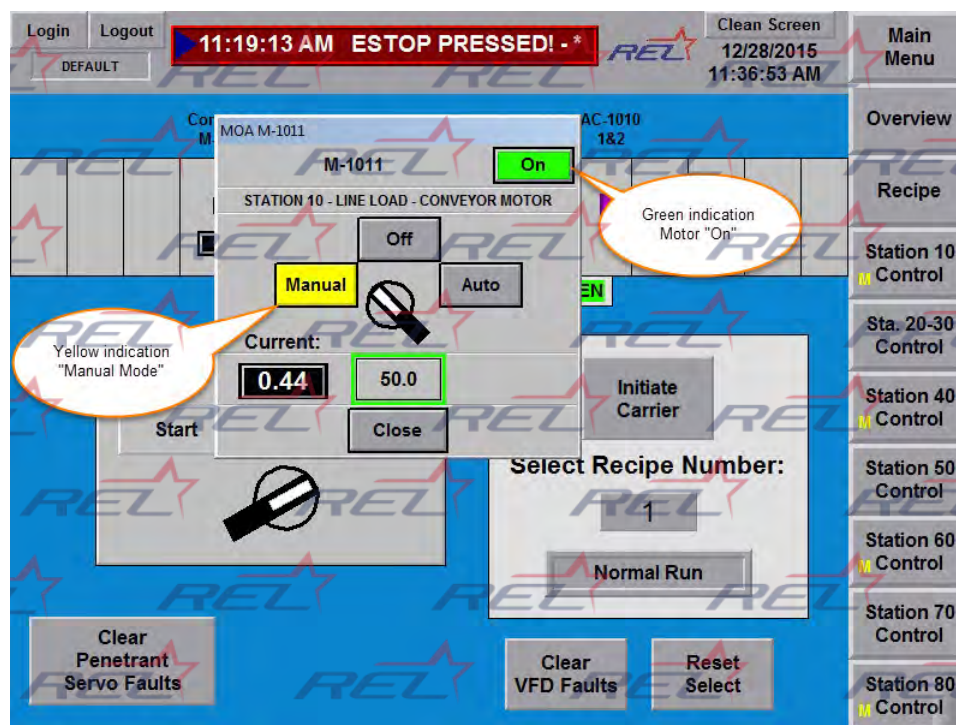


Figure 4: Motor- Manual "On"

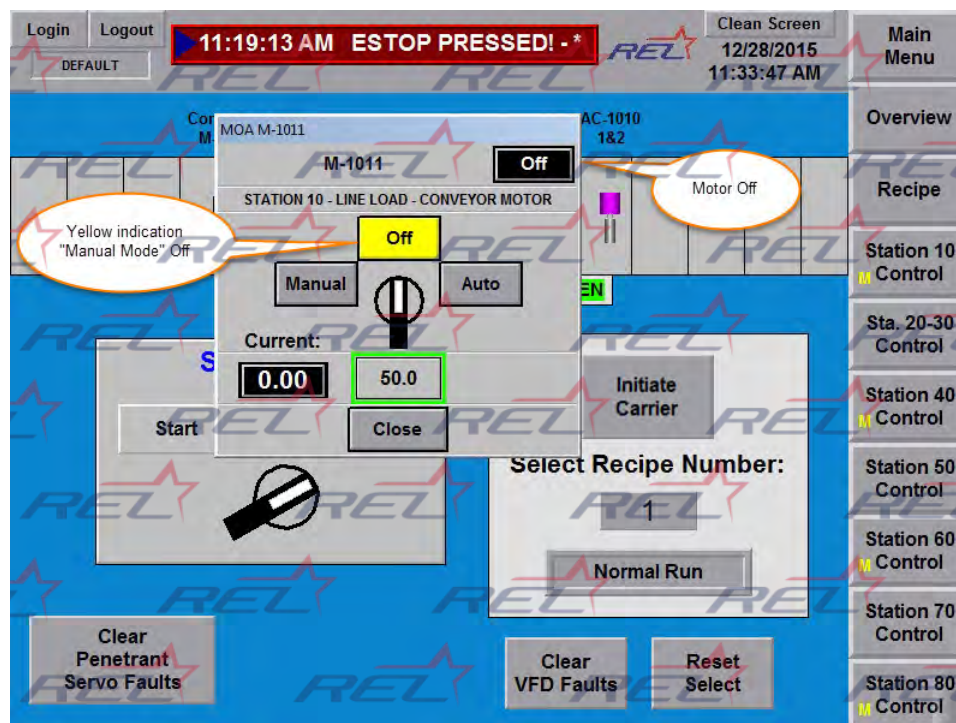


Figure 5: Motor- Manual "Off"

Figure 6 shows M-1011 Faulted. The motor will blink red on the screen, and “Fault” will display in the pop-up with a red background.

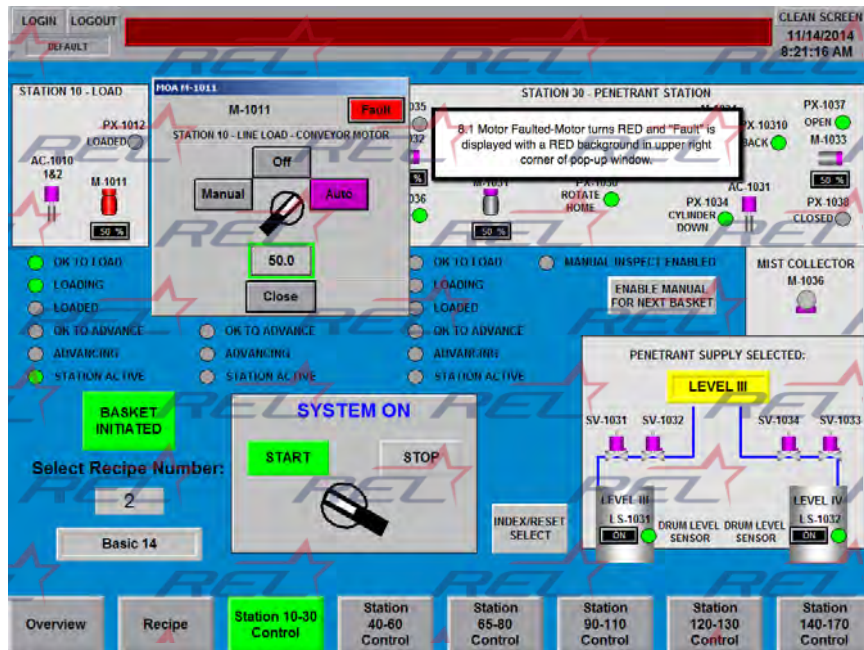


Figure 6: Motor Faulted

When a device is in Manual mode the yellow “M” will display on the Control button for that particular station (Figure 7).

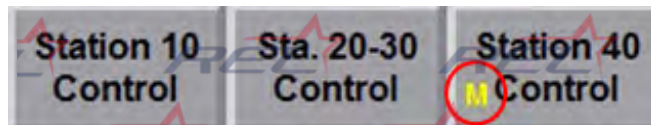


Figure 7: Manual Mode Indication

Note: For proper Automatic operation of the machine, all devices should be in Auto mode.

Figure 8 shows AV-2081 and M-2084 manual off. Their indicator is yellow (unlike M-2082, M-2081 and M-2083 which still have purple indication to show that they are in Auto mode).

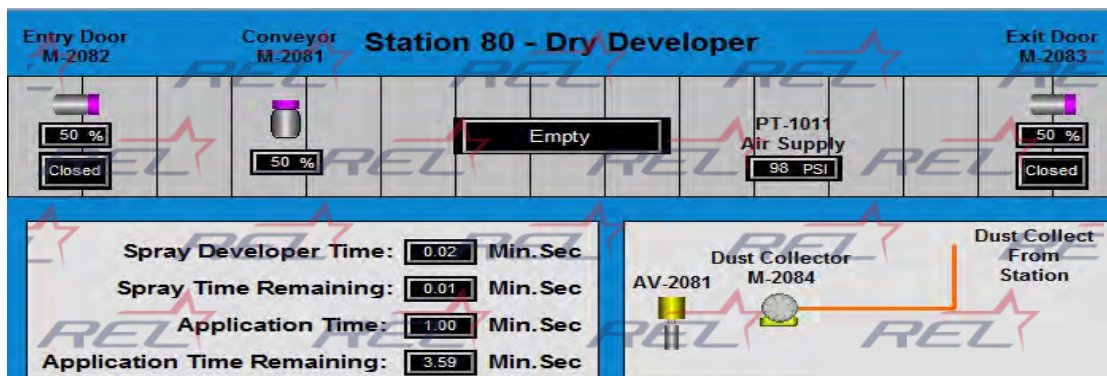


Figure 8: Valve Manual Mode

Door Safety Prox Sensors

The Penetrant station and the two Rinse stations have safety prox sensors on the access doors (as shown below). There are times when the Operator must open the doors to spray or rinse parts. During this time certain parts of the process will stop. When the sensor is displaying green lights (*Figure 9, left*), it is not sensing anything in front of it, meaning that the door is open. When the sensor is displaying yellow lights (*Figure 9, right*), it is sensing something in front of it, meaning that the door is closed. If the prox is blinking green and yellow there is an error with the reading. To clear this error, open and close the doors again.

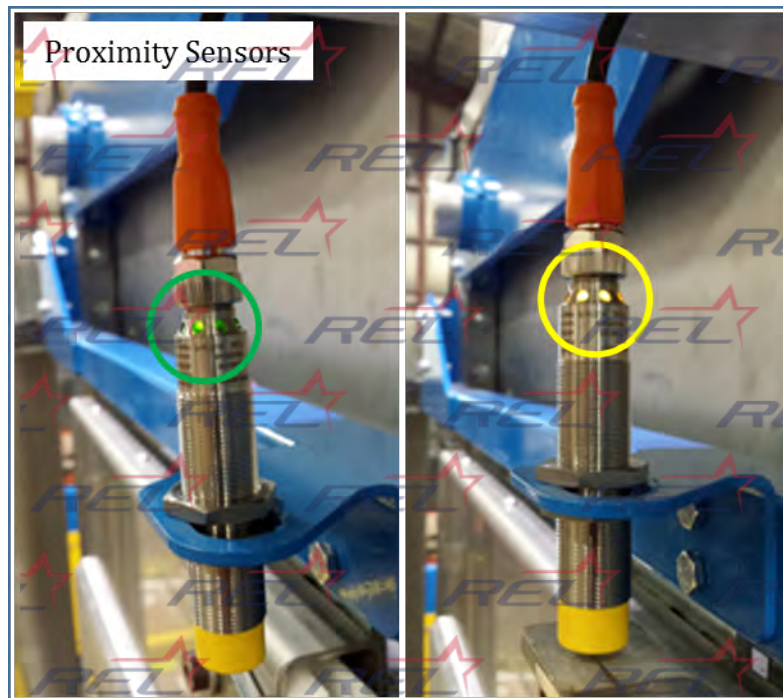


Figure 9: Door OPEN green light (left); Door CLOSED yellow light (right)

Emergency Stops

There are Emergency Stops (E-Stops) located throughout the FPI line. The minimum locations are each main panel CP1000, CP2000, the two HMI panels CP10 and CP20, the Penetrant Station (Station 20), the Pre-Rinse Station (Station 40), and the Post-Rinse Station (Station 60).

An E-Stop is Off, in the Out position and the light will be Off (*Figure 10, left*). If an E-Stop is pressed it will blink red, all other E-Stops will turn solid red (*Figure 10, right*) and all of the functions throughout the line will be stopped.

An Alarm will display on the HMI to tell the operator which E-Stop has been pressed (*Figure 10, bottom*). To restart the line, the E-Stop must be pulled back out and the system will need to be restarted from the HMI.

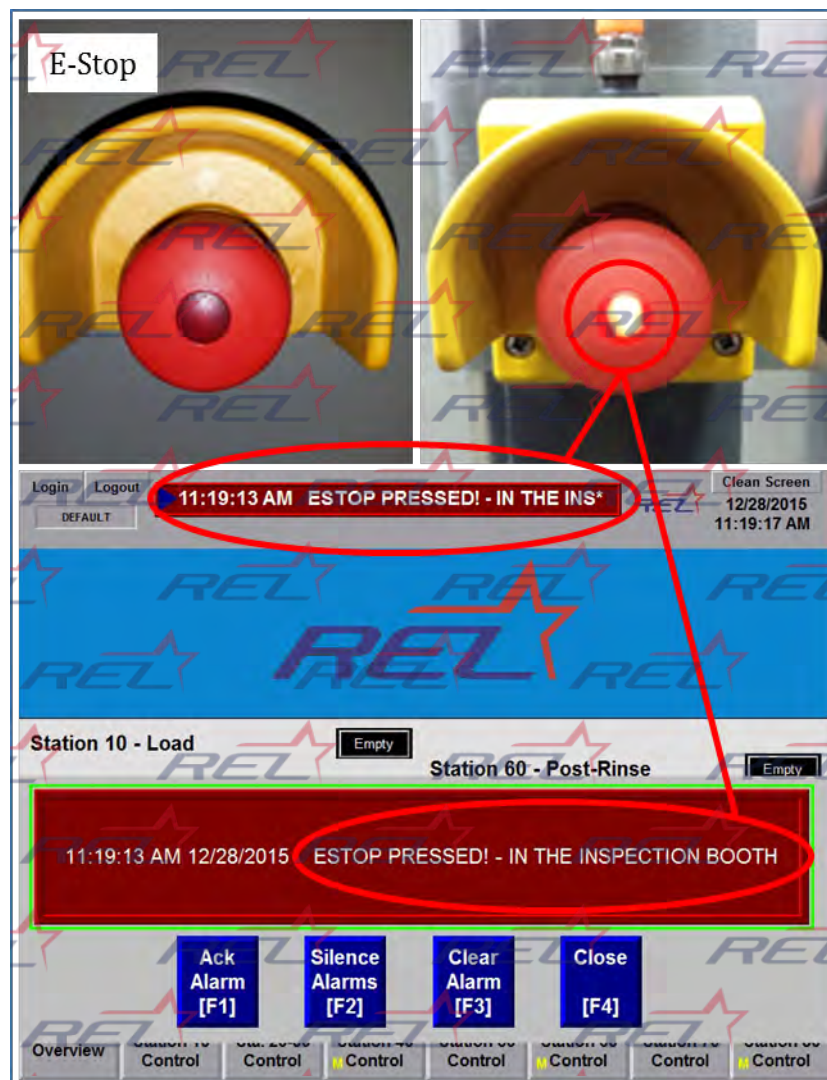


Figure 10: E-Stop Off (above left); E-Stop Pressed (above right);
HMI E-Stop Alarm Notification (bottom)

Light Curtain

If the light curtain is broken at any time, the local conveyors will not run and doors will not go up or down. An LED on the light curtain displays the status Green for OK (Figure 11) and Red for Broken (Figure 12). The HMI screen at Station 10 also displays the status of the light curtain (Figure 11 & 12).

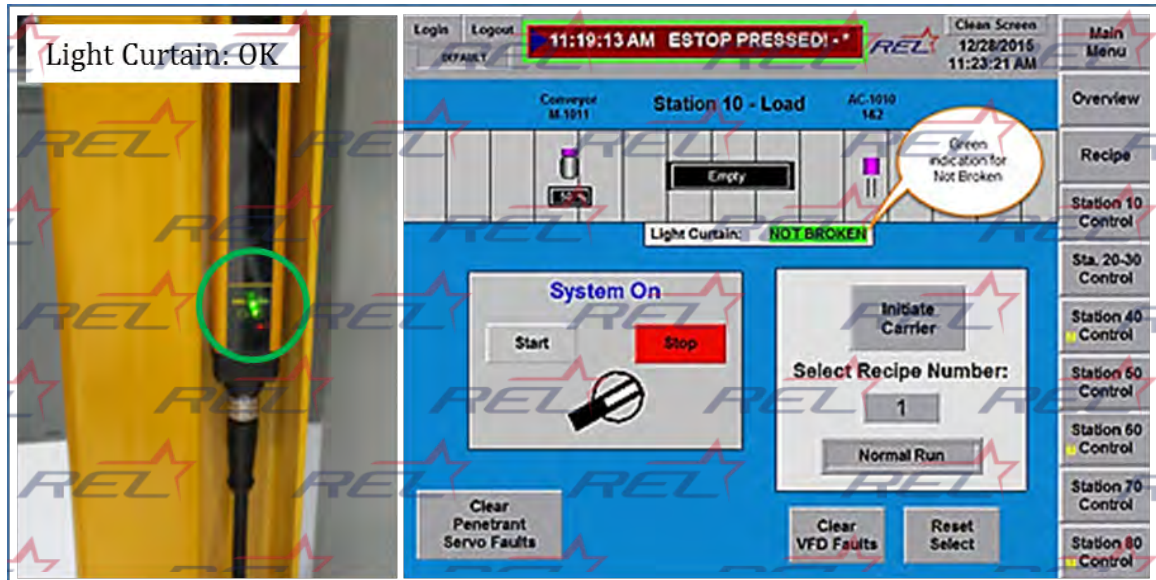


Figure 11: Light Curtain Green- Ok, Unbroken

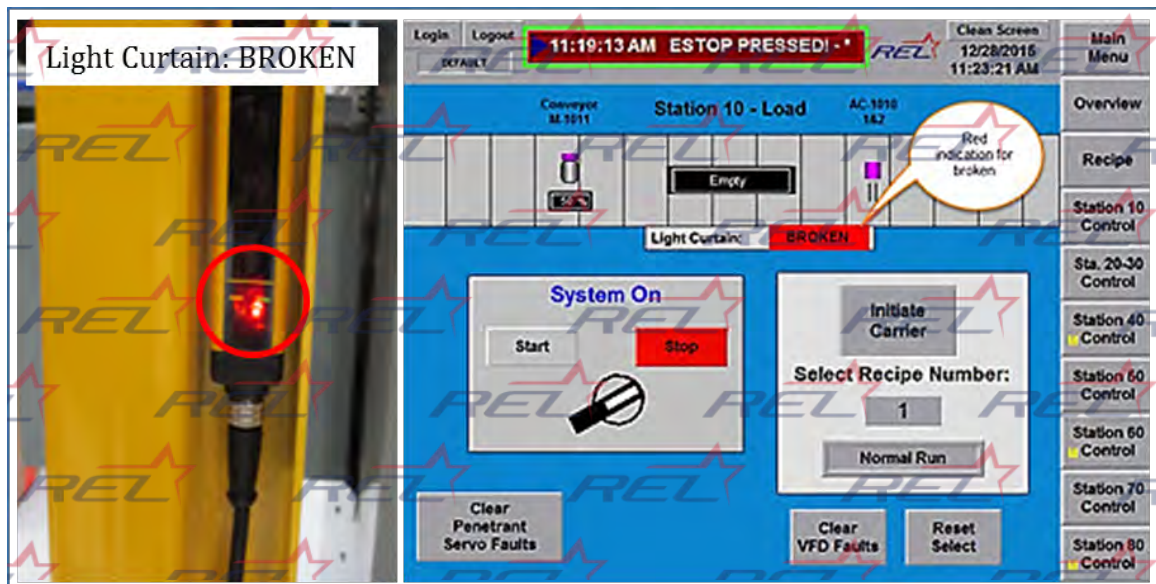


Figure 12: Light Curtain Red- Broken



Recipe Editing

The operator must login with security rights to view this screen. The recipe screen allows the operator to change the parameters throughout the process. This Recipe will control each carrier as it goes through the line.

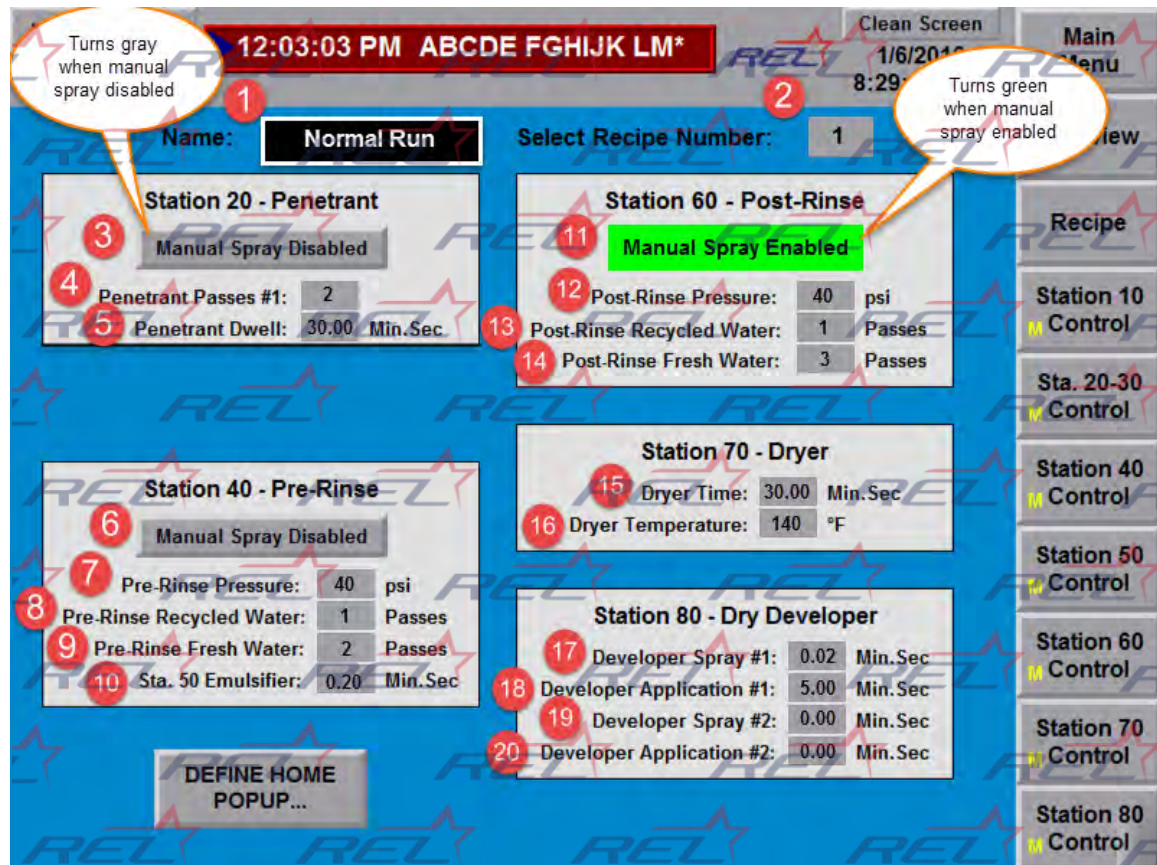


Figure 13: Recipe Editing Screen

Note: The values here do not reflect a recipe that will be used. Times were used for test purposes only.

1. Recipe Name: Each recipe can be given a unique name. This name will also display on the Station 10 Control screen when that recipe is chosen.
2. Recipe Number: Select which Recipe you wish to look at or edit.
3. Penetrant Manual Spray: If chosen, this will stop a carrier after the automatic spray sequence is complete. The operator will be able to open the doors and rotate the carrier (green pushbutton) for inspection or manual spray application. Before the carrier can advance, the operator must send it to the "Home" position (red Button).
4. Penetrant Passes: Sets number of rotations or passes for Penetrant to be applied.
5. Penetrant Dwell: This will be the total time that the parts must Dwell after the Penetrant has been applied, before it can enter the Pre-Rinse Station. The time



- will be remembered whether the carrier is still in Station 20 or has moved to Station 30.
6. Pre-Rinse/Manual Rinse: Enabling this will cause the carrier to stop after the Automatic rinse sequence is complete. The operator will be able to open the doors and rotate the carrier (green pushbutton) for inspection or manual rinse application. Before the carrier can advance, the operator must send it to the "Home" position (red push button).
 7. Pre-Rinse Pressure: Sets water pressure of the rinse.
 8. Pre-Rinse Recycled Water Passes: The number of passes for Recycled Water Rinse.
 9. Pre-Rinse Fresh Water Passes: The number of passes for Fresh Water Rinse
 10. Emulsifier: Sets time the carrier will spend in the Emulsifier Tank. This time will not start until the carrier is lowered to the bottom of the tank.
 11. Post-Rinse/Manual Rinse: Enabling this will cause the carrier to stop after the Automatic rinse sequence is complete. The operator will be able to open the doors and rotate the carrier (green pushbutton) for inspection or manual rinse application. Before the carrier can advance the operator must send it to the "Home" position (red pushbutton).
 12. Post-Rinse Pressure: Sets water pressure of the rinse.
 13. Post-Rinse Recycled Water: The number of passes for Recycled Water rinse.
 14. Post-Rinse fresh Water: The number of passes for Fresh Water rinse.
 15. Dryer Time: Sets amount of time the carrier spends in the Dryer (time will accumulate whether at position one or two).
 16. Dryer Temperature: The set-point for the Dryer Temperature.
 17. Dry Developer Spray Time #1: Amount of time that the Developer will be applied.
 18. Developer Application Time #1: Amount of time that the carrier will dwell in the station after the Developer has been applied.
 19. Dry Developer Spray Time #2: The amount of time for a second spray of Developer (if needed).
 20. Developer Application Time #2 (if needed)

To change a setting in the recipe screen:

1. Choose the setting by tapping it on the screen.
2. A keypad will pop up to allow you to enter a new value.
3. After entering the new value, press the  button and the keypad will disappear.

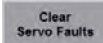


Starting a Carrier: Stations 10-30

- **Station 10-Load Station**
- **Station 20-Penetrant Station**
- **Station 30-Dwell Station (two positions)**

Note: The Dryer must be ON before starting a carrier. This allows the Dryer to get up to temperature before a carrier arrives.

When power is turned on to the system this will be the first screen that is displayed (*Figure 14*). This screen shows all of the control at Station 10. This is also the screen where the line can be started or stopped and where the operator will initiate carriers to the line. When the system is On the “START” button will be highlighted green. If the system is OFF the “STOP” button will be highlighted red. When the system is turned ON and motors start, the motors will turn green and will have a purple indicator to show that the motor is running in Auto mode.

This screen has a  button to clear motor faults and a  button to clear servo motor faults in the stations with rotating tables.

If the program is trying to advance an empty station, wait until all other carriers are stopped in the loaded position. Press the  button to clear the nonexistent carrier from the program.

Station modes such as  are shown on the HMI for each station in a black box. As a carrier moves down the line the following modes are possible:

- EMPTY
- OK TO LOAD
- LOADING
- LOADED
- OK TO ADVANCE
- ADVANCING
- STATION ACTIVE

When a basket is ready on the Load Station, press the  to turn the system On.

To send a basket down the line, press the  button. The Penetrant Entry Door (M1022) will open and the Load Station conveyor (M1011) will turn on. If the Penetrant Station is “OK TO LOAD” the carrier will move from Load Station into the Penetrant Station. When the carrier is “LOADED” in the Penetrant Station and both doors are closed, it will raise up by AC-1024. Penetrant will be automatically applied for the number of rotations set in the recipe. Raising the carrier up above the conveyors will allow it to rotate 360° so parts can be sprayed on all sides. After the

Penetrant has been applied, the carrier has returned to the “Home” position, and the air cylinder has gone back down, it will move on to the Dwell Station.

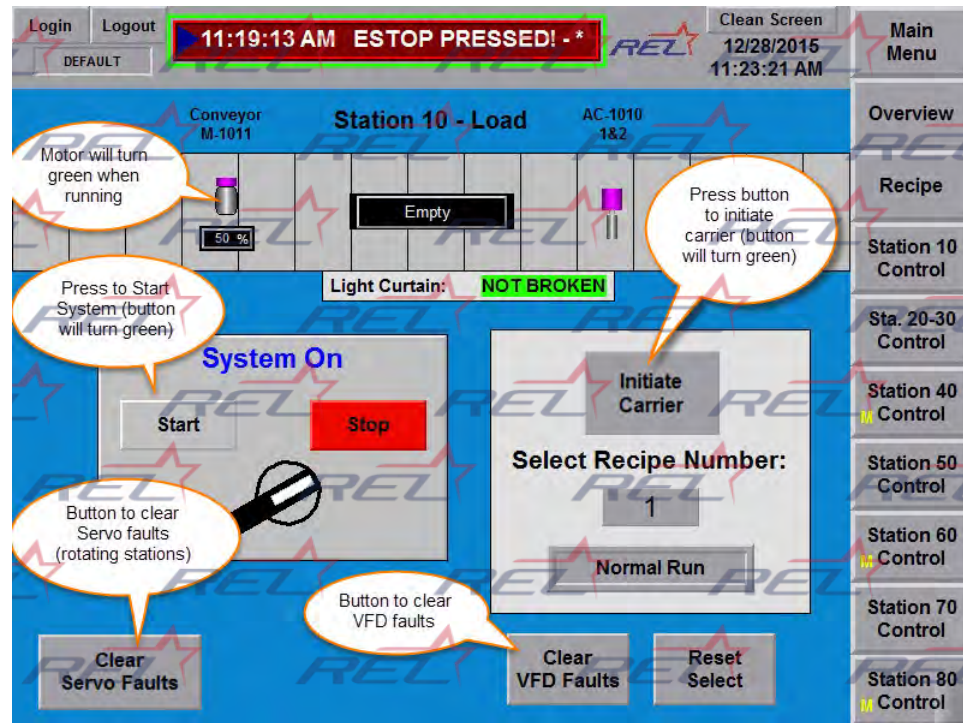


Figure 14: Station 10- System Start

The Control screen for Stations 20-30 (Figure 15) shows the Penetrant Station (20) and the Dwell Station (30). If the Penetrant Level inside the drum gets too low, the indicator on the screen will turn “OFF” (Figure 15) and an Alarm will display. The operator should then replace the drum. The actual level of the Penetrant can be read on the drum.

The Dwell Station allows for two carriers to dwell after Penetrant has been applied. The Penetrant station can also be used as a dwell after penetrant has been applied. If Station 30 is empty, a carrier will automatically move to position two and leave position one open for the next carrier. The Dwell time remaining for a carrier is displayed under each position. The Dwell time will not reset when a carrier moves between position one and two or from the Penetrant station. When Dwell time is complete, the carrier will move on to the Pre-Rinse Station.

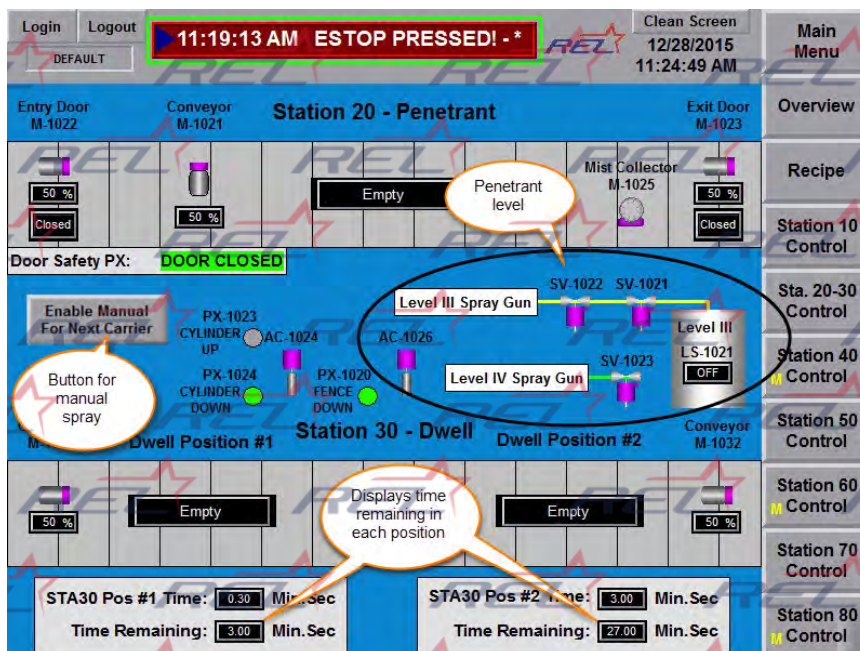


Figure 15: Stations 20 & 30- Penetrant & Dwell

Station 20: Penetrant Manual Enabled

“MANUAL ENABLED FOR NEXT BASKET” button turns green when chosen and allows the parts to be manually sprayed before moving on to the dwell station. If the station is loaded and button is selected, the Operator can manually spray the current carrier. If the station is empty and the button is selected, the operator can manually spray the next carrier coming down the line. If the Manual spray is chosen in the Recipe, all baskets that go through that recipe will need to be manually sprayed.

When Manual Spray is enabled the carrier will need to be rotated using the green pushbutton mounted at the station (*Figure 16, left*). This button will blink after the Automatic Spray sequence is complete indicating that the station is waiting for manual intervention. In order to move to the next station, the carrier will need to be “Homed” by the red pushbutton (*Figure 16, right*).

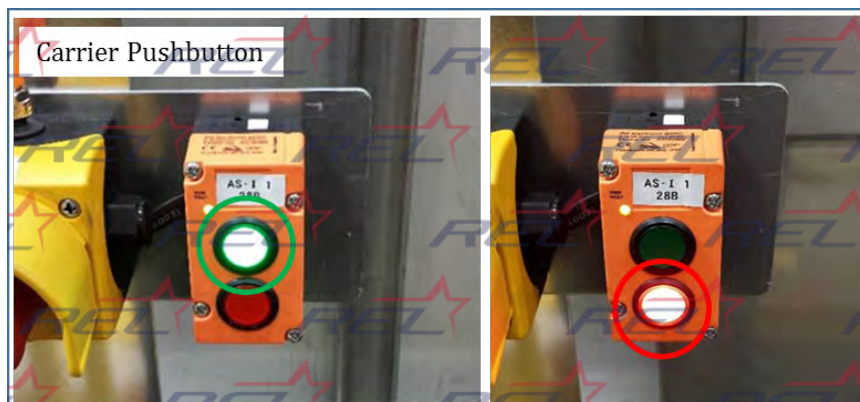


Figure 16: Left- Green Pushbutton will rotate carrier when pressed & stop when released;
Right- Red Pushbutton will automatically rotate carrier to the Home position & lower carrier onto conveyor

Rinse & Emulsify: Stations 40-60

- Station 40- Pre-Rinse Station
- Station 50- Emulsifier
- Station 60- Post-Rinse Station

The temperatures and levels are both displayed on the Station 40 (Pre-Rinse) screen for the Recycled Water Tank inside the Pre-Rinse station and the Fresh Water Tank above the station. The valves for each tank are also shown. During the rinse cycle, the operator will be able to see which valve is open on the HMI screen. The level in each tank will be displayed in inches.

The  button will open a screen that can show a graph of Pre-Rinse and Post-Rinse pressures and Dryer temperatures.

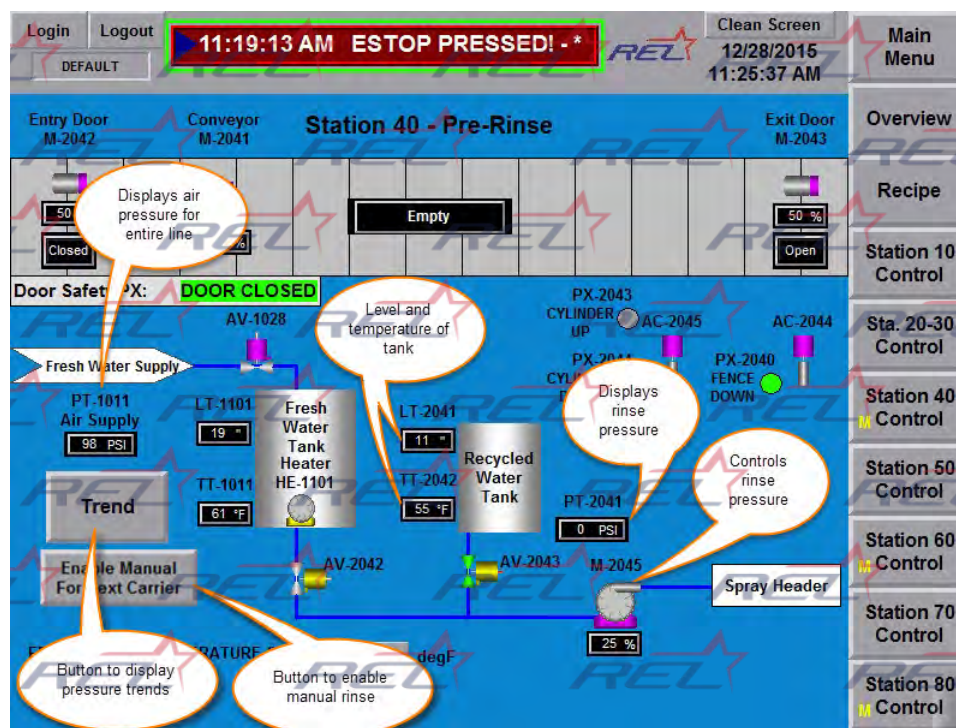


Figure 17: Station 40- Pre-Rinse

When the Trend button is pressed on the Station 40 screen, a graph will be displayed showing the pressures for the Pre-Rinse and the Post Rinse (*Figure 18*). The operator will be able to go back and look at previous pressures from this screen. The Pre-Rinse is shown by a blue line and the Post-Rinse is shown with a green line.

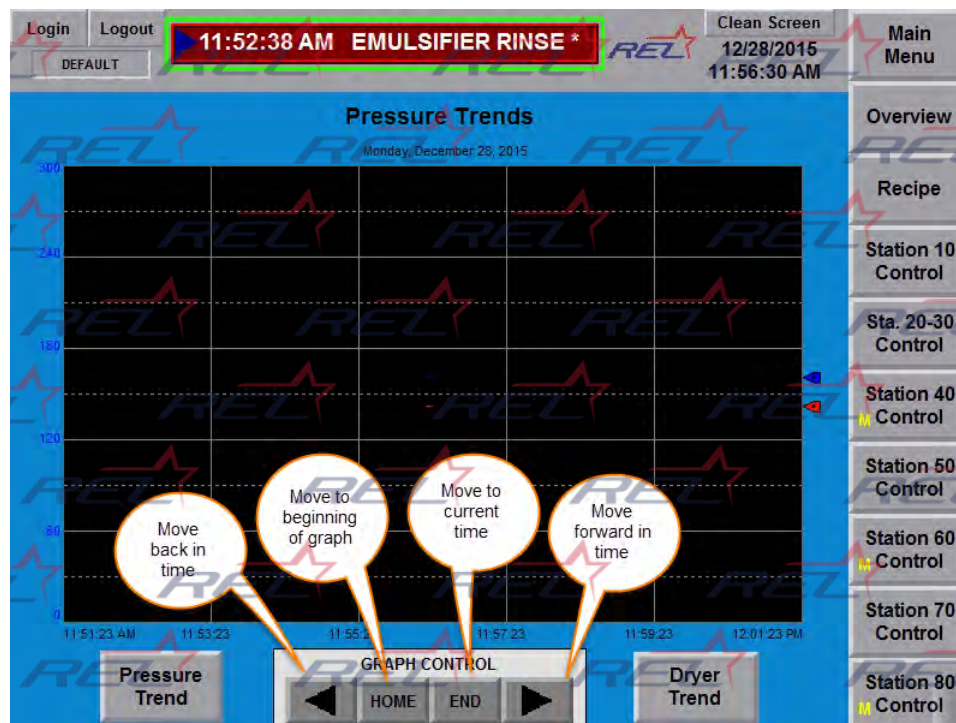


Figure 18: Pressure Trend

When Manual Rinse is enabled, the carrier will need to be rotated using the green pushbutton mounted at the station (*Figure 16, left*). This button will blink after the Automatic Spray sequence is complete indicating that the station is waiting for manual intervention. In order to move to the next station, the carrier will need to be "Homed" by the red pushbutton (*Figure 16, right*).

After the rinse is complete, the carrier will move to Station 50 (Emulsifier). The time for the Emulsifier will not start until the carrier is lowered to the bottom of the tank. The Emulsifier time set point and time remaining are shown on the HMI screen. When the tank level gets below 28 inches, a batch of emulsifier will automatically be added through the flowmeters. If the emulsifier drum gets too low, an alarm will pop-up on the screen and emulsifier will have to be added. The emulsifier concentration can also be changed from this screen. After the time is complete in the Emulsifier, the carrier will be lifted out of the tank and sent to the Post-Rinse Station.

Note: Because the parts must be rinsed in the Post-Rinse Station within two minutes of coming out of the Emulsifier, there are interlocks programmed so the Emulsifier cannot dip until the Post-Rinse Station is "OK TO LOAD."

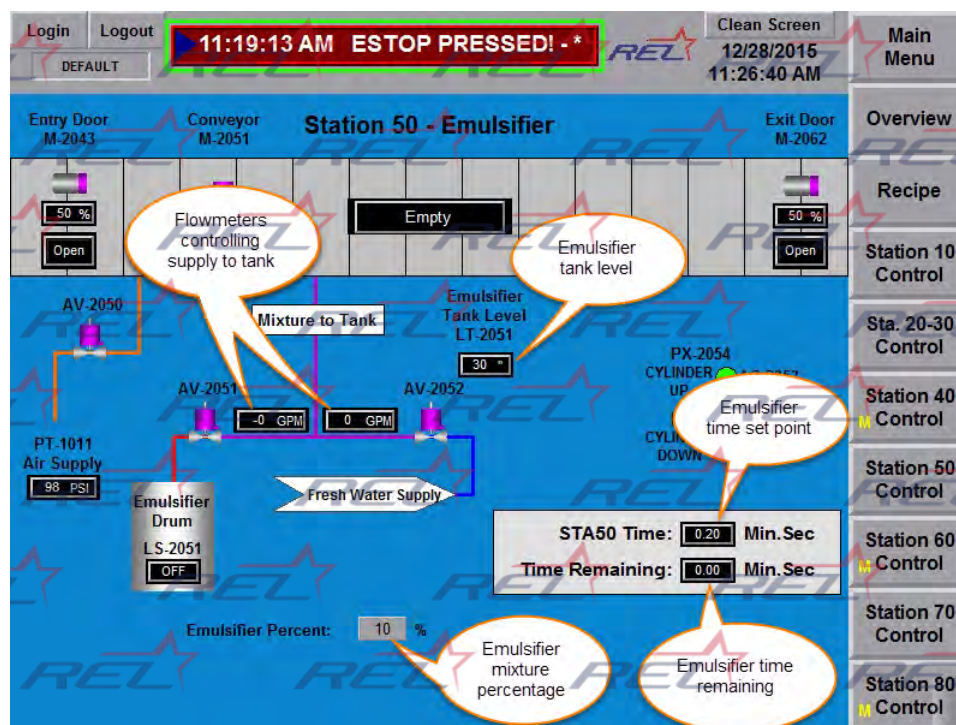


Figure 19: Station 50- Emulsifier

Change Emulsifer Concentration:

1. Select the current value on the screen **Emulsifier Percent: 10**.
2. A keypad will pop up where the operator can enter a new percentage.
3. Press the button to save the value and make the keypad disappear.

The Post-Rinse station is similar to the Pre-Rinse station. The rinse will be controlled by M2065 with the pressure displayed by PT-2061 on the HMI screen.

The temperatures and levels are both displayed on the Station 50 (Emulsifier) screen for the Recycled Water Tank inside the Post-Rinse station and the Fresh Water Tank. Both rinse stations use the same Fresh Water Tank which is above the Pre-Rinse Station. The valves for each tank are also shown. During the rinse cycle, the operator will be able to see which valve is open on the HMI screen.

The button on the Post-Rinse screen will open the same pressure trend graph as the Pre-Rinse Trend button.

The button works the same as the Pre-Rinse. The button turns green when chosen and allows the parts to be manually rinsed before moving on to the next station. This button will only make the Operator manually rinse and home the next carrier (different from the Recipe). If the manual rinse is chosen in the Recipe, all carriers that go through that recipe will need to be manually rinsed.

When Manual Rinse is enabled the carrier will need to be rotated using the green pushbutton mounted at the station (*Figure 16, left*). This button will blink after the Automatic Spray sequence is complete indicating that the station is waiting for manual intervention. In order to move to the next station, the carrier will need to be “Homed” by the red pushbutton (*Figure 16, right*).

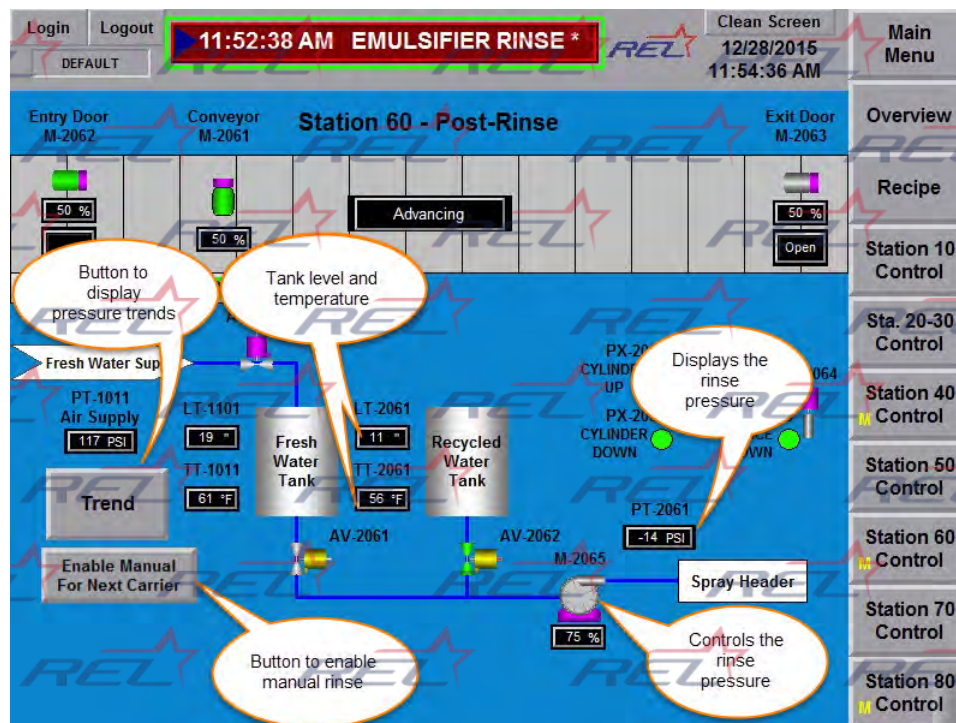


Figure 20: Station 60- Post-Rinse



Dry & Developer: Stations 70 & 80

- Station 70- Dryer
- Station 80- Dry Developer/Unload

When a carrier has completed the Post-Rinse, it will move into the Dryer for a set amount of time. As noted earlier, the Dryer should be turned On before a carrier is loaded. There are two positions in the Dryer allowing two carriers to be dried at the same time. Time remaining for the carrier at each position is displayed on the screen.

The  button on the Dryer Screen will show a graph of the Dryer temperatures (*Figure 22*). Three lines will be shown on the graph. Green is the temperature at the coil, Red is the station temperature and Blue is the true station temperature (with the offset calculation).

There are two temperatures shown on the Dryer screen. TT2071 displays the coil output temperature and TC2072 shows the actual temperature in the station.

Note: The duct fan will stay on for a short time after the dryer is shut off.

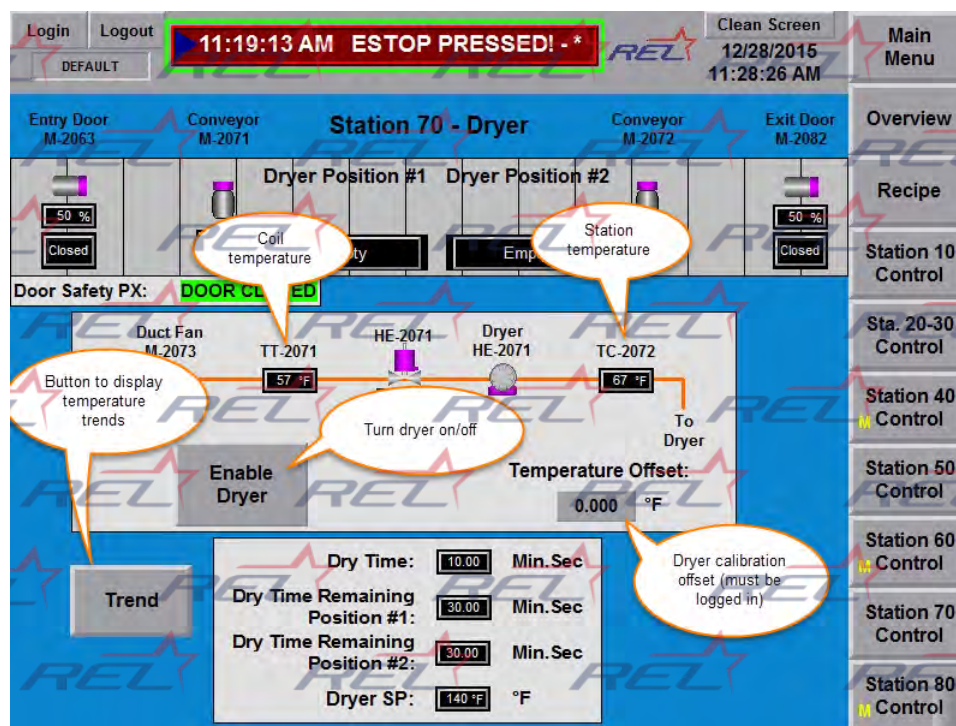


Figure 21: Station 70 -Dryer

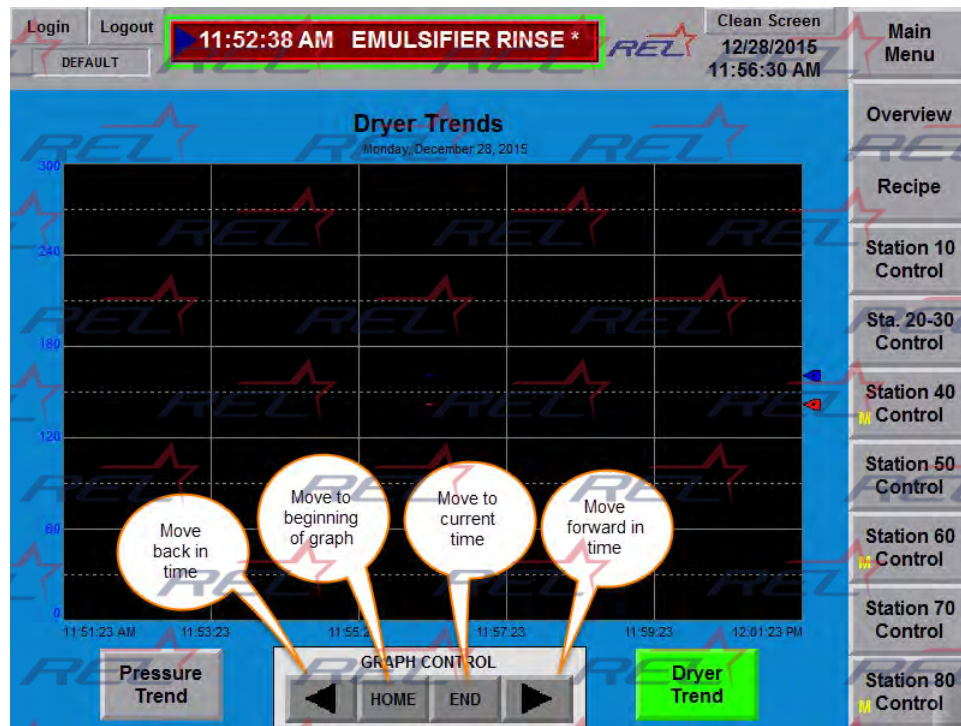


Figure 22: Dryer Trend

Dryer Calibration:

When dryer calibration is needed, there is a box on the side of Panel CP2000 that allows for a calibration tool plug-in to read the thermocouple temperature (*See Temperature Calibration in Preventative Maintenance & Figure 25 for illustration*). The Operator will need to be logged-in with additional security to calibrate the sensor on the HMI.

To Calibrate Sensor:

1. Log into HMI with proper security.
2. Select the current offset value .
3. A keypad will pop up allowing the operator to enter a new offset value (either negative to subtract degrees or positive to add degrees).
4. Press the  button to save the value and make the keypad disappear.

Alarms

There are many alarms programmed into the FPI line. When an alarm pops-up on the HMI screen, it should be Acknowledged. The screen below (*Figure 23*) shows how the alarms are listed. The user will have the ability to scroll through the latest alarms.

The Alarm screen also has a  button that will open a new screen showing the latest motor fault codes (*Figure 24*). This allows the operator to view the fault codes from the drive without having to open up the panel.

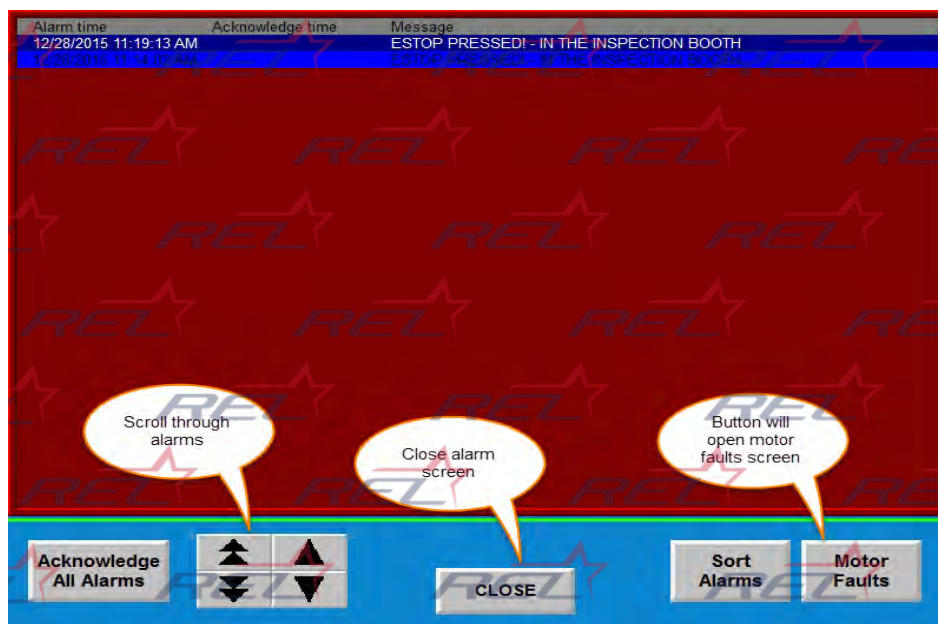


Figure 23: Alarms



Figure 24: Motor Faults



Preventive Maintenance

Introduction

Preventive maintenance (PM) is essential for the proper operation of the Semi-Automated Fluorescent Penetrant Application Machine (FPAM) and the **iFPI** Systems. Elements of an effective PM program include documentation, verification of proper operation, routine maintenance, inspection, spare/replacement parts, and electrical maintenance.

CAUTION!

Do not attempt to perform any maintenance on equipment until all safety instruction have been reviewed and all power sources are locked out as described in Chapter 2 – Safety of the O&M Manual.

Routine Maintenance

Lubrication of Bearings

All of the mounted bearings and turntables require grease lubrication. See Lubrication Charts for all locations. Lubrication charts will be attached to each Station. *(A sample Lubrication Chart is located on page 33)*

Gear Box Oil

See manufacturers recommendations regarding changing oil in the drive motor gearbox. All conveyor and overhead door drives are Nord Drivesystems. Gearboxes on the turntables are by Diequa Corp. Lubrication charts will be attached to each Station.

Chain Maintenance

Over time, the drive chains and carriage lifting chains will stretch. Checking and correcting the chain tension on a regular basis will prevent downtime that can be caused when a chain becomes too loose. Inspect the chains on each Station after every six months of operation. Use the following steps to properly inspect each chain.

- Check the sprocket teeth. Replace the chain if the sprocket teeth show signs of wear. If the teeth are excessively worn, also replace the sprockets.
- Check slack in the chain by rotating the idler sprocket so that one strand is taut and measuring the total sag between the slack chain and a straight edge across the top of the sprockets. For horizontal drives this sag should be 1-2% of the sprocket center to center distance, for vertical drives it should be only 0.5-1%.

UHMW Wear Blocks / Strips

The wear blocks and strips should be inspected after every year of operation. Replace if showing signs of excessive wear.

Pressure Gages

All pressure gages are mounted on quick disconnect fittings. The gages are NIST certified. The calibration sheets are always included.

Temperature Calibration

The calibration point for the oven is located behind the line. There is a test port located in the side of the specifically supplied panel for thermocouple calibration. The junction point (customer specified junction type), micro and macro are installed. The ability to measure the thermocouple sensor's reading either in parallel to our PLC input or separately by the customer supplied Thermocouple calibrator is possible.

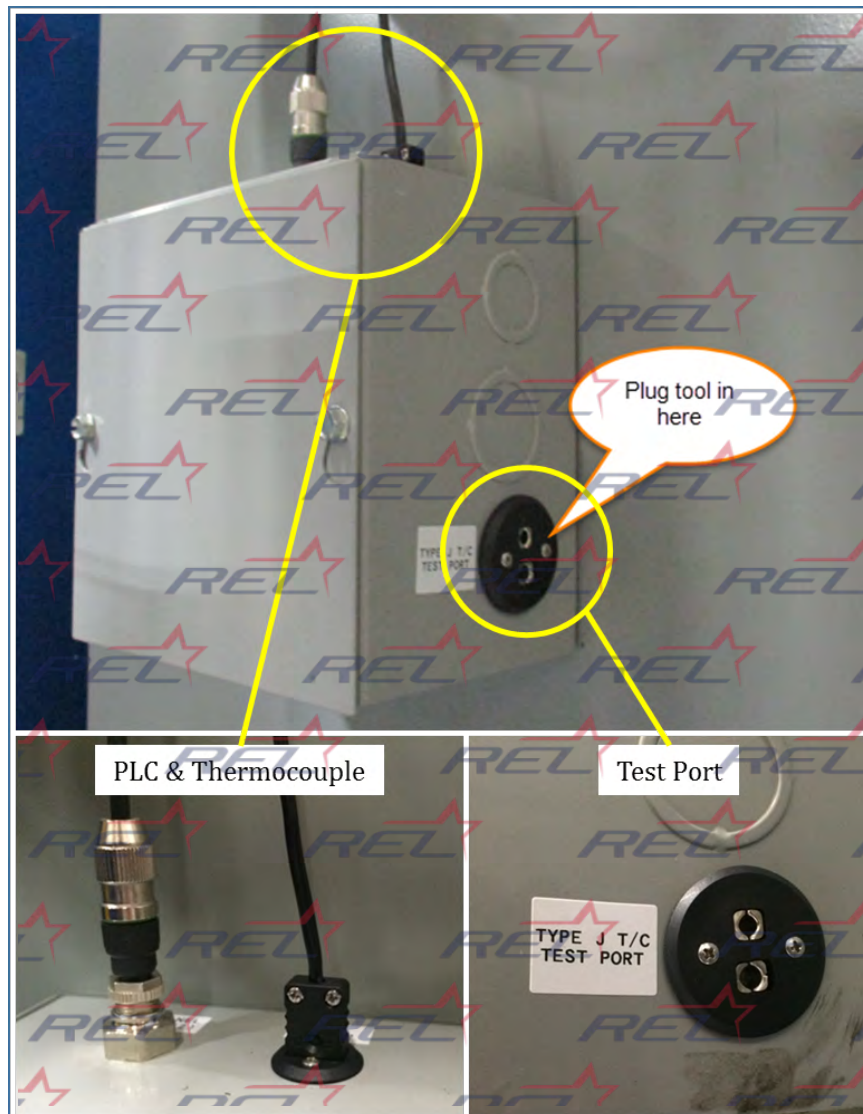
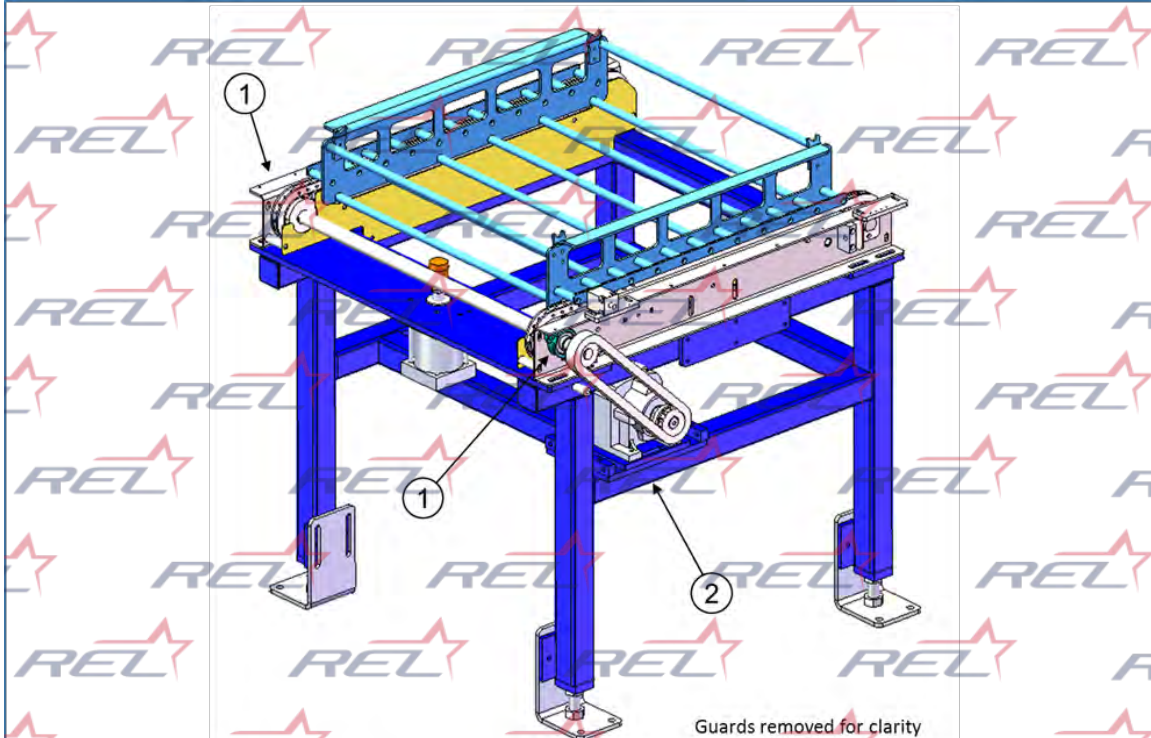


Figure 25: Temperature Calibration- Input Thermocouple & PLC Connection (bottom left); Calibration Test Port (bottom right)

When calibrating the oven verify that the displays on both the HMI and the thermocouple calibrator are consistent.

Example: Lubrication Chart

Station 10 – Load Station lubrication



Station 10- Load Station: Lubrication Chart

Item	Description	Service frequency	Qty	Notes
1	Flange bearing, conveyor	grease every 6 months	2	#2 Lithium grease
2	Nord Gearmotor gearbox	check level every 6 months	1	CLP mineral oil

Example: Parts List

Station 10 – Load Station:

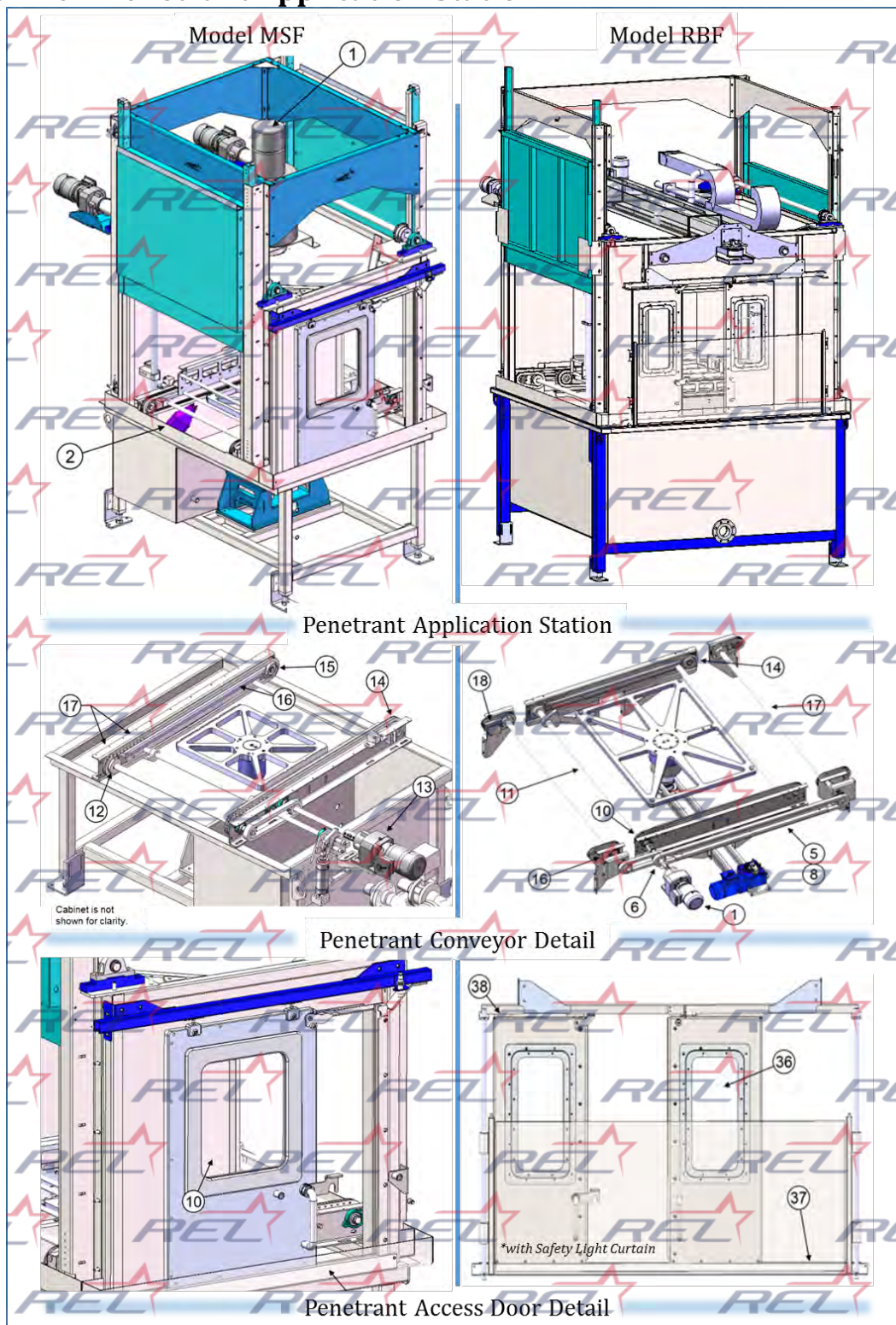


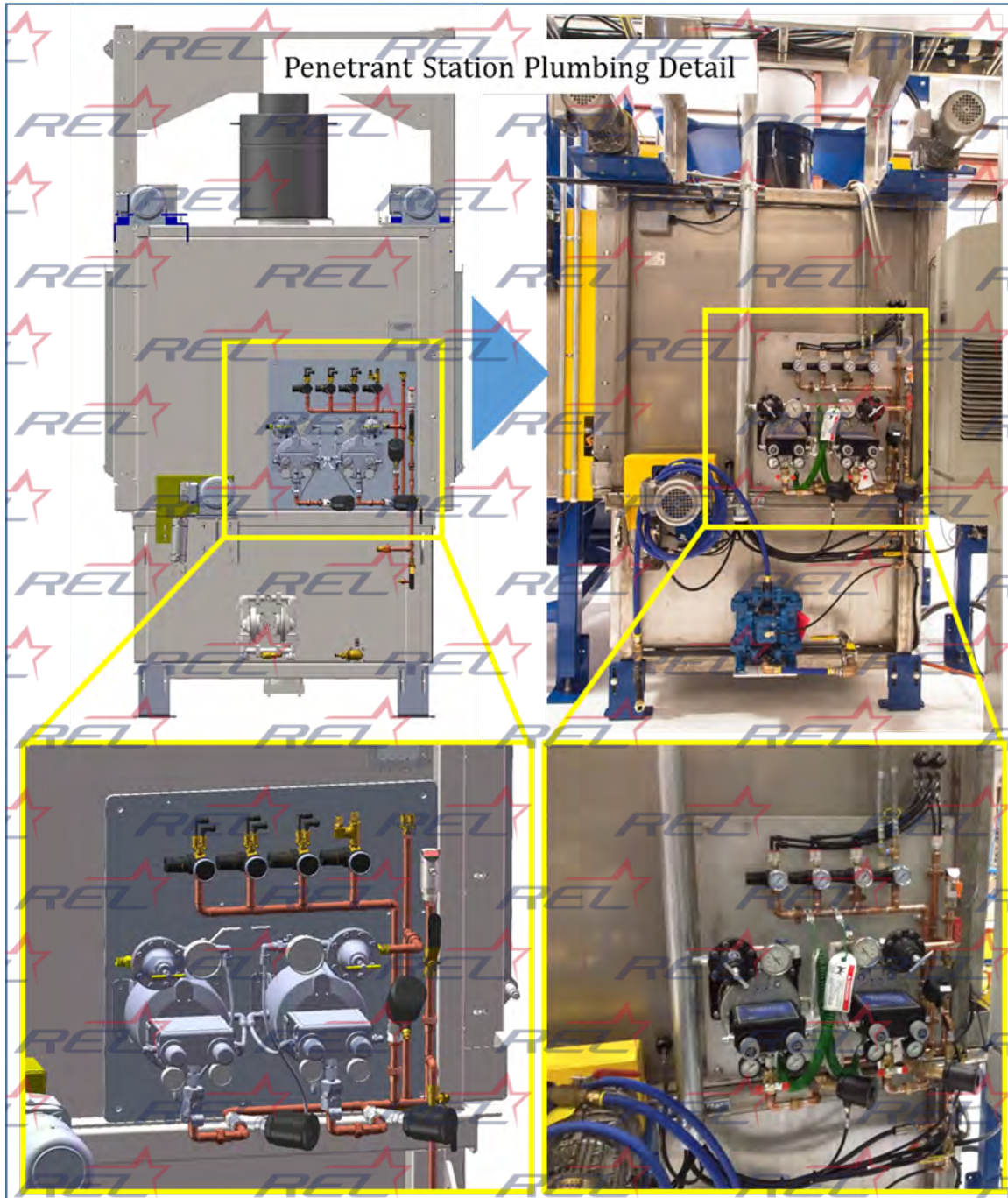
Station 10- Load Station: Parts List

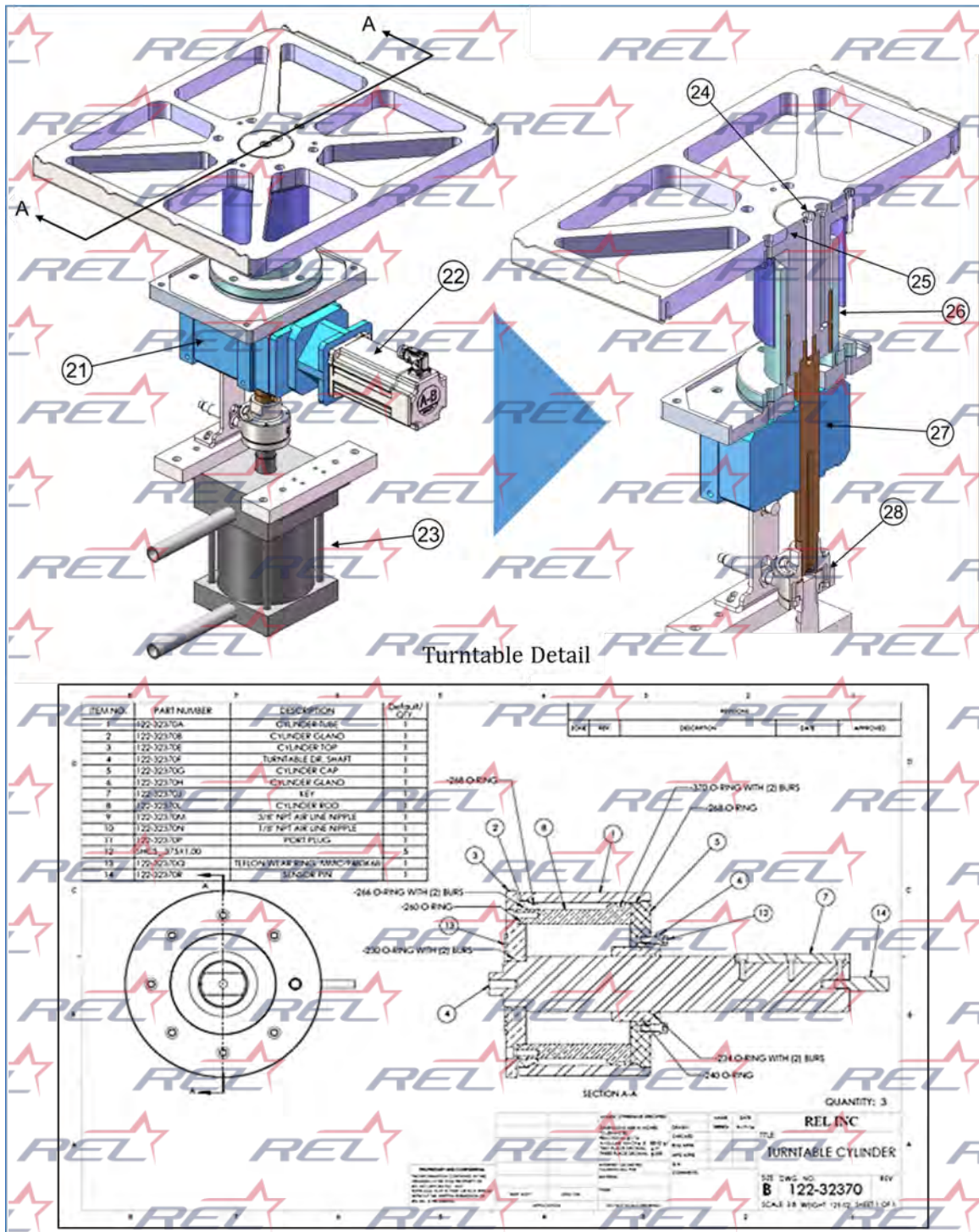
Item #	Mfg P/N	Description	Qty
1	999-SPRKT-D6017	Sprocket Assembly	2
2		#60 Chain (80.5" long)	2
3	190-00505C	Wear Strip	2
4	999-SPRKT-C6017	Sprocket Assembly	2
5		1" Bore Bearing 2-Bolt flange	2
6	999-SPRKT-E6012	Sprocket Assembly	2
7		#60 Chain (34" long)	1
8	SK373.1-XF-71S/4	Nord Gearmotor	1
9	6211K792	NFPA Air Cylinder, Dbl-Act. 4" Bore, 2" Strk	1

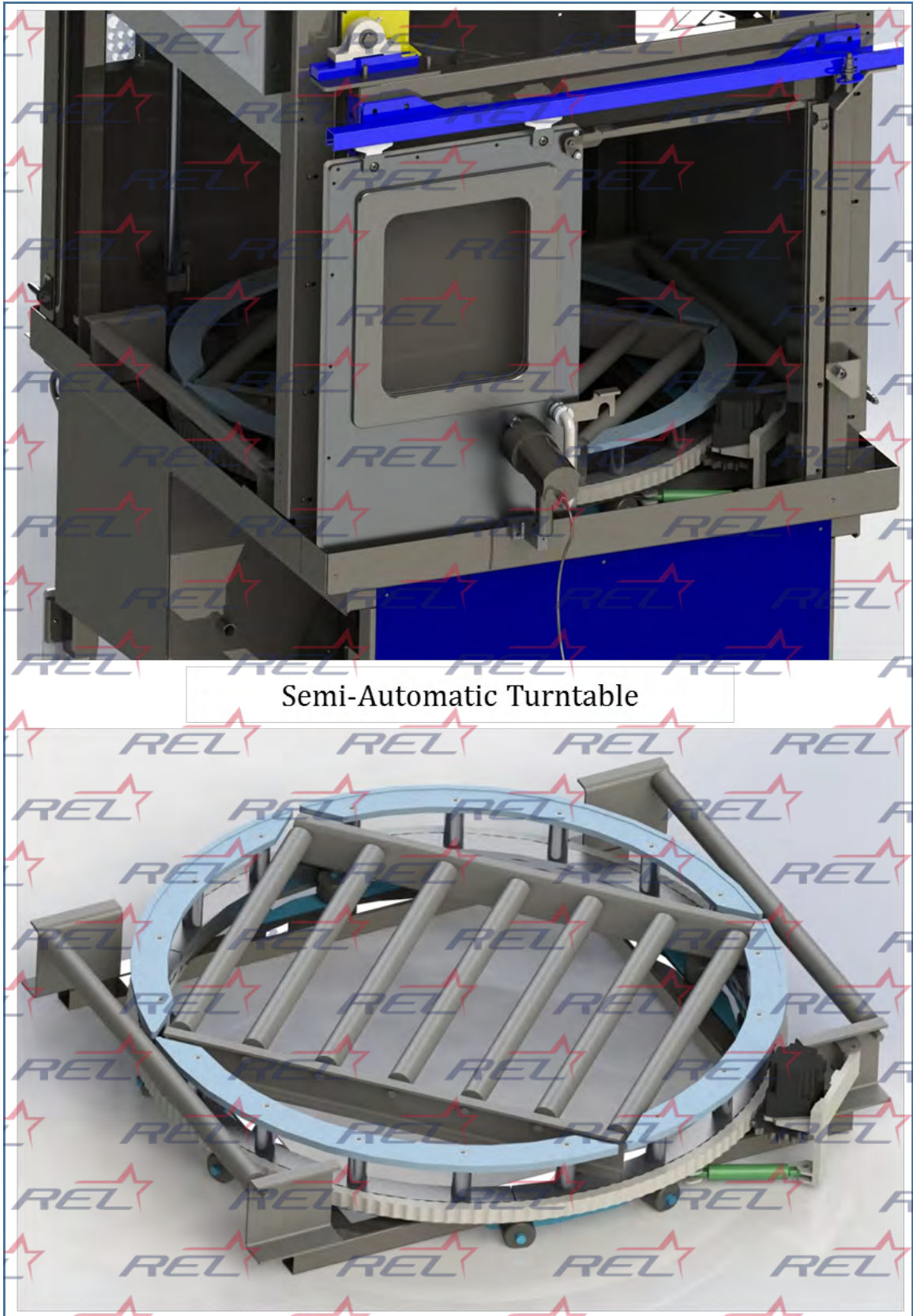
Example: Station Illustrations

Station 20 – Penetrant Application Station



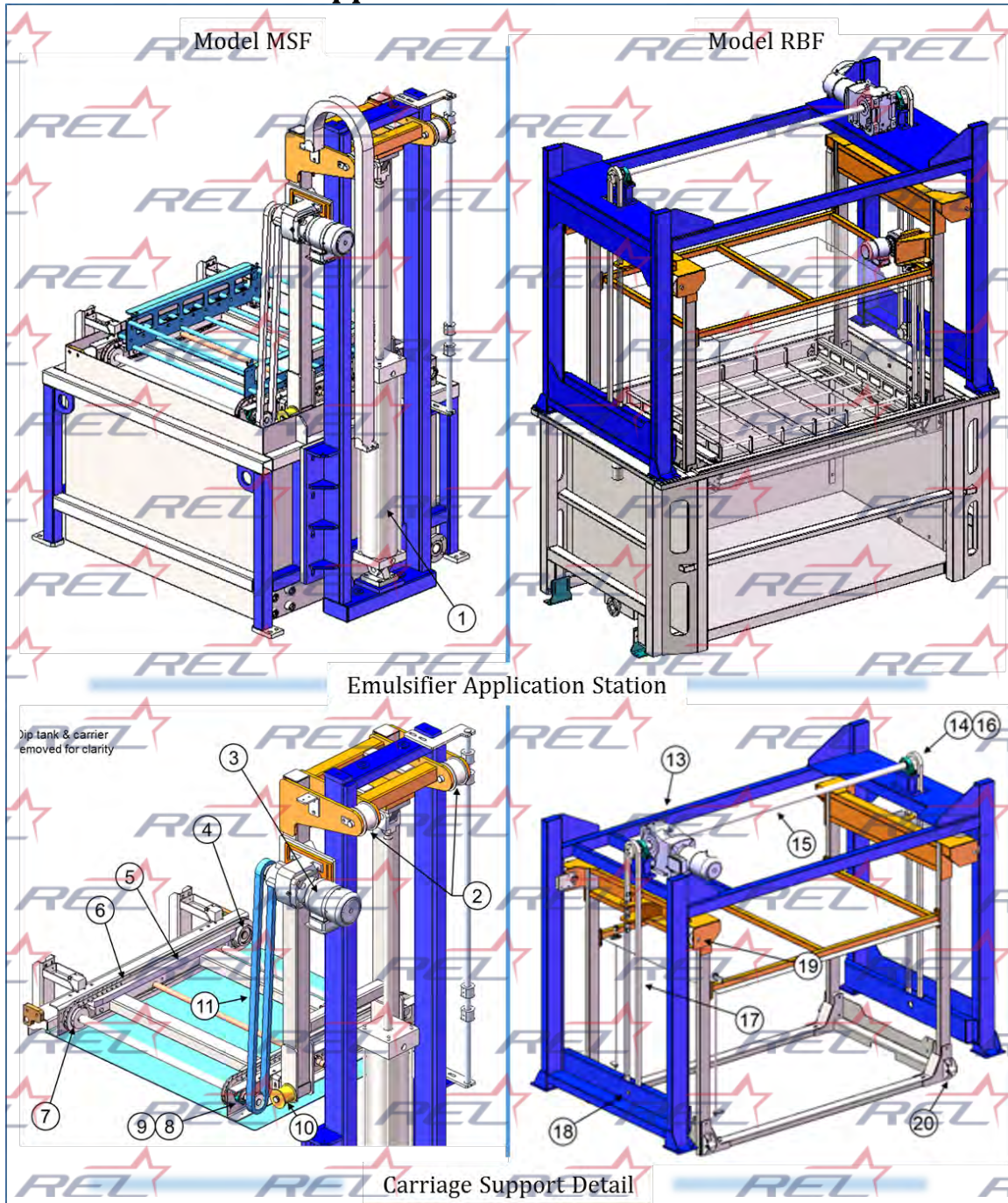


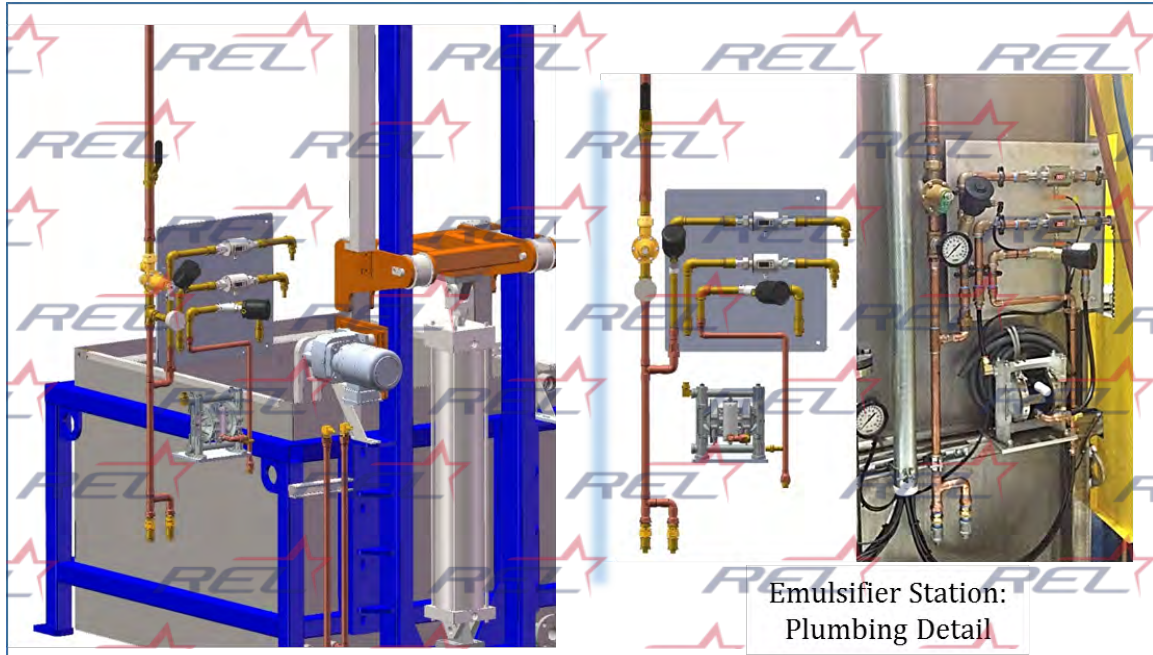




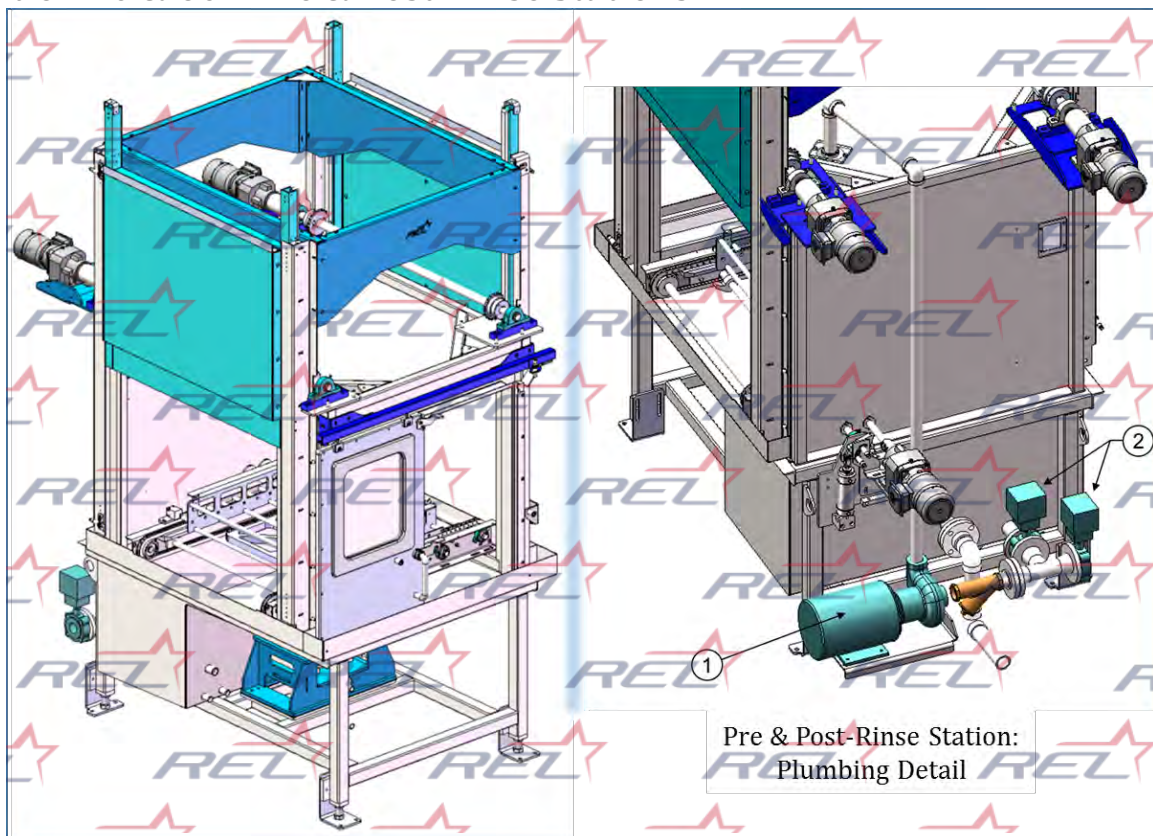
Semi-Automatic Turntable

Station 50 – Emulsifier Application Station



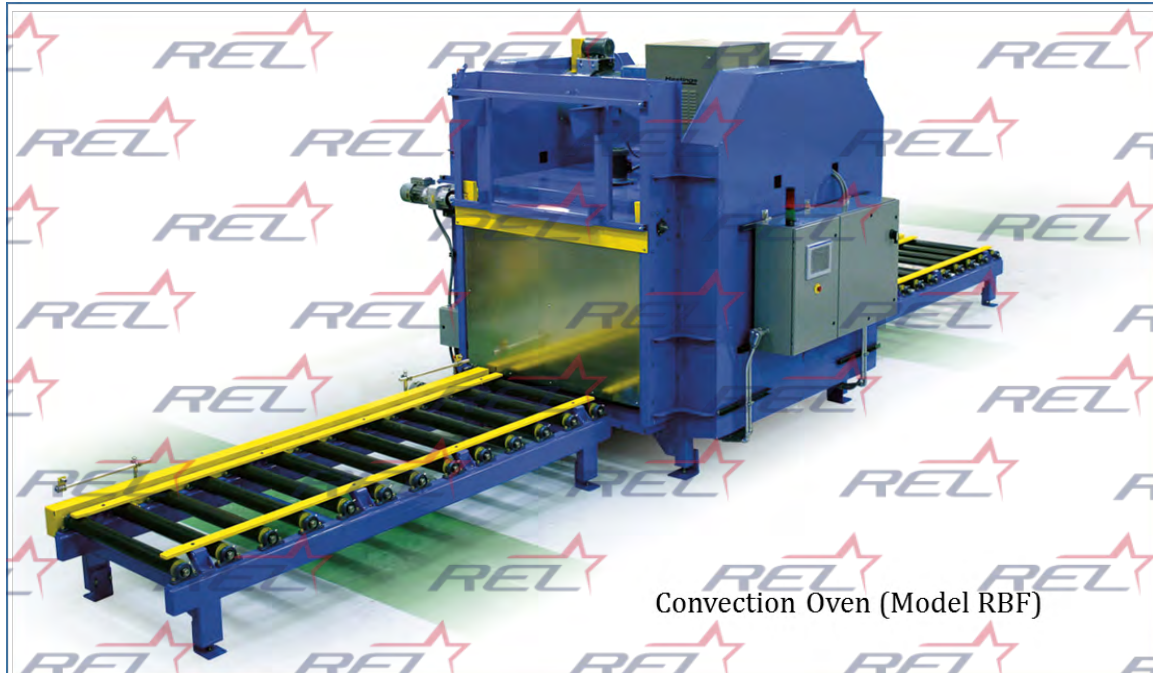


Station 40 & 60 - Pre & Post-Rinse Stations

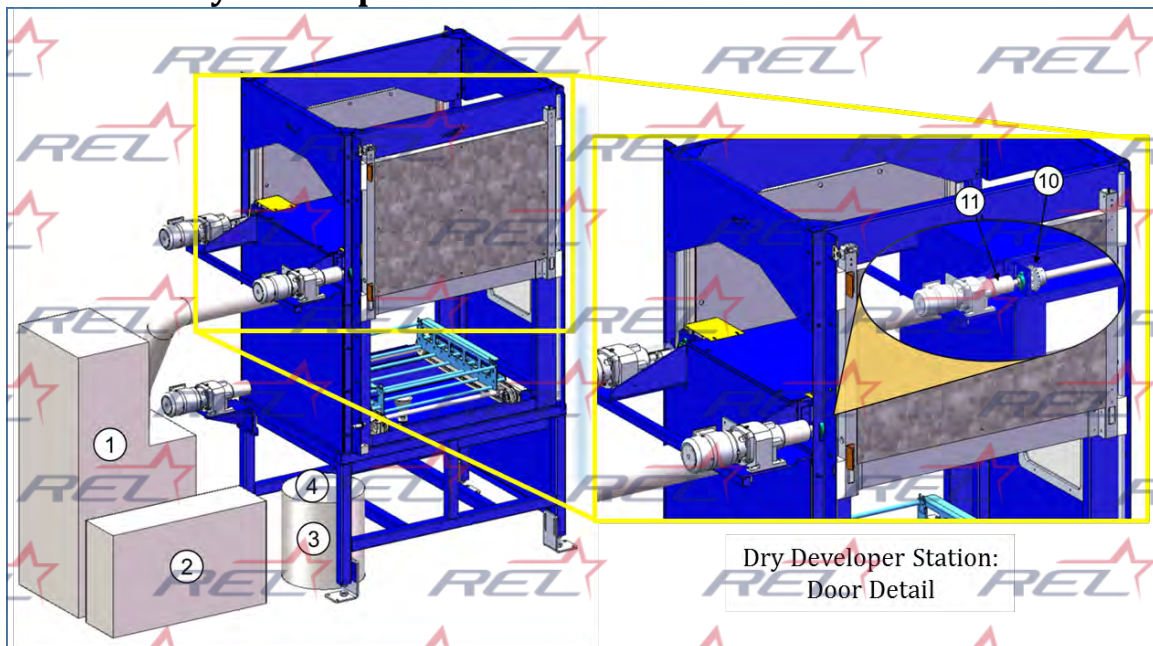


Station 70 – Dryer Station



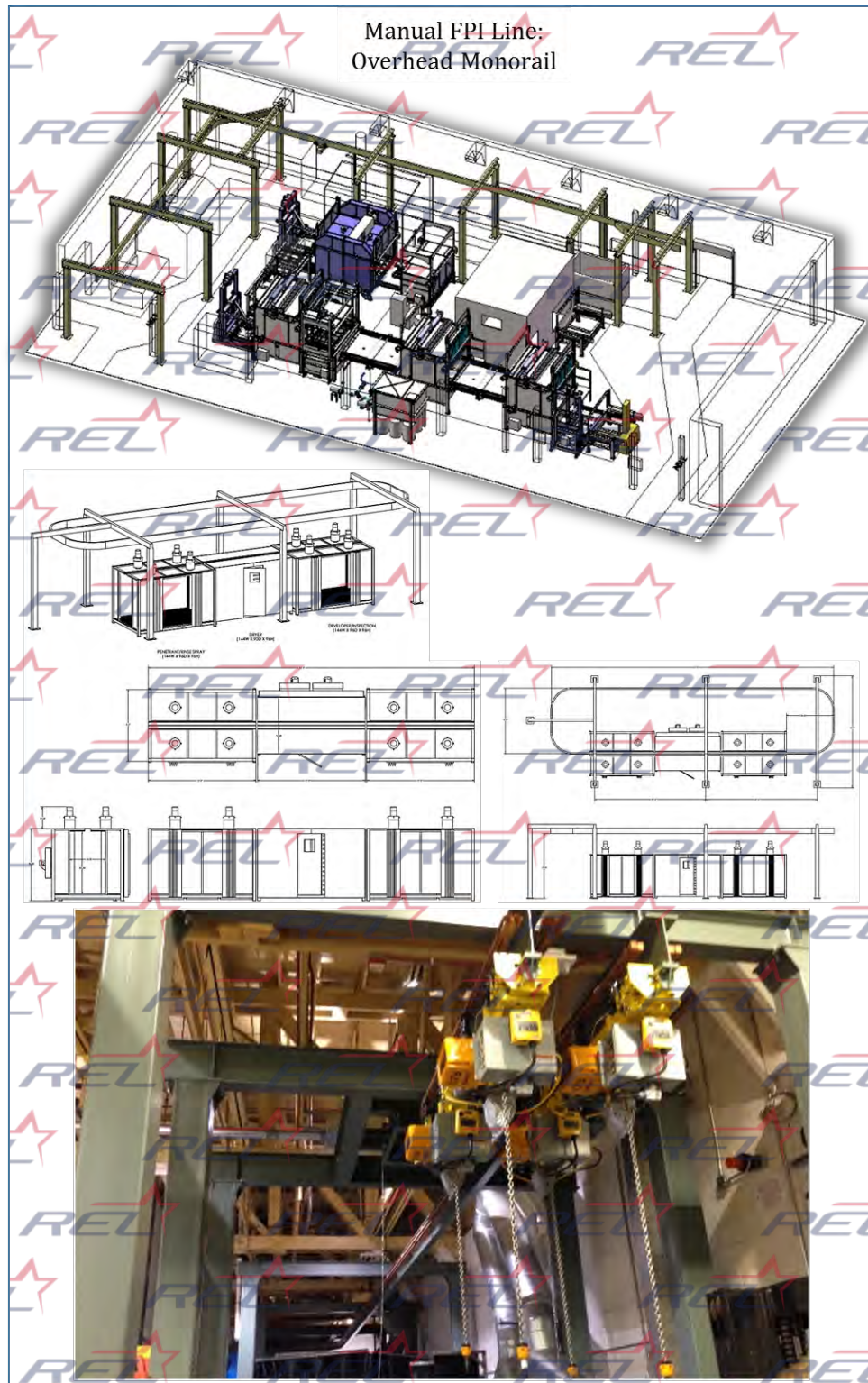


Station 80 - Dry Developer Station

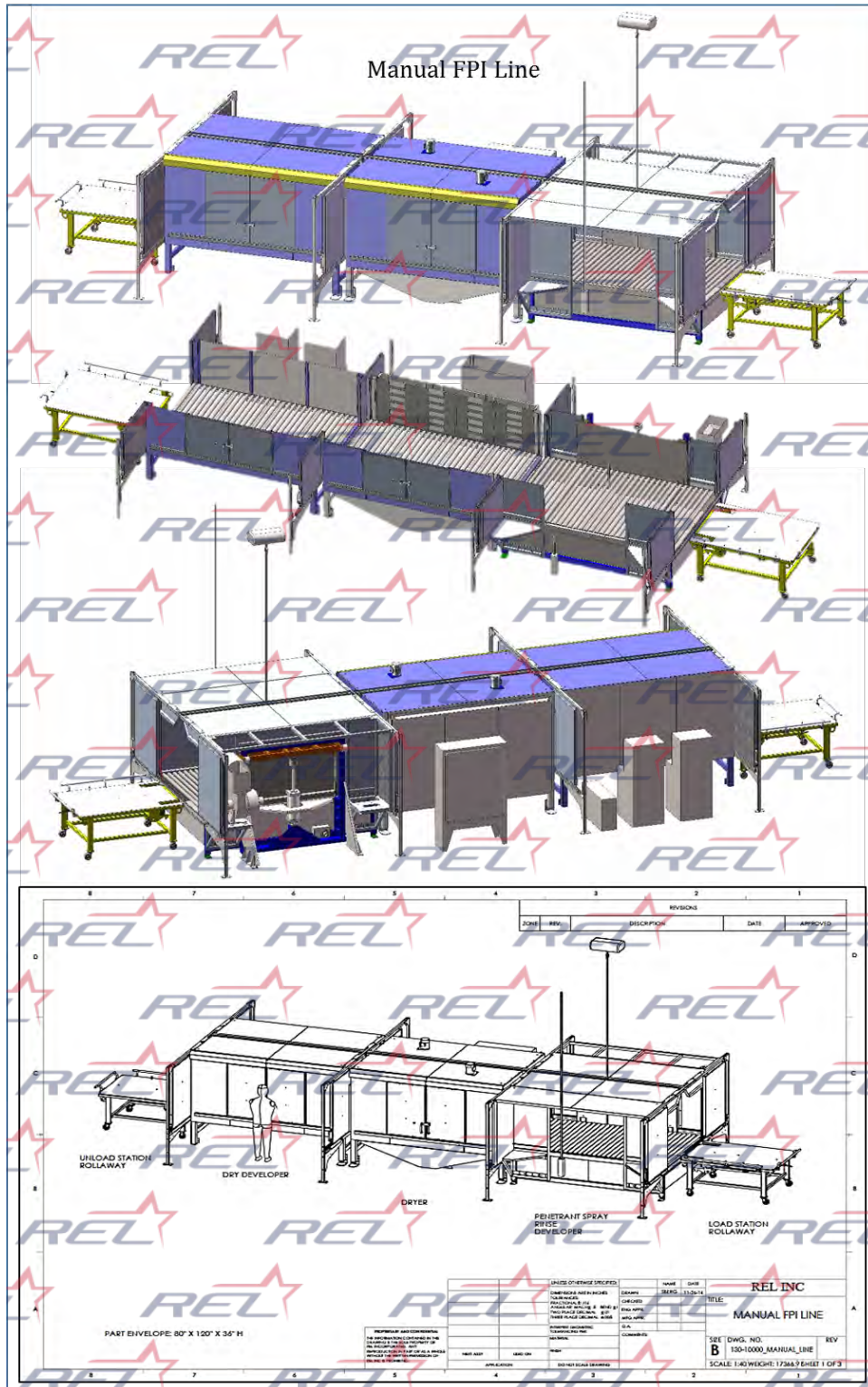


Example: Sample FPI Lay-Outs

Manual FPI Line: Overhead Monorail

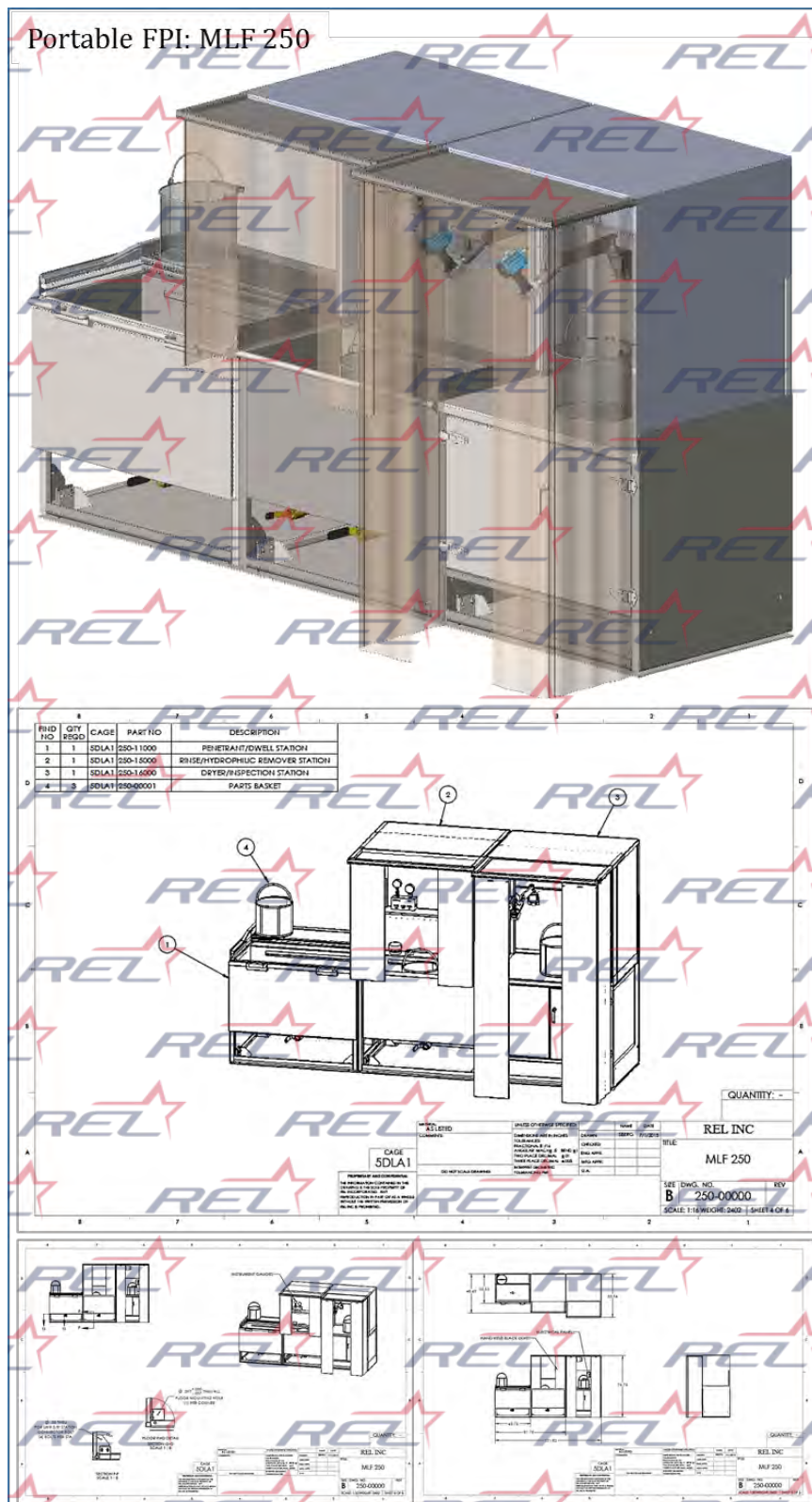


Manual FPI Line



Portable FPI Line

Portable FPI: MLF 250



Gallery



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