SOLAR PHOTOVOLTAIC 9524S THIN FILM SPRAY COATING EQUIPMENT

The 9524S series spray applicator was designed to apply thin coatings to solar panels. The 9524S employs a HVLP atomizing spray head which is mounted to the shuttle conveyor assembly. The HVLP spray head is quickly swept from side to side as the panel passes below on the Pin conveyor. Controlling the sweep width minimizes materials usage. Application thickness is accurately controllable and highly repeatable by adjustments on the atomization nozzle orifice, material flow rate and conveyor speed. The 9524S Thin Film Spray Coater provides a high degree of control and simplifies the thin film coating process significantly.

Available Options

QUICK-TACK IR TACKDRY OVEN: Employs infrared panels to speed the drying process to a highly efficient 3 minutes.

Electrical Service Requirements

Circuit Breaker service is 3-phase configuration with a good Ground.

ITEM	208/240/480V 50/60HZ	380/400/415V 50HZ	POWER
9524 SINGLE SIDE	30A	30A	3kVA

Compressed Air Requirements

The 9524S requires a continuous filtered air supply of 100PSI (6.8 bar). Air consumption is approximately 60 to 80CFM. The air line running to the machine should be 1” (25mm) Diameter Pipe. The connection on the machine is ½FNPT.

Exhaust Requirements

Machine includes blower

ITEM	EXHAUST VOLUME	PORT SIZE
9524 SINGLE SIDE	2000 cu ft/min (57 cu m/min)	10” (254mm) Diameter

BLOWERS SUPPLIED WITH THE MACHINE.

WARNING

Make-up air to the installation area must be at least 2000 cu ft/min (57 cu m/min) for the **9524S**ingle Sided. Insufficient make-up air will result in fumes and over-spray in the work area, causing the machine to operate improperly.

SHIPPING DATA

ITEM	CRATE SIZE	AIR FREIGHT CRATED WEIGHT	COMMON CARRIER CRATED WEIGHT
9524 SINGLE SIDE	102" x 63" x 68"	1,800 lbs.	2,000 lbs.

Note: Crating dimensions and weights are approximate and may vary within 10%.

Practical Thin Film Coating Guide

It is important at this point to reiterate that Argus International must be viewed as a full partner in aiding in the development of a complete understanding of the Thin Film Coating Process. Thin Film Coating is not an exact science, principally because of the variations in panel surfaces, coating material suppliers, cleanliness, maintenance and many other details. The operator must have a firm understanding of the causes and effects of variables in Thin Film Coating. This section is devoted to furthering that understanding.

Parameters Overview

Quality Thin Film Coatings result from attention to detail. Assuming the solar panels arrive at the spray coater with a quality surface, the following parameters will have major effects on the final coating:

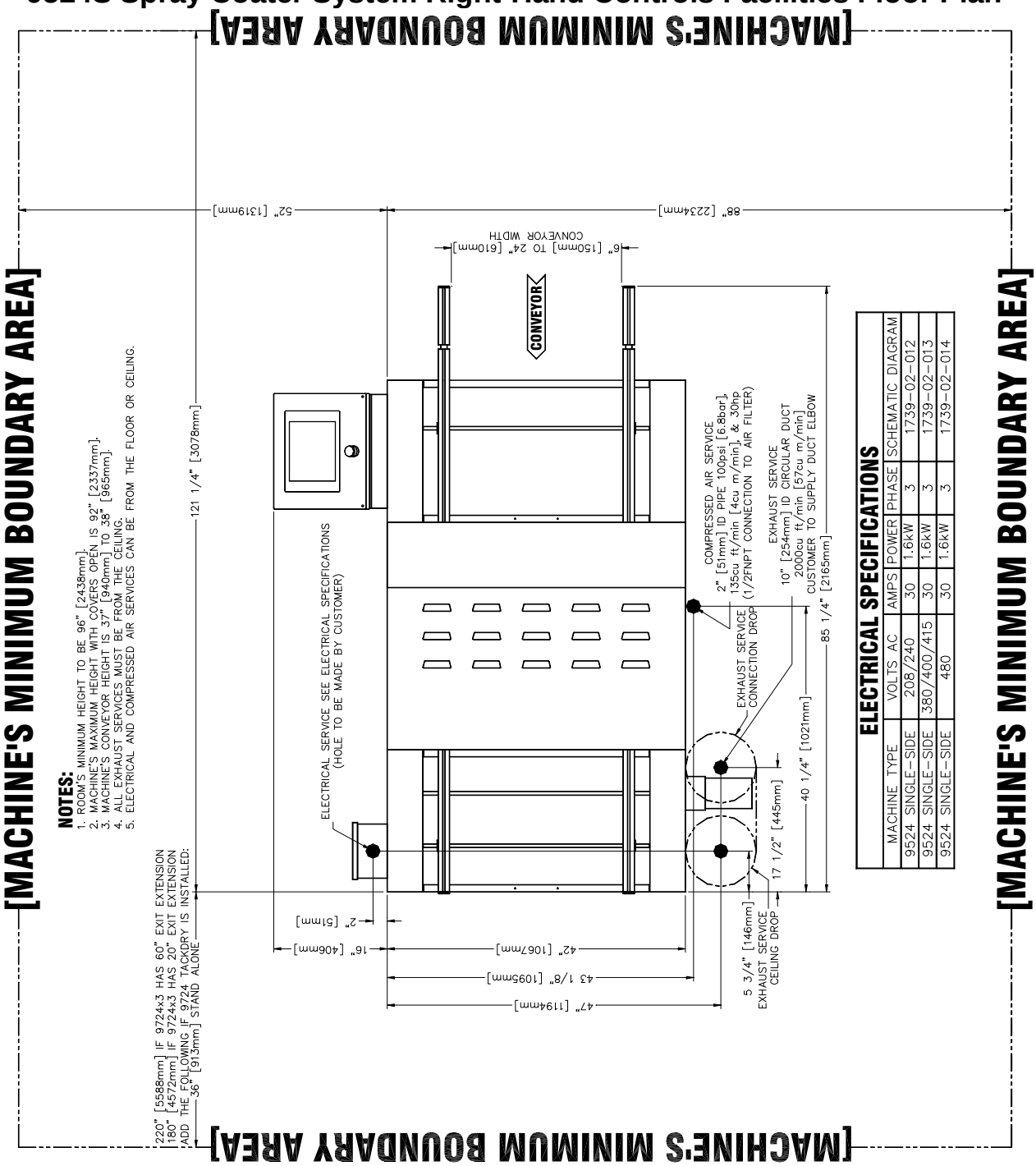
Parameter	Normal Adjustment Range	Minimum	Maximum
Conveyor Speed FPM (m/min)	2 to 6 (.6-2)	2 (.6)	6 (2)
Atomization Air Pressure PSI (bar)	30 to 50 (2.1-3.4)	0 (0)	60 (4.1)
LPISM Tank Pressure PSI (bar)	12 to 20 (.8-1.4)	0 (0)	30 (2.0)
Spray Gun Temperature ^{o}C	80 to 90	50	100
Atomization Air Temperature ^{o}C	75 to 95	50	120

- **Conveyor Speed** is controlled to within 1% of set speed. Conveyor speed is a variable in Thin Film Coating thickness.
- **Atomization Air Pressure** is controlled with a regulator, and generally affects spray pattern and particle size.
- **Coating Material Tank Pressure** is controlled with a regulator, and directly affects the flow rate and thickness of the Thin Film Coating.
- **Coating Material Viscosity** is measured with a Zahn or Ford Cup. As a general rule, the Coating Material's flow rate to the HVLP spray head is a function of the Coating Material's Tank Pressure.

The following general rules are based upon experience learned during product development and solar panel processing done by Argus International Process Engineering Group and Argus International Fabrication Processing Group.

1. Coating Material Tank Pressure, Coating Material Viscosity and Conveyor Speed are the primary variables that affect Coating Material thickness.
2. Orange Peel surface is the result of spray particles which are too large. Particle size may be reduced by increasing the atomization pressure, or by reducing the Coating Material Viscosity.
3. Coating Material usage may be significantly improved by processing panel's nose to tail; solar panels are loaded onto the conveyor without a gap in between. The HVLP spray head will then run continuously in AUTO MODE.
4. For a given Coating Material, the supplier will recommend a solvent dilutant. The dilutant should be used to clean all Coating Material delivery components. Incompatible solvents may cause a coagulation of materials in the Coating Material's delivery tubes. The effect on the panel will appear as concentric rings of thinned Coating Material, known as fish eyes' or 'craters'.
5. The ability of a Coating Material to adhere to the edges of traces is largely a property of the selected Coating Material. However, it is possible to reduce the trace-covering properties of the Coating Material by excessively thinning the material or setting the atomization pressure too high. It is best to run the Coating Material Viscosity as high as possible and the atomization pressure as low as possible, without producing significant 'mottling' or 'orange peel'.
6. Thin Film uniformity on the board is largely affected by the Z-pitch (SPRAY PITCH), which is the distance between each return stroke of the shuttle. Z-pitch ranges from 1.0-3.0 inches (25-75mm), but it is best to set the SPRAY PITCH as low as possible without going beyond the shuttle speed limit. If this happens, the touch screen will display PARAMETERS OUT OF RANGE. Reduce CONVEYOR SPEED or increase SPRAY PITCH settings until the message is cleared.

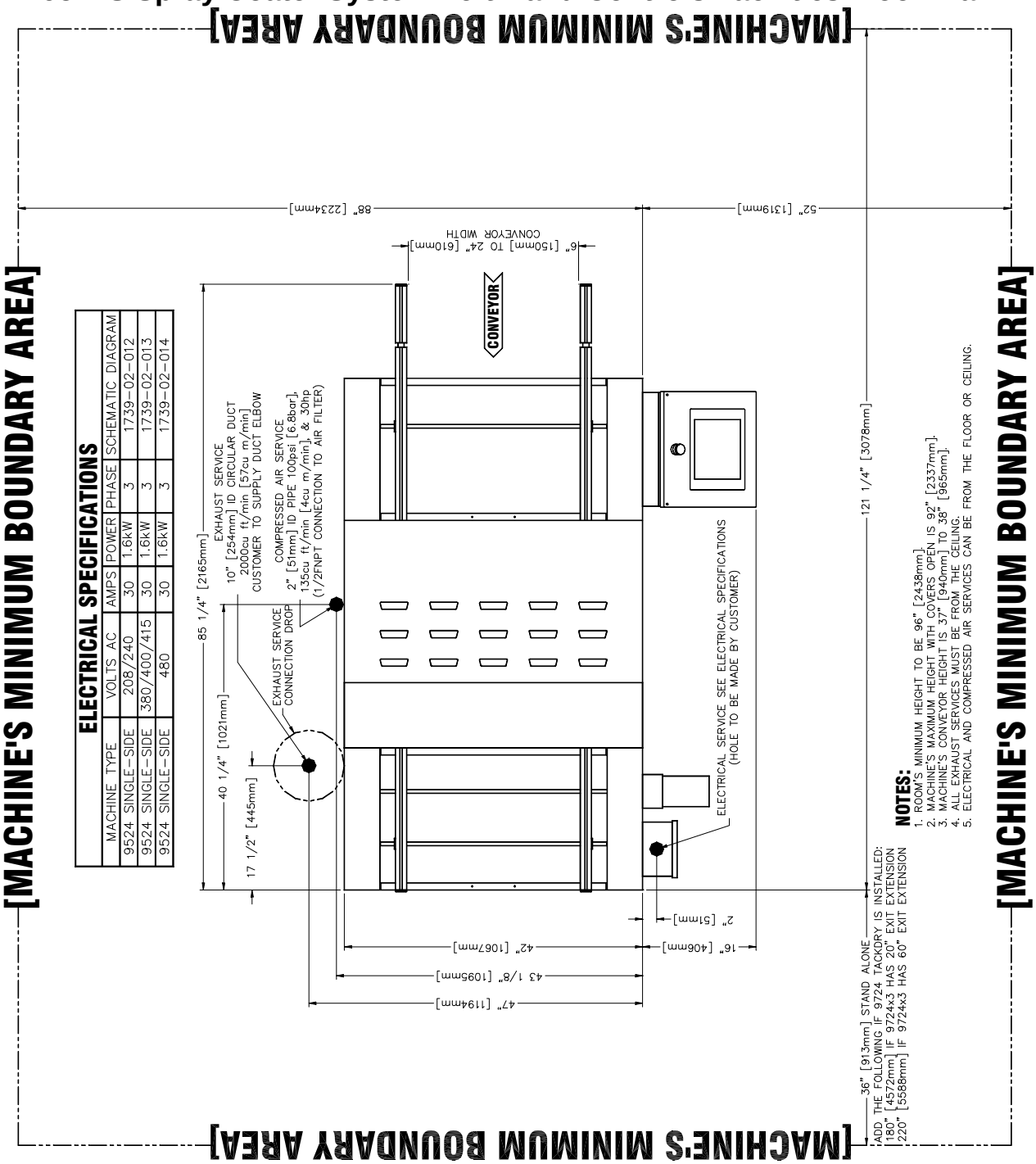
9524S Spray Coater System Right-Hand Controls Facilities Floor Plan



ELECTRICAL SPECIFICATIONS

MACHINE TYPE	VOLTS AC	AMPS	POWER	PHASE	SCHEMATIC DIAGRAM
9524 SINGLE-SIDE	208/240	30	1.6kW	3	1739-02-012
9524 SINGLE-SIDE	380/400/415	30	1.6kW	3	1739-02-013
9524 SINGLE-SIDE	480	30	1.6kW	3	1739-02-014

9524S Spray Coater System Left-Hand Controls Facilities Floor Plan



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Control and Operation

The 9524S is equipped with several key components, and the following figure identifies the major elements of the machine. The operator should be completely familiar with these elements prior to attempting to operate the equipment. Argus International will provide on site training for process, operation and maintenance upon request.

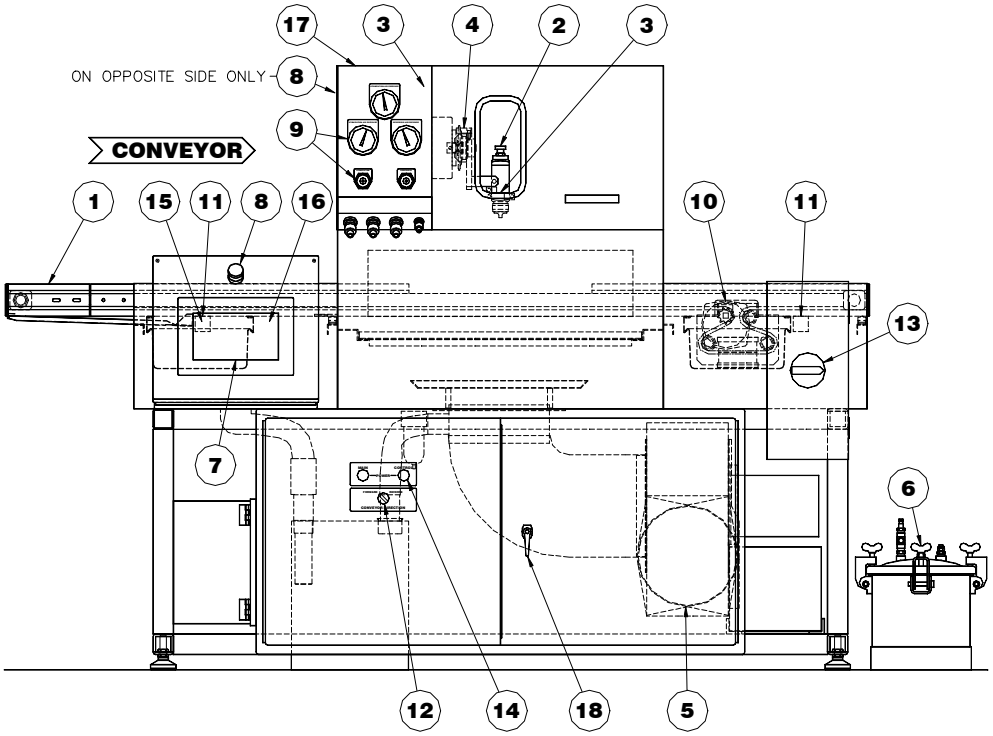

Figure: Major Components of the 9524S Spray Coater System with right-hand controls

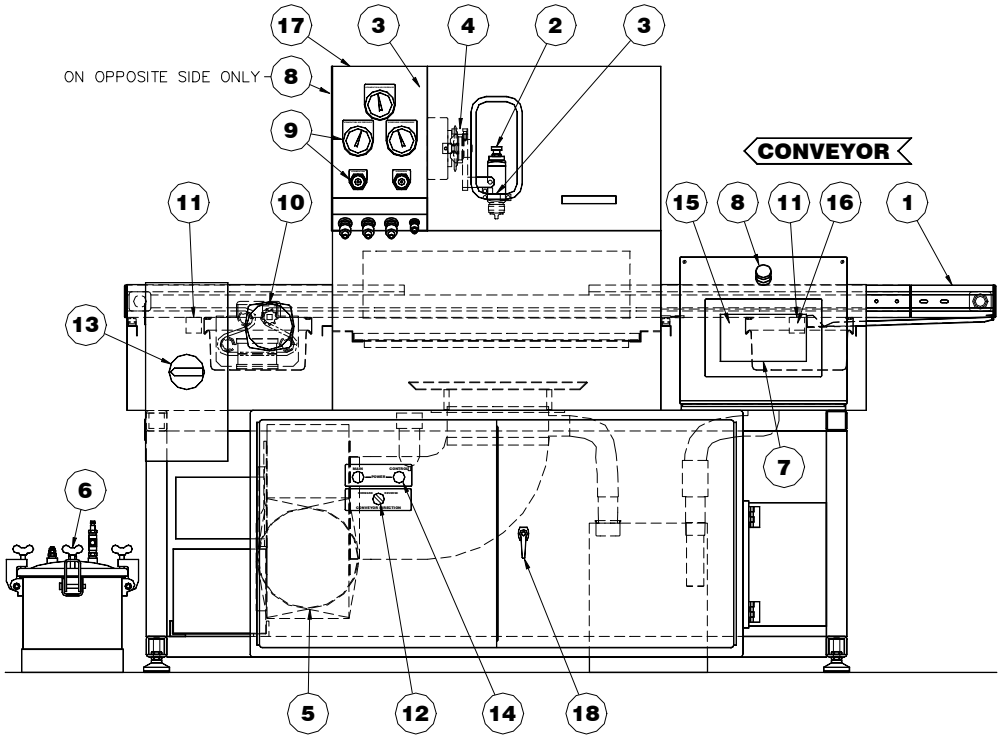

Figure: Major Components of the 9524S Spray Coater System with left-hand controls

1. **Edge Conveyor System** - The solar panel must move through the spray chamber with a minimal contact area. A pin conveyor, which can be adjusted to the individual board width, fills this requirement. The conveyor speed may be adjusted from 2 to 6 feet per minute (.6 to 2 meters per minute). Shielding is provided inside the spray chamber to protect the conveyor rails from Coating Material build-up.
2. **HVLP Spray Head** - The Coating Material is sprayed onto the panel via a high-volume; low-pressure (HVLP) spray head. The HVLP spray head utilizes opposed air jets directed at a continuous stream of Coating Material to generate atomized particles, which are directed at the solar panel by the atomization pressure coupled with directed air flow. Spray pattern, air pressures, Coating Material flow rate and orifice size all affect spray head operation. *See Appendix M in Manual*.
3. **Heating System** - Both the atomization air and gun body are heated during spray, which momentarily drops the viscosity of the Coating Material, making it easier to atomize. The heaters are controlled from the touch screens.
4. **Shuttle Conveyor -** The Shuttle Conveyor Assembly, which is driven by a stepper motor, is designed to move the HVLP Spray Head in a horizontal sweeping motion perpendicular to the direction of solar panel travel. Sophisticated electronics allow very high Shuttle Conveyor speeds with exceptional smoothness and lack of vibration. The pitch setting on the touch screen adjusts the shuttle speed, relative to the conveyor speed, and sweep width. It is possible to adjust the sweep width both left and right of center to allow complete coating of the solar panel with minimal over-spray.
5. **Exhaust Port -** The exhaust system for the 9524S is designed so that air exhausts directly from the spray chamber, as solvents driven from the Coating Material during atomization must be removed to prevent operator exposure. The exhaust port must be connected in accordance with local environmental laws. *See Appendix A, in Manual, - Facilities and Machine Specifications* for details on exhaust requirements.
6. **Coating Material Reservoir (Pressure Vessel) -** The Coating Material reservoir supplies the HVLP spray head with a continuous flow of Coating Material. An adjustable air pressure is supplied through the top of the reservoir; this applies pressure to the top of the Coating Material pool, and the supply tube, located in the reservoir, allows Coating Material to be pushed out and delivered to the HVLP spray head.
7. **Touch Screen -** The main control method is through touch screen, allowing adjustment of conveyor speed, shuttle pitch, sweep distance, spray pattern and heat settings.
8. **Emergency-Stop Switches -** These switches cut power to the conveyor, shuttle, heaters and pneumatic controls. These switches do not cut the main power to the machine or blower (see Circuit Breaker).
9. **Pneumatic Controls -** Pressure adjustments and gauges for atomization air and Coating Material reservoir air are located on the Plenum.
10. **Chain Cleaning System & Conveyor Drive -** *See Appendix K in Manual*.
11. **Conveyor Rail Width Adjustment / Stepper Motor Assemblies -** *See Appendix L in Manual*.
12. **Conveyor Direction Reversal Control and Indicator -** This control is built into the touch screen, and is provided so the operator or maintenance personnel can change the direction of the conveyor chain should it become jammed or extremely coated with the Coating Material.
13. **Circuit Breaker -** This is where the electrician connects the main power to the machine, and where main power of the machine can be powered to 'ON' or 'OFF'.
14. **Power Indicators -** These Indicator lights alert the operator or maintenance personal that power is connected to the machine.
15. **Start/Stop Exhaust Control and Indicator -** This control is built into the touch screen to power on and off the exhaust. The touch screen indicator, **EXHAUST ON**, alerts the operator or maintenance personal that the exhaust is activated.
16. **Start System Control and Indicator -** This control is built into the touch screen and starts the conveyor, and prepares system for activation. The touch screen indicator, **SYSTEM STARTED**, alerts the operator or maintenance personal that the system is activated.
17. **Shuttle & Pneumatic Component Plenum –** This cabinet contains electrical wiring for the shuttle and pneumatic components and controls for the spray.
18. **Electrical Component Enclosure -** This cabinet contains the electrical wiring, control boards and PLC controls.