

Rammstein Air

Heating System Installation, Commissioning, Operation, and Maintenance

Manual

12-02-2016

FOR YOUR SAFETY

The use and storage of gasoline or other flammable vapors and liquids in open containers in the vicinity of this appliance is hazardous.

 **WARNING:** Improper installation, adjustment, alteration, service or maintenance can cause property damage, injury or death. Read the installation, operating and maintenance instructions thoroughly before installing or servicing this equipment.

FOR YOUR SAFETY

If you smell gas:

1. Open windows.
2. Don't touch electrical switches.
3. Extinguish open flames.
4. Immediately call your gas supplier.

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1 What is Covered in This Manual

This manual has instructions for the installation, commissioning, maintenance and operation of the Rammstein Air heater line. All models use a standard line burner except the low NOx heater. The low NOx heater uses a packaged premix burner. The low NOx heater has its own manual. This manual contains important additional information. Read and understand both manuals before installing, commissioning, maintaining, or operating the low NOx heating system.

This manual covers the following models:

R-0.4

R-1

R-1+

R-2

R-3

R-5

R-Low Nox

Information in this manual is subject to change without prior notification. If in doubt, contact the factory for the most recent version of this manual.

2 Distributor, Installer Contact Information

Date of installation

Heater serial number

Heater model number

Distributor

Contact person at distributor

Telephone number of distributor

Street address

City

State

Postal code

Country

Installer company (if different from distributor)

Name of installer

Telephone number of installer

Street address

City

State

Postal code

Country

3 Safety Information

3.1 Responsibilities for Equipment Safety

Everybody in the manufacturing, sales, distribution, installation and use of equipment has specific responsibilities to ensure safety. The following section details the responsibilities of the manufactures, dealer/installer and the operator of the equipment.

Beware that this list may not be complete since Authority Having Jurisdiction (AHJ) may have more specific and more stringent requirements than the general requirements set forth below. Consult the AHJ of the location where the equipment is installed to ensure your compliance with all relevant safety requirements. References to AHJ in this book mean a single AHJ or multiple AHJs. It is the responsibility of the installer to find out who has local jurisdiction over what part of an installation.

Heating systems such as this system cannot be engineered to be inherently safe. There are always hazard present when you use equipment such as this one. Besides the fact that equipment such as this industrial heater cannot be designed to be inherently safe, not all possible hazards and problems can be listed in a heater manual. You have to use sound judgment and common sense when you work with this equipment. The cardinal rule is the following: **If you do not know the consequence of an action while using servicing, supervising and/or working with or around this equipment, DO NOT do whatever you were thinking about doing!** It is imperative that you know for sure if an action may create a hazard or it may not. If it may create a hazard, clearly you don't want to do whatever you are about to do. **Only do things while working with or around this equipment that you know for certain will not cause hazardous conditions!**

3.1.1 Manufacturer

The equipment manufacturer is responsible to provide the following:

- Assembly and installation instructions
- Schematics and wiring diagrams
- Operating instructions
 - Start-up procedures
 - Shut-down procedures
 - Emergency procedures
- Inspection, testing and maintenance instructions

Electrical diagrams applicable to the heater shall be placed in a suitable pocket and furnished in each of the following forms:

- a. A connection diagram to aid locating components during field service
- b. A schematic diagram of the ladder form; and
- c. A cycle chart or printed sequence of switching action.

3.1.2 Dealer/Installer

Code compliance

The dealer/installer is responsible for code compliance. The dealer/installer is responsible for checking with the AHJ to ensure local compliance.

Commissioning

The dealer/installer is responsible for following the manufacturer's instructions for installing and commissioning of the system. Commissioning means that the system is installed according to the specifications. **Installation IS NOT**

commissioning! The commissioning process includes the testing of all necessary parameters to make sure that they are within the manufacturer's specifications. Commissioning also includes the documentation to show that at the time of installation the system was performing as intended. Part of commissioning is the process that verifies that the equipment is working as intended.

Operator training

The installation and commissioning process includes training the customer how to properly use the equipment, what are the hazards, etc. The dealer/installer shall explain the required inspection, testing and maintenance programs to the operator. **The installation and commissioning of the system and the operator training procedure have to be documented in writing!**

Failure to comply voids all warranties both express and implied under the law.

3.1.3 Operator

The operator is the person or persons responsible for the operation of the equipment. The term operator includes but is not limited to the following personnel: people who operate the equipment, people who work inside or in the vicinity of the equipment, supervisors, managers, maintenance personnel, etc. The operator is responsible for establishing a regularly scheduled safety training program. This program has to include a demonstration of understanding of the subject material by trainees. **The operator is responsible for documenting the training program and the results of the training program in writing!**

The operator is responsible for making the equipment manuals and the safety training materials accessible for reference for all personnel.

It is the responsibility of the operator to establish, schedule, and enforce the frequency of the inspection, testing and maintenance program. The inspection, testing and maintenance program shall be based on the manufacturer's recommendations, location specific factors, all relevant standards and the requirements of the AHJ. The operator is responsible for checking with the AHJ to ensure that system operation, training and maintenance programs satisfy the requirements of the AHJ(s).

The operator is responsible for documenting the inspection, testing, and maintenance program and the corrective actions that have been taken.

Failure to comply voids the warranty and may result in injury to personnel and/or property damage.

3.2 General Safety Information

Specifications in this manual are subject to change. Contact tech support to receive the most up to date version of this manual through email.

If in doubt regarding the application, consult the heater manufacturer.

The system shall be installed and maintained by experienced, trained and qualified spray booth professionals.

Experienced, trained and qualified spray booth professionals mean people who are:

1. People who are familiar with the applicable laws, rules, standards and codes.
2. They have training and experience in installing and commissioning direct fired heating systems for finishing applications.

3. Qualified spray booth professionals who understand, recognize, capable and are equipped to avoid the hazards involved.
4. They have industrial controls experience sufficient to install commission and troubleshoot such equipment. Industrial controls experience includes but not limited to the ability to reach schematics and follow circuit diagrams.

Observe all warnings and make sure you are thoroughly familiar with this manual and the equipment.

Follow all general standards and good practices for spray booths and spray booth related equipment installations.

Proper protective equipment includes but is not limited to protective footwear, gloves, safety goggles, and ear plugs when noise levels exceed 80 decibels must be used.

Spray booths and heating systems are not designed to be load bearing structures. Do not climb on top of the spray booth or heating system. Use proper equipment to reach difficult to access areas on spray booths and heating systems.

Guards, covers, and components that prevent contact with electrically and/or pneumatically energized parts must not be removed or left open during operation.

If waterborne drying system option is part of this control system, read and understand the waterborne drying system manual completely before installing waterborne drying system.

It is impossible to list all potential hazards of this equipment. If you are uncertain of a procedure, please consult the AHJ on the issue.

Do not operate the heater with the blower access door(s) removed! There are two issues:

1. It is a crush hazard. Moving parts can cut and crush.
2. If the burner is turned on while the fan access door(s) is removed, the heater will overheat. Overheating can cause extensive equipment damage and may start a fire.

3.3 Electrical Safety Information

Serious injury or death can result from improper installation. High voltage is present.

There are two sources of power in the gastrain control panel. Disconnect and lock out both sources before adjusting or servicing system.

All electrical work is to be done by a licensed electrician to conform to applicable local and national codes.

All field wiring must be done in accordance with local codes or, in the absence of local codes, the most recent version of the National Electrical Code (NFPA 70).

If any of the original wire as supplied with the heater must be replaced, it must be replaced with the same type wire (THHN or MTW) or its equivalent.

Field-wiring having a temperature rating of at least 90C shall be used and supply circuit wiring shall have a minimum size calculated using the MCA calculations in this manual.

An electric disconnect switch having adequate ampacity (see marking on the heater for voltage and ampacity) shall be installed in accordance with the national Electrical Code, ANSI/NFPA 70.

3.4 Gas Safety Information

The system must be installed in compliance with the national gas code and with the requirements of the AHJ.

3.4.1 Gas Pressure Testing

The heater and its individual shutoff valve must be disconnected from the gas supply piping system during any pressure testing of that system at test pressures in excess of ½ psi (3.5kPa).

The heater must be isolated from the gas supply piping system by closing its individual manual shutoff valve during any pressure testing of the gas supply piping system at test pressures equal to or less than ½ psi (3.5kPa).

3.4.2 Minimum Gas Supply Pressure

Refer to the heater rating plate for determining the minimum gas supply pressure for obtaining the maximum gas capacity for which this heater is specified.

Minimum gas supply pressure is dynamic pressure!

Static pressure is the gas pressure when the gas is not flowing. For example, the gas inlet pressure when the burner is off. **Dynamic pressure** is when the gas is flowing. For example the gas inlet pressure when the burner is on.

3.4.3 Gas Leak Check Upon Startup

Service personnel shall perform a gas leak check during heater start-up, to verify the gas tightness of the heater's components and piping under normal operating conditions.

3.4.4 Emergency Gas Shutoff Valve

The gas piping installer is required to locate a manual emergency shutoff valve in an appropriate location that allows access to this valve to shut off the fuel to the process heater in case of fire or explosion at the heater.

3.5 Installation Into Specialty Locations

3.5.1 Aircraft Hangars

Installation must comply with the most recent revision of NFPA409.

3.5.2 Parking Structures and Repair Garages

Installation must comply with the most recent edition of NFPA88A, NFPA30A in the USA and with CSBA B149.1 in Canada.

3.6 Pressure Relief of Structure

Adequate pressure relief of the structure shall be provided to as to prevent overpressurization when the heating system is operating at its rated capacity. It should be noted that this can be accomplished by taking into account, through standard engineering methods, the structure's designed infiltration rate; by providing properly sized relief openings; or by interlocking a powered exhaust system; or by a combination of these methods.

3.7 Ventilation Air

Ventilation air to the heater shall be ducted directly from outdoors when the heater is operated in the ventilation air mode.

4 Labeling Requirement

There are hazard information labeling requirements and general labeling requirements.

4.1 Hazard Information Labeling Requirements

It is the responsibility of the seller to inform about possible hazards. We identified the following hazard sources that require safety labels. The required safety labels have to be attached to the equipment. **If safety labels are removed or missing they have to be replaced!** For replacement safety labels contact your dealer.

1. Read Manual Label

Installation, operation and servicing should only be done by qualified people.

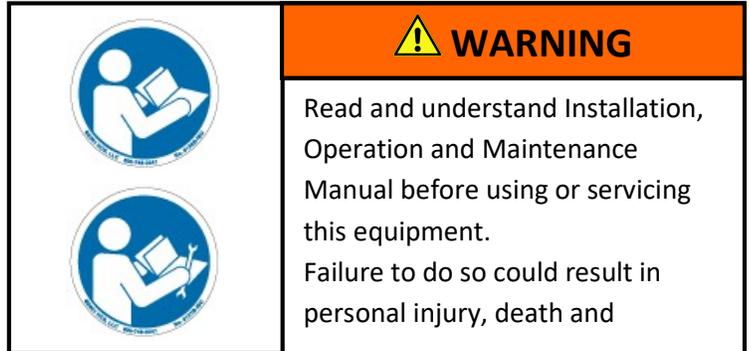
Material: Class IIIC

Number of labels

One per control panel.

Location

Control Panel



2. Fan Hazard

Moving parts can cut and crush.

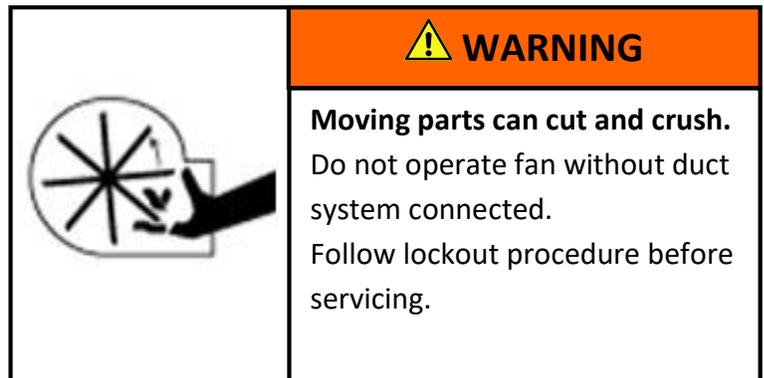
Material: Class IIIA1

Number of labels

Standard: One per heater.

Location of labels

One at heater discharge



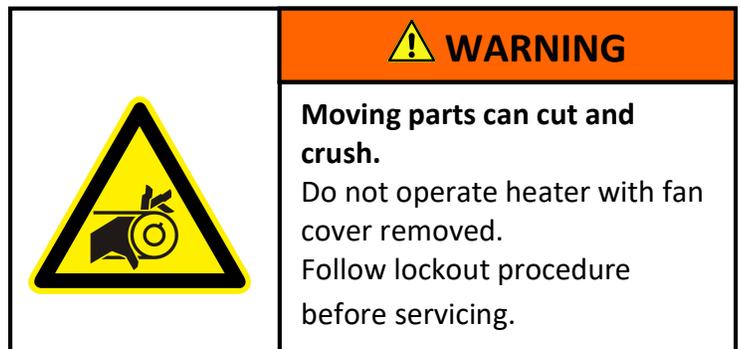
3. Cut/Crush hazard Moving Parts of Heater

It is possible to remove fan cover while equipment is running. The moving parts, electric motor, pulleys, belts sheave, blower, may cause serious injuries.

Material: Class IIIA1

Number of labels: Two

Location of labels: One on each removable side cover/fan access cover.



4. Heater Warnings

This label contains nine different warnings.

Number of labels

One per heater.

Location

Gastrain enclosure door.

a. Read Manual Label

Installation, operation and servicing should only be done by qualified people.

b. Toppling and Crush Hazard

Because of uneven weight distribution, equipment may topple over.

c. Falling Hazard

Do not climb on equipment. You can fall off.

d. Burn Hazard

Internal and external parts may be hot enough to cause burns.

e. Fire and Explosion Hazard #1

Fuel utilization equipment can be a source of fire and explosion.

f. Carbon Monoxide Hazard

This equipment produces carbon monoxide.

g. Cut/Crush Hazard Moving Parts of Heater

It is possible to remove fan cover while equipment is running. The moving parts, electric motor, pulleys, belts sheave, blower, may cause serious injuries.

h. Electric Shock Hazard

Contact with live parts can cause electric shock and burns.

i. Fire and Explosion Hazard #2

This equipment can be a source of ignition for flammables located next to or near the heater.

5. Location of Entry Points for Wiring

Material: Class V marking material.

Number of labels: One

Location of label: Inside of electrical enclosure on heater

Label has to indicate location of field installed wiring entry points into electrical enclosure. This label does not have to be replaced after installation is complete.

R-0.4, R-1, R-2, R-3

Field installed wiring entry points shall be located in the bottom of the gastrain box in the vicinity of this label. For connection, use wires suitable for at least 90C.

R-5 wiring

Field installed wiring entry points shall be located in the side of the gastrain box in the general vicinity of this label. For connection, use wires suitable for at least 90C.

6. Wiring Temperature Specification

Material: Class III

Number of labels: One

Location: Inside of remote control panel.

Use copper conductors rated at least 90C.

7. Vent to Outdoors

Material: Class III

Number of labels: One

Location: On regulator of R-4 heater.

Vent regulator to outdoors.

8. Cutout Calibration Temperature of High Temp Limit

Material: Class III

Number of labels: One

Location: Next to high temp limit switch on blower housing

High temperature limit switch
cutout calibration:
180F (82C)
Tolerance is + - 8F (13C)

9. Electrical Diagrams

Material: Class IV

Number of Labels: One copy of each pages

Location: Inside of electrical panel door on heater.

COPY OF ELECTRICAL
DIAGRAMS

4.2 General Labeling Requirement

1. System Name Plate

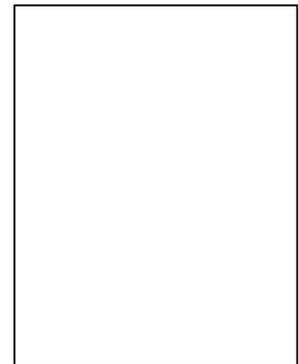
Material: Class IIA3

Number of Labels

One per system.

Location of labels

Outside of gastrain box.



4.3 Associated Equipment Labeling Requirement

If the heater is used as a process heater that creates temperatures in excess of 160F (71F), it is recommended that the following warning is posted on each spray booth access door: "Do not enter this space until cool down cycle is complete." Installer is responsible for providing this warning label.

5 System Specifications

Specifications in this manual are subject to change without notice!

5.1 Clearances to Combustibles

External heater components may be hot. External heater components may pose a burn hazard, a combustion hazard, and/or an ignition source hazard. Combustibles are materials that can ignite at a certain temperature. Radiant heat from the heater may be sufficient to increase material temperature to its combustion temperature. Combustibles shall be kept at a minimum distance of 48" (122cm) from heaters.

Heaters and heater surfaces may also become a source of ignition. Keep combustible fluids, vapors, and dust away from heater to prevent ignition. Determining these clearances should be part of the initial hazard evaluation after the heater is installed.

Additional requirements may apply when heater is installed into specialty locations.

5.2 Clearance for Access

Clearance for access is not less than 48" (122cm). This means that you have to be able to walk around the heater to the gastrain panel. This access path to the gastrain panel shall be not less than 48" (122cm).

5.3 Altitude

These air heaters can be installed without modifications at elevations up to 2,000' (609.6m) in the USA. These heaters can be installed without modifications at elevations up to 4,500' (1,371.6m) in Canada.

5.4 Operating Temperature

These heaters are designed to operate in temperatures of -10F (-23C).

5.5 Maximum Discharge Temperature

Occupied modes: 160F (71C).

5.6 Maximum Temperature Rise

The table below shows the maximum temperature rise of heaters. The heater must maintain the maximum temperature rise it is rated to during the reduced air flow mode (Prep Mode).

Maximum Temperature Rise (Spray & Prep Modes)					
Heater	Natural Gas		Liquid Propane Gas		
	F	C	F	C	
R-0.4	28	2.2	28	2.2	
R-1	100	38	100	38	
R-1+	90	32	90	32	
R-2	90	32	90	32	
R-3	90	32	90	32	
R-5	90	32	90	32	
R-1 LowNox	50	10	50	10	

5.7 Minimum Air Flow Rate

The minimum air flow rate of heaters is the same with natural gas and propane.

The minimum air flow rate is proven by the heater low air flow switch. The heater low air flow switch pickup tube is installed into the discharge opening of the blower.

Model	CFM		HP @ 0.5" ext.	Max Input Btu/hr	Allowed Temp Rise (F)		Gas pressure inwc	Burner Length (in)	Blower Size
	Max	Min			NG	LP			
R-400	12,600	2,900	10	459,400	28	28	5	6	18x18
R-1 NOx	10,600	9,600	10	646,100	50		4.3	Riello RX250	18x18
R-1	12,600	2,900	10	1,427,800	100	100	5	24	18x18
R-1+	16,500	3,500	15	1,713,900	90	90	7	30	20x20
R-2	26,900	5,700	20	2,785,200	90	90	9	42	25x25
R-3	41,400	8,800	30	4,284,900	90	90	11	60	30x30
R-5	47,200	12,000	50	4,885,200	90	90	14	72	36x36

5.8 Circuit Protection for Transformer

The 300VA transformer is equipped with circuit breakers for branch circuit protection. Breakers shall be UL489 type D curve breakers. Circuit breaker size depends on voltage and the number of wires on the secondary of the transformer.

110VAC and 24VAC on secondary (3 wires on secondary)			
	208VAC	230VAC	460VAC
Primary Side	3A	3A	1.5A
Secondary side – 110VAC	4A	4A	4A
Secondary side – 24VAC	15A	15A	15A

110V only on secondary (2 wires on secondary)			
	208VAC	230VAC	460VAC
Primary Side	4A	3A	1.5A

5.9 Gas Manifold

5.9.1 Standard Gas Manifold Sizes

	R-400	R-1	R-1+	R-2	R-3	R-5	R-1LowNOx
Gas manifold size: in (mm)	3/4 (19)	1-1/4 (32)	1-1/4 (32)	1-1/2 (38)	2 (50)	2 (50)	1 (25)
Minimum inlet pres.: in wc (mbar)	5 (12.5)	5 (12.5)	7 (17.5)	9 (22.4)	11 (27.4)	14 (34.9)	4.3 (10.7)
Max. inlet pressure: in wc (mbar)	14 (35)	14 (35)	14 (35)	14 (35)	14 (35)	14 (35)	14 (35)

5.9.2 Standard Gas Manifold Type

It is the dealer/installer's responsibility to determine which type of manifold is required by the AHJ. The standard manifold is the ANSI compliant manifold. If you have other requirements, please contact the tech support.

5.9.3 Gas Manifold Options

- Other manifold types, FM and XL are available as upgrades.
- Manifolds with lower minimum inlet pressures are available as options.
- Regulators with higher inlet pressures are available as options.

5.9.4 Gas Regulator Position

The RV61 gas regulator can be mounted in a horizontal, vertical or an upside down position.

All other regulators have to be mounted in a horizontal position!

5.9.5 Gas Regulator Pressure

Verify that line pressure does not exceed the maximum inlet pressure rating of the regulator. The following regulators are CSA rated to 1/2psi (35mbar):

RV52

RV53

RV61

RV81

RV91

RV111

5.9.6 Gas Regulator Venting

All Maxitrol regulators except the RV91 and larger regulators use a vent limiting device. A vent protector is NOT a vent limiting device. The RV91 and larger regulators have to be vented to the outdoors. These regulators must use a vent protector at the end of the vent line. The vent protector has to be installed in the vertical position into the breathing hole in order to protect the line from rain, snow, insects and foreign particles.

5.10 Burner Differential Air Pressure

Burner differential air pressure is the same for both natural gas and propane.

Burner differential air pressure should be between 0.3" WC (0.75 mbar) and 0.38" WC (0.95 mbar) during reduced air flow mode.

Air flow switch is calibrated to cut out at 0.34"wc (0.85mbar) on falling pressure. If burner differential air pressure is outside of specifications, adjust sheet metal over air intake to reach the correct differential air pressure.

5.11 Belt Tension

Use a Goodyear SAP# 20044882 belt tensioning tool or equivalent to properly tighten the belts.

5.12 Sheave and Busing Torque Settings

5.12.1 Sheaves:

VP series

All setscrews: 110inlb (12.4 nm) – 130 inlbs (14.7 nm).

Do not tighten to more than 130inlb (14.7 nm)! Sheave may be damaged.

5.12.2 Bushings:

SK 180 inlb (20.3 nm)

SF 360 inlb (40.7 nm)

E 720 inlb (81.4 nm)

5.13 Waterborne Paint Drying System Option

Blower motor: 2HP 208/230/460VAC, 3phase, 60hz (all other voltages and single phase are considered options).

6 Standard Features and Options

6.1 Heater Options

6.1.1 Low NOx Burner

A low NOx burner upgrade is available. The low NOx burner is designed to meet the usual 30ppm (adjusted to 3% O₂) emission requirement by some jurisdictions. Please see the Low NOx Burner Notes section for additional information. This heater is approved by the Southern California AQMD. **This heater still has to be source tested.**

6.1.2 Heater and Discharge Orientations

The heater is available in all standard orientations and discharge configurations. The gastrain box can be located on any side of the heater.

6.1.3 Indoor and Outdoor Installation

The heater can be installed indoors or outdoors. Outdoor applications may require additional components at additional costs.

6.1.4 Dampers

There are a great number of combinations how a damper system can be implemented into a spray booth oven ventilation system. We can create up to 4 damper positions. Please call tech support in order to determine the right damper system for your application.

Our dampers are installed into the heater discharge transition. If a discharge transition is not used, you have to install the damper into the discharge duct. This may require some field fabrication.

If a discharge damper is used to create the reduced air flow option, the low air flow switch has to be field calibrated! Please refer to the Minimum Air Flow and the Low Air Flow Switch sections for instructions.

The most common damper options are below.

6.1.4.1 Two Position Discharge Damper

The two position discharge damper is used to restrict fresh air intake during the Bake Mode.

1. Partially Open

During Bake Mode the damper cuts fresh air ventilation by about 50% in order to save energy.

2. Fully Open

The discharge damper is fully open during Spray Mode.

6.1.4.2 Three Position Discharge Damper

The three position discharge damper option is used to create three different damper positions: closed, partially open, and fully open.

1. Closed Position

A. Non recirc System

With a non recirculating system, this position is only used to prevent cold air infiltration.

B. Recirc System

With a recirc system this position is used to:

- i. Prevent cold air infiltration.

- ii. Save energy during the Flash-Off and Bake modes.

2. Partially Open Position

Prep Mode – reduced air flow

The intake air flow may be restricted in Prep Mode with the use of a damper. The three position damper comes with a potentiometer. During installation, the partially open position can be adjusted by turning the potentiometer.

3. Open Position

The damper has to be in the fully open position during Spray Mode.

6.1.5 Single Phase

Heaters are available in single phase. Above a certain capacity, we have to use a 3 phase motor and a VFD on the intake motor. The VFD is a 3 phase VFD wired for single phase input. In order to be able to power a 3 phase motor from a single phase input, the VFD capacity has to be approximately double of the driven motor capacity. For example, if the heater has a 20hp (15kW) 3 phase motor, the factory has to install a 40hp (22kW) 3phase VFD to drive the 20hp (15kW) motor.

6.1.6 Lightning Protection

This system protects equipment from lightning strikes. Please call the factory for more detail.

6.1.7 Vertical Stand

Indoor Prefilter

Outdoor Prefilter

6.1.8 Vertical Fresh Air Wrap

6.1.9 Vertical Recirculation Wrap

6.1.10 Horizontal Fresh Air Wrap

6.1.11 Horizontal Recirculation Wrap

6.1.12 Roof Curb

6.1.12.1 Standards

Flat roof curb.

6.1.12.2 Pitched

Roof curbs are available in various pitches: 1/12, 2/12, 3/13, etc.

6.1.13 Rainhood

6.1.14 Discharge Transition

6.2 Control Panel Specifications and Options

Installation Notes:

Use four existing holes on the back panel to mount control panel.

Use knockouts to wire panel to the system.

Use the knockouts to route pressure tube to pressure gauge.

Do not drill holes into panel! Metal shavings can short out PLC and other components.

Wiring Specifications:

Powers wires have to be sized by installer according to name plate information.

Control wires, except analog signal wires, should be a minimum of 18ga copper conduction MTW wires with a temperature rating of not less than 90C.

Torque all fasteners according to the torque specifications.

6.2.1 Control Panel Display Messages

Every control panel with a Bake Mode has a PLC. The PLC displays messages on its built in screen. The control panel display gives feedback to for both operation and trouble shooting. The LCD has four lines. Some messages show mode related information others show warning messages. Each mode has two alternating screens. The first screen is a temperature screen and the second screen is a time screen. The mode related messages have the following format;

Bake Mode = name of mode

Temp = temperature or time screen

Set = setpoint temperature or mode duration

Proc = process temperature or elapsed time

The display shows the operator what mode the system is in:

Preignition Purge Mode

Prep Mode,

Spray Mode

Spray Purge Mode

Flash Off Mode

Flash Off Mode Over

Bake Mode

Cool Down Mode

Error messages help in basic trouble shooting. Error messages are based on inputs that the PLC was supposed to see.

There are four inputs on the PLC that generate error messages during certain modes:

1. Door switch (I2)
2. Fire suppression (I3)
3. Mode #2 air flow switch (I4)
4. Flame on (I5)

The PLC can show the following alarm messages:

Door Open

There are two Door Open alarm messages. In Spray Mode the operator simply has to close the door to be able to spray again.

In Flash and Bake Modes, the operator has to press the Reset switch to reinstate the Flash or bake set point temperature.

Mode 2 Air Flow Switch

This is the Spray Mode air flow switch. **This is used in other modes also.** If the air flow switch does not sense air flow during modes it was supposed to, the alarm message appears.

Fire Suppression

During a fire suppression alarm, the system goes into Spray Mode air flow. Compressed air and heat is turned off.

Flame Controller Off

This alarm message appears if the PLC is turns on the power to the flame controller but the flame controller does not try to turn on the safety valves within a certain time frame.

6.2.2 Spray Only Panel or Comfort Heat Panel

This panel has one setpoint temperature. It can be used for providing comfort heating or to provide the functionality of Spray Mode.

The Spray panel can be upgraded to include a Prep Mode. This panel includes a Spray Purge Mode timer. Switching from Prep Mode to Spray Mode can be accomplished two different ways:

1. Manual switching from Prep Mode to Spray Mode. The operator has to manually turn the Off/Prep/Spray selector switch from Prep to Spray.
2. Automatic switching from Prep Mode to Spray Mode. An air flow switch can be connected to the system. The Off/Prep/Spray selector switch stays in the Prep Mode position during system operation. When the operator pulls the spray gun trigger, the system automatically switches from Prep Mode to Spray Mode. When the trigger is release, the system goes through Spray Purge Mode and then switches back to Prep Mode air flow.

6.2.3 Prep/Spray Panel

The Prep/Spray panel controls the temperature rise during Prep Mode through a dedicated Prep Mode temperature controller. Temperature rise during Prep Mode shall not exceed the temperature rise specification of the heater. For temperature rise adjustment, please refer to Section 8.20.6.

6.2.4 Bake Only Panel

The Bake Only panel comes with a Bake Mode timer and a Preignition Purge timer. A Cool Down Mode timer is optional.

6.2.5 Spray/Bake Panel – Standard Panel

The Spray/Bake panel provides a Spray Mode and a Bake Mode.

The standard control panel includes the following features:

- Spray/Bake selector switch
- Light switch
- Off/Fan/Heat selector switch
- Magnehelic gauge to indicate booth pressure
- Spray and Bake potentiometers to adjust booth pressure
- LCD display to show current mode, time, temperature, error messages, etc.
- Time up/down switch
- Temperature up/down switch

- Hour counter

6.2.6 Prep/Spray/Flash/Bake Panel - Deluxe Operator Panel

The deluxe operator panel provides four modes:

Prep Mode

Spray Mode

Flash-Off Mode

Bake Mode

Reduced air flow Prep Mode.

There are two ways to implement reduced air flow rate during Prep Mode.

A. Intake air flow may be restricted with a damper.

B. The intake fan (heater fan) may be slowed down by controlling the intake fan motor speed with a VFD.

6.2.7 Multiple Heater Panel

Control panels can be built to operate multiple heaters. A single control panel may be configured to operate any number of heaters simultaneously.

Call technical support with your specifications for a quote.

6.3 Indicator Light Options

Heat on

Indicator light turns on when safety valves are open to indicate that the heater is operating.

Burner fault

Indicator light turns on when the flame controller is in a lockout state.

Clogged intake filter

Indicator light turns on when intake filter is clogged.

Clogged exhaust filter

Indicator light turns on when exhaust filter is clogged.

Booth lights on

Indicator light turns on when both lights are on.

Fan on

Indicator light turns on when intake fan is on.

Combustion blower on

Indicator light turns on when combustion blower is on.

6.4 VFD Keypad

Some VFD keypads may be installed on control panel door.

6.5 Intake VFD

The system can be upgraded with an intake VFD. Instead of using a damper an intake VFD is a more efficient air flow control option.

6.6 Automatic Pressure Balancing

The panel may be ordered with an automatic spray booth pressure balancing option. A digital pressure gauge is connected to the exhaust VFD to balance booth pressure without user intervention.

6.7 Umbilical Cord

If this option is selected, a 30' (9.1m) long umbilical cable will be wired into the remote control panel. The installer simply has to terminate the other end of the cable in the gastrain panel.

Umbilical cord extension kits are available if the 30' (9.1m) is not long enough. Umbilical extension kits come in 30' (9.1m) increments.

6.8 Propane Fuel

The heater does not require any changes for propane operation. It simply requires a lower gas manifold pressure. Follow the standard procedures for installation.

6.9 Automatic Spray Mode

The automatic Spray Mode is a feature that switches the system from the Prep Mode air flow to the Spray Mode air flow automatically. Pressure drop of the compressed air line supplying the spray gun is monitored. When the operator pulls the trigger on the spray gun, the pressure drops in the compressed air line is detected and the system ramps up to the Spray Mode air flow. When the trigger is released, the system enters Spray Purge Mode. When the Spray Purge timer expires, the system ramps down into the Prep Mode air flow. If the trigger is pulled during Spray Purge Mode, the Spray Purge Timer is reset and the system will restart the Spray Purge timer when the trigger is released again.

This feature has two components:

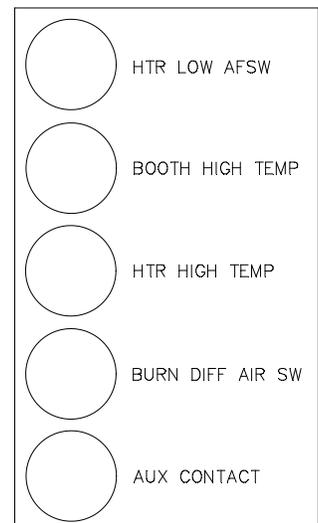
1. Compressed air flow switch. The system has to have a compressed air flow switch wired into the control panel according to the wiring diagram.
2. The Setup Screen has to be changed to enable this feature. Please see the PLC Programming/Setup Screens section for details.

Compressed air flow switch adjustment:

Please refer to the compressed air flow switch instructions.

6.10 Flame Controller Limits Indicator Light Option

We offer a visual indicator light option for the flame controller interlocks. This is a column of 5 light wired to the flame controller interlocks. If there is a problem, the first light that is off is where the problem is.



6.11 Blower Bearing External Grease Fittings

7 Component Assembly Instructions

Please refer to the component assembly manuals.

7.1 Low NOx heaters

Low NOx burners cannot be used with paper type prefilters. There is a danger of fire. Radiant heat from the burner can create heat that exceeds the temperature rating of the paper type filters. Only use filters that have temperature rating of not less than 240F (116C).

Use aluminum intake filters. Use a sheet of exhaust filter media in the intake plenum on top of the intake filter to prefilter intake air and to extend the service life of the intake filter.

8 Installation and Commissioning

MCA/MOP

Gas inlet pressure

Burner manifold pressure

Burner differential air pressure

Low air flow switch

High fire – max temp rise during max air flow

Low fire

Reduced air flow temp rise

8.1 MCA and MOP Calculations

Use the values in the tables below to calculate minimum conductor ampacity (MCA) and maximum overcurrent protection (MOP).

Motor full load current (FLC) tables

Induction-Type Squirrel Cage and Wound Rotor (Amperes)				
	3 phase			
Horsepower	208 Volts	230 Volts	460 Volts	575 Volts
1/2	2.4	2.2	1.1	0.9
3/4	3.5	3.2	1.6	1.3
1	4.6	4.2	2.1	1.7
1 1/2	6.6	6	3	2.4
2	7.5	6.8	3.4	2.7
3	10.6	9.6	4.8	3.9
5	16.7	15.2	7.6	6.1
7 1/2	24.2	22	11	9
10	30.8	28	14	11
15	46.2	42	21	17
20	59.4	54	27	22

25	74.8	68	34	27
30	88	80	40	32
40	114	104	52	41
50	143	130	65	52

Induction-Type Squirrel Cage and Wound Rotor (Amperes)				
	1 phase			
Horsepower	115 Volts	200 Volts	208 Volts	230 Volts
1/2	9.8	5.6	5.4	4.9
3/4	13.8	7.9	7.6	6.9
1	16	9.2	8.8	8
1 1/2	20	11.5	11	10
2	24	13.8	13.2	12
3	34	19.6	18.7	17
5	56	32.2	30.8	28
7 1/2	80	46	44	40
10	100	57.5	55	50

If VFD(s) are used, consult the VFD manual for input current draw specifications.

Transformer capacity: 300VA

Minimum Conductor Ampacity Calculation

Intake FLC x 1.75 **Round UP** to next fuse size to get **Intake Fuse Size**

MOP = Intake Fuse Size + EVFD input A + comb blower FLC + transformer + Total Amp draw of lights

Select smallest gauge wire that can handle the MCA current.

Maximum Overcurrent Protection Calculation

If using an inverse time breaker:

MOP = (largest motor FLC x 2.25) + Load2 + Load3 + Load4 + ...

If using a dual element fuse:

MOP = (largest motor FLC x 1.75) + Load2 + Load3 + Load4 + ...

Choose overcurrent protection device that is the next size DOWN from the MOP values you calculated using one of the formula above.

8.2 Control Panel to Heater Wiring: Spray/Bake

Wiring Between CP and GTP: Spray/Bake, Prep/Spray/Bake, Prep/Spray/Flash/Bake			
Non shielded cable – 16ga			
x	N	Neutral	
x	H1	Power	
x	G	Ground	
x	T9	From flame controller	
x	Y2	To flame cont and combustion blower	
x	Y8	To light relay	
x	X4	From Mode#2 air flow switch	
	IC	To intake contactor	Not used if intake VFD
x	24VDC	24VDC +	
x	24DCC	24VDC -	
x	T6-1	EVFD running	Option: Flame controller interlock
x	T6-3	Combustion air pressure OK	
x	T6-5	Heater high temp limit OK	
x	T6-7	Spray booth high temp limit OK	
x	T6-9	Minimum air flow OK	
	Y7	Burner relay	Option: Prep Mode
	H3	H3 to RUN relay	Option: Auto balancing
	RD	Recirc damper	Option: Recirc damper
x	ID	Intake damper	Option: Intake damper
Shielded cable – 18ga			
Exhaust VFD: manual balancing			
	10VDC	10VDC from exhaust VFD	
	10DCC	10VDC common from exhaust VFD	
	E-VFD	Exhaust VFD speed reference signal	
Modulating valve signal			
x	V1	0-10VDC mod valve signal	
x	C1	0-10VDC common	
Temp sensor			
x	A1	Temp sensor wires	
x	B1		
x	b1		
Intake VFD			
	RL1-6	1st preset speed	Option: Intake VFD
	RL2-6	2nd preset speed	
	RL3-6	3rd preset speed	
	I-COM	Intake VFD common	
Exhaust VFD: auto balancing			
	E-COM	VFD common	Option: auto balancing
	ACCEL	Accelerate	
	DECEL	Decelerate	
	RESET	Flame controller reset	Option: flame controller reset

8.3 Control Panel to Heater Wiring: Spray

Wiring Between CP and GTP: Spray and Prep/Spray			
Non shielded cable – 16ga			
x	N	Neutral	
x	H	Power	
x	G	Ground	
	T4	Flame controller alarm light	
x	T9	From flame controller	
x	Y2	To flame cont and combustion blower	
x	Y8	To light relay	
x	X4	From Mode#2 air flow switch	
	IC	To intake contactor	Not used if intake VFD
x	24VAC	24VDC +	
	24C	24VDC -	
x	T6-1	EVFD running	Option: Flame controller interlock
x	T6-3	Combustion air pressure OK	
x	T6-5	Heater high temp limit OK	
x	T6-7	Spray booth high temp limit OK	
x	T6-9	Minimum air flow OK	
	Y7	Burner relay	Option: Prep Mode
	H3	H3 to RUN relay	Option: Auto balancing
	RD	Recirc damper	Option: Recirc damper
x	ID	Intake damper	Option: Intake damper
Shielded cable – 18ga			
Exhaust VFD: manual balancing			
	10VDC	10VDC from exhaust VFD	
	10DCC	10VDC common from exhaust VFD	
	E-VFD	Exhaust VFD speed reference signal	
Modulating valve signal			
x	V1	0-10VDC mod valve signal	
x	C1	0-10VDC common	
Temp sensor			
x	A1	Temp sensor wires	
x	B1		
x	b1		
Intake VFD			
	RL1-6	1st preset speed (Prep Mode)	Option: Intake VFD
	RL2-6	2nd preset speed (Spray Mode)	
	I-COM	Intake VFD common	
Exhaust VFD: auto balancing			
	E-COM	VFD common	Option: auto balancing
	ACCEL	Accelerate	
	DECEL	Decelerate	
	RESET	Flame controller reset	Option: flame controller reset

8.4 Combustion Blower Wiring

The combustion blower is wired according to the NEC 1/3 rule (430.53 (D) (2)).

Feeder		Comb. Blower Min. Wire Size	TECO Contactor
MCA (not more than)	Wire Size		
40	10	14	CU-9-F6
55	8	12	CU-9-F6
75	6	10	CU-9-F6
95	4	8	CU-22-F6
130	2	6	CU-40-F6
150	1	4	
170	1/0	4	
195	2/0	2	

8.5 Gas Pressure and Gas Supply Capacity

Refer to the heater rating plate for determining the minimum gas supply pressure for obtaining the maximum gas capacity for which the heater is specified.

Model	CFM		HP @ 0.5" ext.	Max Input Btu/hr	Allowed Temp Rise (F)		Gas pressure inwc	Burner Length (in)	Blower Size
	Max	Min			NG	LP			
R-400	12,600	2,900	10	459,400	28	28	5	6	18x18
R-1 NOx	10,600	9,600	10	646,100	50		4.3	Riello RX250	18x18
R-1	12,600	2,900	10	1,427,800	100	100	5	24	18x18
R-1+	16,500	3,500	15	1,713,900	90	90	7	30	20x20
R-2	26,900	5,700	20	2,785,200	90	90	9	42	25x25
R-3	41,400	8,800	30	4,284,900	90	90	11	60	30x30
R-5	47,200	12,000	50	4,885,200	90	90	14	72	36x36

8.6 Low Air Flow Switch

Standard discharge pressure (0.5"wc [1.25Mbar])

During a reduced air flow mode while the booth is occupied (Prep Mode) the heater shall maintain the minimum air flow rate specified below.

Air Flow @ 0.5" wc (1.25mbar)		
Model	Max CFM (m3/min)	Min CFM (m3/min)
R-0.4	12,800 (363)	2,900 (82)
R-1	12,800 (363)	2,900 (82)
R-1+	16,000 (453)	3,520 (100)
R-2	26,000 (736)	5,720 (162)
R-3	40,000 (1,133)	8,800 (249)
R-5	55,000 (1,557)	12,000 (340)

During reduced air flow modes, heaters are required to maintain a minimum ventilation rate. Minimum required ventilation rate must be proven by low air flow switch

The low air flow switch shall turn off the burner if air flow drops below the specified minimum air flow rate. The standard pickup location is in the heater discharge.

However, if there is increased or decreased static pressure in the heater discharge, the switch may provide a false reading. For example, too much ductwork, too many elbows, or a discharge damper can all produce excessive pressure in the heater discharge area. If there are any dampers installed in the discharge area, the pickup tube has to be extended or relocated. The pickup location has to be downstream of any and all damper(s) between the heater and the spray booth plenum. The low air flow switch has to be re calibrated.

Low air flow switch recalibration process

1. Relocate low air flow switch pickup tube downstream of damper(s).
2. Turn on system in the low air flow mode (Prep Mode).
3. Determine ventilation rate through heater by measuring air flow rate in either intake or exhaust stack.
4. Make necessary air flow rate adjustments to maintain not less than the minimum air flow rate specified for heater.
5. Disconnect air flow tubing from low air flow switch.
6. Connect a manometer to air flow tubing.
7. Measure air pressure with manometer.
8. Check to make sure that low air flow switch has a range that includes air pressure reading.
9. Recalibrate or replace air flow switch.
10. Turn on heater.
11. Make sure burner lights.
12. Remove air flow tube from low air pressure switch.
13. Burner should turn off.
14. Document the process and the setpoints.

8.7 Burner Differential Air Pressure Adjustment – Combustion Blower Test

Make sure air flow or air pressure switches are in a vertical position. If switch is in a horizontal position, the weight of the diaphragm will cause errors in pressure sensing!

During a reduced air flow mode (Prep Mode) Burner differential air pressure has to be between 0.3"WC (0.75Mbar) and 0.38"WC (0.95Mbar) with both natural gas and propane.

During a maximum air flow mode (Spray Mode with 12,800 cfm [362cum] @ 0.5"WC [1.2Mbar]), burner differential air pressure should be about 0.4" WC (1Mbar).

Burner Differential Pressure Test Procedure

Burner differential pressure switch has two pressure tubes connected to it. The first tube is coming from the burner combustion air pressure chamber. Since the chamber is positively pressurized by the combustion air blower, this tube should be connected to the + port (black) on the air pressure switch. The second tube is coming from the heater cabin. Since this is in the suction side of the intake blower, this tube has to be connected to the – port (white) on the air pressure switch.

1. Turn heater on in Spray Mode with Heat.
2. Disconnect heater cabin pressure tube from negative (-) port of differential pressure switch.
3. Disconnect burner differential air pressure tube from positive (+) port of air pressure switch.
4. Connect manometer positive (+) port to combustion air tubing to measure combustion air pressure.
5. Measure combustion air pressure.
6. Document combustion air pressure value.
7. If value is outside of specifications, make necessary adjustments to system. Move sheet metal that blocks part of the intake opening of the combustion air blower to reach differential pressure specification.
8. Reconnect pressure tubes to their respective ports on the differential pressure switch
9. Document process and setpoints in writing.

8.8 Burner Differential Air Pressure Switch Test

The burner differential air pressure switch monitors the pressure drop over the burner. The correct pressure drop over the burner is necessary for proper fuel combustion. The following test establishes the correct minimum differential pressure over the burner.

The burner differential air pressure switch is factory calibrated and sealed. Field adjustment is not possible. If switch fails test, contact factory for replacement.

Test Procedure

1. Go through ignition sequence. Document burner status (did burner light or did not light). Burner should be lit.
2. Remove combustion air pressure tubing from + port of air pressure switch. Flame controller should turn burner off.
3. Repeat ignition sequence. Burner should not light.
4. If burner lit, check actual burner differential pressure.
5. If actual differential pressure is within specifications, replace combustion air flow switch.

8.9 Regulator adjustment procedure:

1. Connect manometer to the inlet of the regulator.
2. Verify that inlet pressure does not exceed regulator inlet pressure rating.
3. Unscrew the cap on top of the regulator.
4. Use a flat head screw driver with a ¼" wide blade to turn the spring tension adjuster inside.
5. Tightening the spring tension (turning the adjuster clockwise) increases the outlet gas pressure of the regulator.
6. Loosening the spring tension (turning the adjuster counter clockwise) decreases the outlet gas pressure of the regulator.

8.10 Pilot Regulator Pressure Adjustment - CV100

1. After connecting the heater to the gas supply, isolate all controls and conduct a leak down test.
2. Verify that line pressure does not exceed the rating of the regulator.
3. Connect manometer to pressure tap on outlet side of pilot solenoid valve.
4. Unscrew the pilot pressure regulator adjustment screw all the way.
5. Turn on heater.
6. In the pilot gas line locate the second ball valve (pilot choke valve) downstream from the main gas line, immediately upstream from the pilot solenoid valve. The turn handle should be off of the pilot choke valve. The handle should be secured to the pilot gastrain with a piece of wire.
7. Put the handle onto the pilot choke valve and open the valve all the way.

8. Start closing the pilot choke valve while monitoring the pilot gas pressure.
9. Adjust pilot solenoid valve to provide the correct pilot gas pressure.
Natural gas: 0.20" WC (0.5mbar) to 0.25" WC (0.63mbar)
10. Verify that the flame controller is sensing the presence of the pilot flame. Check for 5VDC on the flame amplifier.
11. Remove pressure tap and reinstall plug.
12. Remove choke valve handle and use a piece of wire to secure it back to the pilot gastrain.
13. Document process and setpoints in writing.

8.11 High Fire Adjustment - Spray Mode

Maxitrol MR212

Maxitrol EXA

OPERATING INSTRUCTIONS

▲ WARNING

Read these instructions carefully. Failure to follow them could result in a fire or explosion causing property damage, personal injury, or loss of life.

Service and/or installation must be performed by a trained, experienced service technician.

Disconnect power before installation to prevent electrical shock, equipment or control damage.

WHAT TO DO IF YOU SMELL GAS

1. Do not operate any appliance.
2. Do not touch any electrical switch; do not use any phone in your building.
3. Immediately evacuate the area and contact the gas supplier. Follow the gas supplier's instructions.
4. If you cannot reach the gas supplier, call the fire department.

▲ WARNING

This control **must** be installed and operated **strictly** in accordance with the instructions of the OEM and with all applicable government codes and regulations, e.g. plumbing, mechanical, and electrical codes and practices. These instructions do not supersede OEM's installation or operating instructions.

DESCRIPTION

The EXA STAR modulating valves are highly accurate and precise modulating control valves (see Figure 1). EXA valves provide repeatable process control with minimal hysteresis throughout the entire range of modulation.

The EXA STAR modulation system's high fire setting and low fire setting are user programmable.

SPECIFICATIONS

Maximum Inlet Pressure: 5 psig

NOTE: Up to 10 psig available, consult Maxitrol Company.

Power Requirements: 24VAC/DC +/- 10% 50/60hz

NOTE: The 24V power supply potential must be isolated from the control signal. For more information, see our Power Supply Compatibility Bulletin.

Maximum Current Draw: 200mA



Figure 1: EXA STAR Modulating Valve Series

Temperature Limits: -40°F to 150°F operating

Control Signal (user selectable): 0-10VDC, 2-10VDC, 0-20mA, 4-20mA; 100KOhm Input Impedance

Mounting: Multipoise

Gases: Suitable for natural, manufactured, mixed gases, liquefied petroleum gases, and LP gas-air mixtures.

Certifications:

- EMC (EN 61000:2001)
- Immunity (EN 61000-6-2:2001)
- Emissions (EN 61000-6-4:2001)
- UL Recognized
- CE

Enclosure: IP40

Electrical Connection: UL310

Sizes: EXA40: 3/8", 1/2" NPT or Rp ISO 7-1
EXA50: 1/2", 3/4" NPT or Rp ISO 7-1
EXA60: 3/4", 1" NPT or Rp ISO 7-1

Table 1: Capacity

Capacity @ 1" Pressure Drop - 0.64 sp. gr. gas:	
EXA40 (3/8")	190 cfm
EXA40 (1/2")	215 cfm
EXA50 (1/2")	385 cfm
EXA50 (3/4")	435 cfm
EXA60 (3/4")	670 cfm
EXA60 (1")	780 cfm

Burner high fire gas pressure adjustment procedure

Close manual safety valve between pressure regulator and first safety solenoid valve downstream from regulator.

1. Open manual safety valve between modulating valve and burner.
2. Locate outlet pressure tap on the first safety valve upstream of burner.
Orient valve with coil on top. Side pressure ports are inlet pressure ports. Bottom pressure port is outlet pressure port.
3. Remove ¼" plug from outlet pressure port and connect manometer.
4. Turn on equipment in Spray Mode.
5. Make sure combustion blower is running.
6. Follow the Maxitrol EXA instructions to adjust high fire.
7. Monitor pressure reading.
8. Record reading. This is the burner negative pressure value.
9. Complete the following manifold pressure calculation to find out the pressure reading that is necessary to obtain correct high fire:

Burner negative pressure + maximum manifold pressure (from name plate) = high fire gas pressure
This is the high fire gas pressure the burner needs for firing at the highest capacity.

Sample calculation:

Burner negative pressure = -0.4" WC (1mbar)

Maximum manifold pressure = 3.5" WC (8.7mbar)

High fire gas pressure = -0.4 + 3.5

High fire gas pressure = 3.1" WC (7.7mbar)

10. Heater should be still running with modulating valve in the high fire position and with the pilot on.
11. Open manual safety valve downstream of regulator.
12. Make sure burner lights in a low fire state.
13. Monitor gas pressure on the outlet side of the first safety valve upstream of the burner.
14. Adjust high gas pressure regulator to achieve the correct gas pressure. This is the value you calculated in Step 9.
15. Verify that discharge air temperature does not exceed the maximum of 185F (85C).
16. If discharge air temperature exceeds maximum, decrease high fire gas pressure until discharge air temperature drops below the maximum allowed discharge air temperature.
17. Turn equipment off. Lockout tagout.
18. Turn off manual shutoff valve immediately downstream of regulator.
19. Remove manometer and install ¼" plug back into pressure tap of safety valve.
20. Remove lockout tagout and power up equipment.
21. Document process and setpoints in writing.

8.12 Spray Mode Temperature Rise Adjustment – High Fire Adjustment

The maximum safe temperature rise of the heater in occupied modes is the following:

Model	CFM		HP @ 0.5" ext.	Max Input Btu/hr	Allowed Temp Rise (F)		Gas pressure inwc	Burner Length (in)	Blower Size
	Max	Min			NG	LP			
R-400	12,600	2,900	10	459,400	28	28	5	6	18x18
R-1 NOx	10,600	9,600	10	646,100	50		4.3	Riello RX250	18x18
R-1	12,600	2,900	10	1,427,800	100	100	5	24	18x18
R-1+	16,500	3,500	15	1,713,900	90	90	7	30	20x20
R-2	26,900	5,700	20	2,785,200	90	90	9	42	25x25
R-3	41,400	8,800	30	4,284,900	90	90	11	60	30x30
R-5	47,200	12,000	50	4,885,200	90	90	14	72	36x36

Adjustment and Test Procedure:

1. Put heater into maximum air flow mode.
2. Determine maximum air flow rate through the installed heater.
3. Put heater into high fire: Burner High Fire Adjustment section.
4. Measure temperature rise through heater.
5. Adjust gas regulator while heater in high fire and maximum air flow mode to set high fire at a level that produces a temperature rise that is less than the allowed temperature rise in the Maximum temperature Rise – Spray Mode table.
6. Take heater out of high fire.
7. Document process and setpoints in writing.

8.13 Low Fire Adjustment

Adjust the minimum burner capacity while carefully observing the flame. Ensure that the flame remains stable over the entire burner front. If the burner is ignited at minimum capacity, verify (by several repeats) that the flame is smoothly cross-igniting over the entire burner front.

Follow the Maxitrol EXA instructions to adjust low fire.

8.14 Prep Mode Maximum Temperature Rise Adjustment

Temperature rise has to be limited in occupied modes. In Prep Mode you have to limit how far the modulating valve opens.

Maximum Temperature Rise (Spray & Prep Modes)					
Heater	Natural Gas			Liquid Propane Gas	
	F	C		F	C
R-0.4	28	2.2		28	2.2
R-1	100	38		100	38
R-1+	90	32		90	32
R-2	90	32		90	32
R-3	90	32		90	32
R-5	90	32		90	32
R-1 LowNox	50	10		50	10

8.14.1 Prep/Spray Systems

The temperature rise is limited through the Prep Mode temperature controller.

1. Turn Off/Fan/Heat switch to Off.
2. Install a properly calibrated temperature meter in the intake air stream of the heater
3. Increase Prep Mode maximum temperature to 160F (71C).
4. In the temperature controller adjust the maximum analog modulating valve signal to a low value. Somewhere around 20% of the maximum is a good starting point. Temperature controller programming is very similar among various brands. In the Delta and SOLO brand controllers, this is Regulation Mode function under CrHt. Press and hold the SET button for more than 3 seconds to access the CrHt parameter. Generally analog output value corresponds to a numerical value. Read the controller instructions before adjusting the maximum analog output. Adjust the numerical value to 20% of the maximum and run temperature rise test.
5. Turn the mode selector switch to Prep Mode.

6. Turn the Off/Fan/Heat switch to Heat.
7. Use the Temperature Up/Down switch to increase the setpoint temperature to 160F (71C).
8. Monitor the analog output. When output reaches the maximum, note intake and discharge temperatures.
9. Subtract the intake temperature from the discharge temperature.
10. If the temperature rise is greater than the temperature rise specified for the heater, lower maximum analog output signal.
11. If the temperature rise is less than the maximum specified for the heater, raise the maximum modulating valve signal in the Setup Screens.
12. Re test temperature rise and adjust until temp rise is not more than the maximum specified for the heater.
13. Repeat steps 1 through 12.
14. Turn Off/Fan/heat selector to the Off position.
15. With the temperature UP/Down switch decrease Prep Mode temperature setpoint to 70F (21C).
16. In the Setup Screens decrease Prep Mode maximum temperature to 90F (32C)
17. Document process and setpoints in writing.

Temperature controller programming parameters

The following parameters have to be programmed into the temperature controller:

tPUn: temperature unit of measure = F

tP-H: Upper limit of temperature range = 180F

PO: PID control P value =

IO: PID control I value =

d0: PID control D value =

tPoF: process temperature offset = program in offset value to correct difference between measured and actual process temperature.

8.14.2 Prep/Spray/Bake Systems

The heater controls limit the modulating valve opening during an occupied mode with reduced air flow (Prep Mode with reduced air flow). The installer has to program the correct maximum limit of the modulating valve opening. Limiting the maximum signal to the modulating valve limits the maximum temperature rise in Prep Mode. Please see PLC Programming/Setup Screens section.

Maximum Temperature Rise (Spray & Prep Modes)					
Heater	Natural Gas			Liquid Propane Gas	
	F	C		F	C
R-0.4	28	2.2		28	2.2
R-1	100	38		100	38
R-1+	90	32		90	32
R-2	90	32		90	32
R-3	90	32		90	32
R-5	90	32		90	32
R-1 LowNox	50	10		50	10

8.15 Spray Booth Lights Interlock

The spray booth lights are turned off by the PLC during process heater modes. Spray booth light interlock wiring is done at the factory. Installer has to connect the following:

1. Control wire from control panel RL41 terminal block to gastrain panel RL41 terminal block.
2. Light power wire to the light contactor.

8.16 Temperature Sensor Installation

Temperature sensor is installed into the blower housing

8.17 Installation Code Conformity

The installation shall conform with local codes, or in the absence of local codes, in accordance with the National Fuel Gas Code, ANSI Z223.1 – NFPA54, or the Natural Gas and Propane Installation Codes, CAN/CSA B149.1.

8.18 Heater Location

The heater shall be located in accordance with the applicable building code or mechanical code provisions for ventilation air.

8.19 Spray Booth Exhaust Air and Recirculated Air Filtering

Exhaust

Install a polyester filter downstream from the standard spray booth exhaust filter. The traditional single stage fiberglass exhaust filter allows significant amount of overspray into the exhaust (and recirculating) duct. When overspray deposits on the fans, the fan capacity will be reduced. It is necessary to install a more efficient filtration system in order to minimize fan cleaning intervals and the possibility of decreased air flow rates that are outside of the specifications of this heater.

Recirculated Air Filtering

This heater may only recirculate during non occupied modes.

Recirculated air shall be filtered inside the recirculating air duct. Filters shall be approved by the AHJ.

The recirculating air duct shall be equipped with doors, removable panels or similar in order to facilitate the inspection, maintenance and cleaning of the recirculating duct work and the fire suppression system inside.

The recirculating duct system shall be inspected and cleaned periodically. It is the operator's responsibility to determine the inspection and cleaning intervals.

8.20 Heater Inlet

The heater inlet shall be located in accordance with the applicable building code provisions for ventilation air.

8.21 Snow and Rain Entry Into Heater

Field constructed intake accessories should be properly designed to minimize the entry of snow and rain.

8.22 Preventing Objects to be Picked up From Outside

The heater shall have means provided to prevent leaves, papers or other objects from being picked up from the outside, ignited and discharged into the heated space. The upper limit of the size of the openings of this means shall be such as to prevent the entrance of a 1-1/8 inch (28.6mm) diameter rod. The lower limit of the size of the openings in this means shall not prevent the entrance of ¼ (6.4mm) inch rod.

We supply a wire mesh for outdoor installations. The wire mesh has to be installed over the intake opening of the heater. The wire mesh should be sandwiched between heater intake and whatever accessory is bolted to the intake: rainhood, vertical stand, intake duct, etc. If there is no accessory bolted to the intake opening of the heater, the installer shall choose a method to securely attach the mesh to the intake opening.

8.23 Field Wiring Entry points

8.23.1 Control Panel

Use knockouts on panel. Do not drill any holes into panel. Metal shavings can damage components inside.

8.23.2 Gastrain Panel (GTP)

R-0.4, R-1, R-2, R-3

Field wiring should always enter at the bottom of the gastrain box where label is placed

R-4

Field wiring should always enter at the side of the gastrain box where label is placed.

Line voltage wires should have a different entry point from low voltage control wires. Always keep high and low voltage wires at least 2" (51mm) apart.

8.24 Low -Temperature Limit Control

It is recommended that low-temperature limit control be installed in areas where freeze-up protection is needed in the event of burner shutdown.

8.25 Uninsulated Buildings, 32F (0C)

Recirculation is not recommended in uninsulated buildings where outside temperatures fall below 32F (0C).

8.26 External Heater Interlocks

Direct fired air heaters may be used in a wide variety of applications. Some of these applications may require additional interlocks. Failure to integrate these interlocks into the system may cause a hazardous situation. Make sure you follow all applicable standards and codes, and the requirements of the AHJ.

If the failure or malfunction of this heater creates a hazard to other fuel burning equipment in the building, (e.g. when the heater is providing the make-up air to a boiler room), the unit is to be interlocked to open air dampers or other such devices.

8.27 Spray Booth Oven System Interlocks

Install all interlocks according to wiring diagrams and according to all relevant requirements. Always consult the AHJ about their specific requirements.

8.27.1 Spray Mode exhaust air flow switch

The following table shows the theoretical air flow switch values to prove air flow in a 30" (76cm) duct at various air flow rates. The table is for reference information only. You have to actually measure air flow in the exhaust to be able to accurately choose the air flow switch range.

Air pressure for 30" duct	
CFM	WC (mbar)
8,000.00	0.17 (0.42)
10,000.00	0.26 (0.65)
12,000.00	0.37 (0.92)
14,000.00	0.51 (1.27)

8.28 Spray Booth is not a Load Bearing Structure

Do not place heater on top of a spray booth. Spray booths are not load bearing structures. Spray booth may collapse causing property damage, serious injury and /or death. Use properly engineered heater supports to hold the weight of the heater.

8.29 Explosion Relief Panels of Spray Booths

Blocking explosion relief panels can cause serious injury or death. Do not obstruct relief panels. Check NFPA 86 5.3 for requirements.

8.30 Bleeds and Vents

Bleeds and vents that require venting shall be vented to the out-of-doors.

Heaters with RV61 and the RV81 regulators are shipped with a vent limiting device.

The RV91 regulator has to be vented to the out-of-doors. The RV91 regulator has to use the Maxitrol vent protector. The vent protector has to be installed in a vertical position.

8.31 Fossil Fuel Powered Equipment

If gas fork trucks or other fossil fuel powered equipment are utilized in the conditioned area, additional ventilation requirements for the facility must be addressed separately.

8.32 Ventilation Air From Outdoors

All ventilation air to heater shall be ducted directly from the outdoors when operated in the ventilation air mode.

8.33 Hazards of Room Air Recirculation

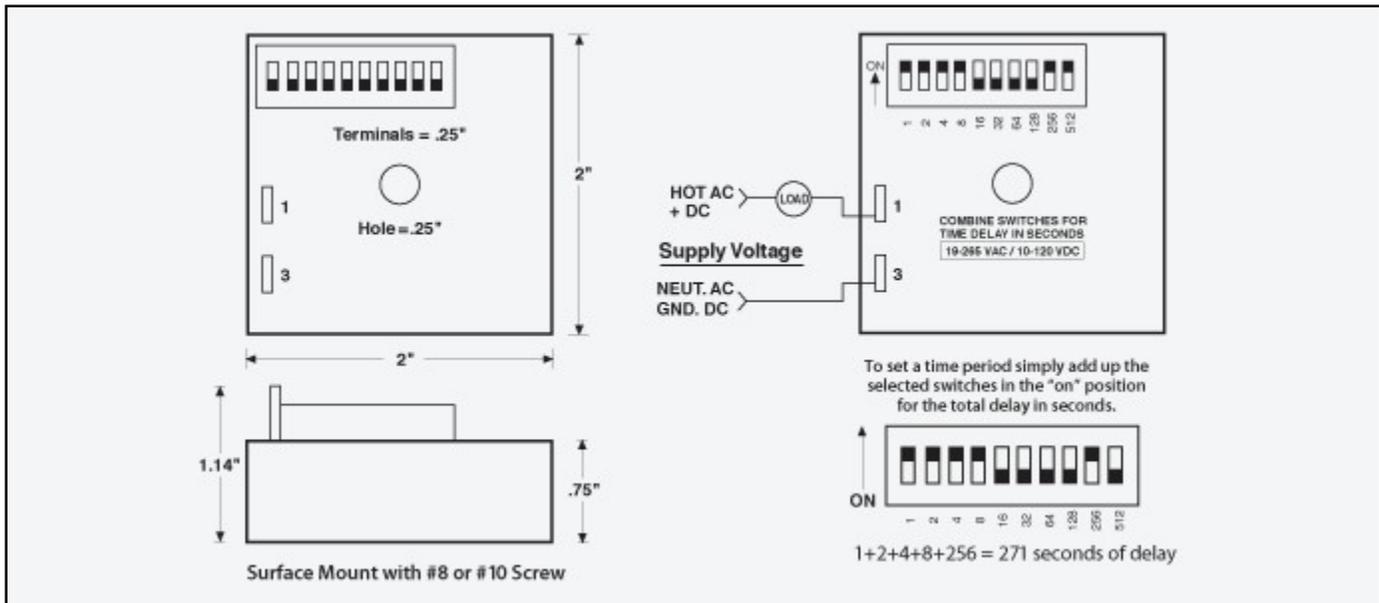
Recirculation of room air may be hazardous in the presence of:

- a. Flammable solids, liquids and gases;
- b. Explosive materials (e.g., grain dust, coal dust, gunpowder, etc.); and
- c. Substances which may become toxic when exposed to heat (e.g., refrigerants, aerosols, etc.).

8.34 Intake Fan On-Delay

8.34.1 Intake fan is turned on with a contactor

In spray booth applications when the fans start, the intake fan usually develops a higher air flow rate faster than the exhaust fan does. The spray booth over pressurizes and the doors blow open. The intake fan time delay postpones the start of the intake fan. The intake fan time delay can be programmed in one second intervals through the dip switches. Please see programming instructions below.



8.34.2 Intake Fan VFD (option)

If the intake fan is controlled with a VFD, an on delay is not necessary. The intake VFD ramp up rate can be adjusted to prevent the intake fan from over pressurizing the spray booth.

8.35 Interlock Operation and Setpoint Documentation

During commissioning, the set points of all interlocks have to be recorded in writing!

8.35.1 Spray Booth Lights off in Process air Modes

The booth lights have to be turned off during process air/Class A oven modes. This means that the lights have to be off during Flash-Off and Bake modes. It is sufficient to test the operation of the spray booth lights in Bake Mode.

Test Procedure: Bake Mode

1. Turn heater on in Bake Mode.
2. Turn light switch on.
3. Spray booth lights have to be off.
4. If lights are on, perform necessary repairs.
5. Document process and results in writing.

8.35.2 Spray Booth Door Switches

The access opening(s) to the heater space shall be equipped with door interlock switch(es) to prevent the operation of the heater during a bake cycle when an access door is opened.

ANSI z83.25 recommends posting the following warning at each door:

“Do not enter this space until cool down cycle is complete”.

Spray booth oven door switches are generally used to fulfill two safety functions. Our system accomplishes both of the following:

1. The first safety interlock function is required by ANSI z83.25. ANSI z83.25 requires the spray booth oven door switches to terminate Class A oven mode if the door(s) is opened during Class A oven modes. If the spray booth

oven doors are opened during Flash-Off or Bake modes the system will reference the Spray Mode temperature setpoint. In order to reference the Flash-Off or bake Mode temperature again, the door(s) has to be closed and the operator has to press the Reset button.

2. The second safety function is usually required by the AHJ. Many AHJs require the spraying operation to be disabled if a spray booth door is opened. As soon as the spray booth door is closed, spraying operations can be resumed. There is no reset or user intervention required.

Test Procedure #1: Class A oven modes (Flash Off and Bake)

1. Note Spray Mode temperature setpoint. Note outside air temperature. You will use whichever of these two numbers are higher for the test.
2. Turn selector to Bake Mode. Wait until temperature climbs to 130F (54C).
3. Open one door and then close the door. Temperature should start falling. Wait until spray booth temperature reaches the higher of the temperature determined in Step 1.
4. Press the Reset button.
5. System should start referencing Bake Mode temperature setpoint again. Process temperature should start climbing in spray booth oven.
6. Repeat steps 1 through 5 for all doors.
7. Make necessary repairs if system does not pass test.
8. Document process and results in writing.

Test Procedure #2: Spray Mode – Disable Spraying Operations

1. Turn on system in Spray Mode.
2. Connect an empty spray gun to the compressed air outlet.
3. Pull spray gun trigger. Compressed air should come out of spray gun.
4. Open a spray booth door and leave it open.
5. Pull spray gun trigger. There should be no air coming out of spray gun.
6. Close door.
7. Repeat Step 4 – Step 6 for all spray booth doors.
8. Make necessary repairs if system does not operate as required.
9. Document process and results in writing.

8.35.3 Product of Combustion Dilution

Products of combustion have to be diluted based on the following formula: 200cfm ($5.7\text{ m}^3/\text{min}$) of fresh air ventilation x burner capacity (MBtu). For example, the 1.5MBtu heater will need the following fresh air flow rate to dilute products of combustion: 200cfm ($5.7\text{m}^3/\text{min}$) x 1.5MBtu = 300cfm ($8.55\text{ m}^3/\text{min}$) of fresh air. In our systems the combustion air blower provides this fresh air flow rate. The combustion air blower is interlocked with the flame controller.

Test Procedure:

1. Use heater rating plate to determine maximum burner capacity.
2. Use maximum burner capacity and the equation above ($200\text{CFH} \times \text{Btu}$) to calculate fresh air ventilation requirement.
3. Verify that the burner differential air pressure switch is properly calibrated.
4. Drill a sampling hole into the combustion air intake duct. Sampling hole should be about half way between the intake opening and the combustion air blower intake.
5. Do a transverse air velocity measurement and calculate air flow rate.
6. Multiply air flow rate by cross sectional area of combustion blower intake duct to find out fresh air ventilation rate.

7. Compare required rate to calculated rate.
8. If required rate is greater than calculated rate, make necessary adjustments and/or repairs.
9. Document process and results in writing.

8.35.4 Solvent Vapor Ventilation

During Class A oven modes solvent vapor ventilation should keep the LEL level below 25%. In spray painting applications this is generally not an issue. During standard spray finishing applications the LEL level will never exceed 25% in a spray booth. However, if the system is used to dry coating applied by other methods, for example dipping, please call the manufacturer. If you have any questions about standard and custom drying processes please contact the manufacturer.

8.35.5 Preignition Purge Requirement

The system includes a Preignition Purge timer. This timer is adjustable from the Setup Screens. Please see Setup Screens section.

Preignition Purge Mode has to provide four (4) air volume changes for the intake duct and the spray booth. To ensure that this required number of air changes takes place follow the instructions below.

Test Procedure:

1. Determine air flow rate of heater in Preignition Purge Mode. This is the same air flow rate spray booth has to have in Spray Mode to satisfy regulations and AHJ requirements. Measuring the exhaust air flow rate during Spray Mode is one way to determine the Preignition Purge air flow rate of the heater.
2. Determine air volume of intake duct. Intake duct is the duct that is between the fresh air intake and the intake of the heater. Intake duct also includes ducting that is used to connect the heater to the spray booth. The heater is also part of the intake duct system.
3. Determine air volume of spray booth. Air volume of spray booth includes air volume of the intake plenum.
4. Determine intake duct air volume. Intake duct air volume is the air volume of the equipment the intake air has to travel before entering the spray booth. Intake duct air volume can be calculate using the following formula: Heater intake duct air volume + heater air volume + heater discharge duct air volume = intake duct air volume
5. Add intake duct to air volume to spray booth air volume to get the total Preignition Purge Mode air volume.
6. Divide heater air flow rate by the total air volume. This will tell you the number of actual air changes **per minute**.
7. Divide the required number of air changes, 4, by the actual air changes per minute. This will give you the number of minutes the system has to run to ensure 4 (four) air changes.
8. Round up the results to the nearest half a minute. NEVER round the results down!
9. Document process and results in writing.

Sample calculation:

Required air changes: 4

Heater air flow rate: 12,500cfm (354m³/min)

Intake duct volume: 250cf (7.1m³)

Spray booth volume: 2,950cf (83.5m³/min)

Total volume: 250cf (7.1m³) + 2,950cf (83.5m³/min) = 3,200cf (90.6m³)

12,500cfm (354m³/min) / 3,200cf (90.6m³) = 3.9 air changes per minute will take place

We have to provide not less than the required four air changes per minute: 4 required air changes / 3.9 actual air changes = 1.03 minutes

For this example, 1.03 minutes is the minimum required Preignition Purge Mode time.

We suggest rounding up the results to the nearest half a minute. Program 1.5 minutes for the duration of Preignition Purge.

8.35.6 Spray Purge Mode

After spraying operations takes place, the spray booth shall be purged before it enters other modes. At the beginning of these modes the spray booth shall stay in the Spray Mode air flow to achieve not less than three (3) air volume changes of the spray booth. To ensure that this required number of air changes takes place follow the instructions below.

Test Procedure: Required Air Changes

1. Determine air flow rate of heater in Spray Purge Mode. This is the same air flow rate spray booth has to have in Spray Mode to satisfy regulations and AHJ requirements. Measuring the exhaust air flow rate during Spray Mode is one way to determine the Spray Purge Mode air flow rate of the heater.
2. Determine air volume of exhaust duct.
3. Determine air volume of spray booth. For these calculations air volume of spray booth DOES NOT include air volume of the intake plenum.
4. Add exhaust duct to air volume to spray booth air volume to get the total Spray Purge Mode air volume.
5. Divide heater air flow rate by the Spray Purge Mode total air volume. This will tell you the number of actual air changes **per minute**.
6. Divide the required number of air changes, 3, by the actual air changes per minute. This will give you the number of minutes the system has to run to ensure 3 (three) air changes.
7. Round up the results to the nearest half a minute. NEVER round the results down!
8. Document process and results in writing.

Sample calculation:

Required air changes: 3

Heater air flow rate: 12,500cfm (354m³/min)

Exhaust duct volume: 200cf (5.7m³)

Spray booth volume: 2,650cf (75m³)

Total volume: 200cf (5.7m³) + 2,650cf (75m³) = 2,850cf (80.7m³)

12,500cfm (354m³/min) / 2,850cf (80.7m³) = 4.3 air changes per minute will take place

We have to provide not less than the required four air changes per minute: 3 required air changes/ 4.3 actual air changes = 0.7 minutes

For this example, 0.7 minutes is the minimum required Spray Purge Mode time.

We suggest rounding up the results to the nearest half a minute. In this case we would program at least 1 minute for the duration of Spray Purge Mode.

Our system accomplishes this in two ways.

a. Standard Spray Mode

When the system is manually switched out of the Spray Mode (turning Mode Selector switch) Spray Purge Mode starts. The air solenoid valve is locked out. Duration of Spray Purge Mode shall be calculated and programmed by installer.

Test Procedure: Spray Purge time in Standard Spray Mode

1. Start Spray Mode.
2. Wait for 5 seconds.
3. Switch to Bake Mode.
4. Use a watch to time how long it takes the spray booth to turn lights off and to start slowing down the ventilation system.
5. The time should be not less than the required Spray Purge Mode timer.

6. If actual time is less than required time, make necessary repairs.
7. Document process and results in writing.

b. Automatic Spray Mode

In Automatic Spray Mode every time the system senses that the spray gun trigger is release, the system starts a Spray Purge Mode count down. If the system is able to finish the countdown two things can happen. The system will either go back to Prep Mode or if the Mode Selector was switches into another mode, the system will enter the mode selected by the Mode Selector switch. If the system is switched over to, for example, Bake Mode before the Spray Purge Mode countdown completes, the system will stay in Spray Purge Mode until the countdown finishes. Once the countdown finishes, the system will enter the selected mode. Duration of Spray Purge Mode shall be calculated and programmed by installer.

Test Procedure: Spray Purge Time in Automatic Spray Mode

1. Program control panel for Auto Spray Mode through the Setup Screens (see Automatic Spray Mode Option)
2. Turn on system in Prep Mode.
3. Connect empty spray gun and pull trigger.
4. System will start speeding up ventilation fans and starts transitioning into Spray Mode air flow conditions.
5. Release trigger of spray gun. Start timing how long will system stay in Spray Mode air flow before beginning to ramp down to Prep Mode level.
6. This time interval should be not less than the required Spray Purge Mode time.
7. Pull spray gun trigger again for about 3 seconds then release trigger. Start timing on a watch.
8. Turn Mode selector switch to Bake.
9. Stop timer when system turns lights off and starts slowing down ventilation fans.
10. This time interval should be not less than the required Spray Purge Mode time.
11. If actual time is less than required time, make necessary repairs and/or adjustments.
12. Document process and results in writing.

8.35.7 Cool Down Mode

Cool Down Mode shall be implemented after the Bake Mode for two reasons.

1. The Cool Down Mode is necessary to purge contaminant from the space and to cool the product down.
2. Spray booth components and the coated product may present a burn hazard. Their temperatures may be over 160F (71C).

The system automatically enters Cool Down Mode upon the completion of the Bake Cycle. Cool Down mode is 3-5 minutes long. Cool Down Mode must complete before people enter the space.

Test Procedure: Part Temp Below 160F (71C)

1. Run a full finishing cycle.
2. Use the highest possible Bake Mode setpoint temperature (at least 160F/71C)
3. Use a 3 minute Cool Down mode timer setting.
4. Enter the booth after the completion of the Cool Down Mode. Measure the surface temperature of the refinished product. If surface temperature is still 150F (66C) or more, increase Cool Down Mode timer.
5. Document process and results in writing.

Cool Down Mode timer can be accessed through the Setup Screens.

8.35.8 Exhaust Fan Interlock

Exhaust fan operation has to be interlocked into the safety circuit. The burner shall not light unless the exhaust fan is running. This requirement may be satisfied in two different ways.

1. Exhaust VFD: The safety circuit signal is routed through the VFD NO alarm contact. When VFD is running the NO contact closes and sends the signal to the flame controller through the safety circuit.
2. Exhaust contactor: The safety circuit signal is routed through a NO auxiliary contact on the exhaust contactor.

Test Procedure:

Exhaust VFD Alarm Contact

1. Go through the ignition sequence. Burner should light.
2. Measure continuity on the alarm contact terminals. There should be continuity.
3. Turn off heater.
4. Measure continuity on the alarm contact terminals. There should be no continuity.
5. If there is continuity, check to make sure contacts are programmed to be NO. Reprogram or replace VFD.
6. Document process and results in writing.

Exhaust Contactor Auxiliary Contact

1. Go through the ignition sequence with the auxiliary contact installed on contactor. Burner should light.
2. Measure continuity on the auxiliary contact terminals where the safety circuit wires are installed. There should be continuity.
3. Turn off heater.
4. Measure continuity on auxiliary contact terminals where the safety circuit wires are installed. There should be no continuity.
5. If there is continuity, replace auxiliary contact.
6. Document process and results in writing.

8.35.9 High Temperature Limit Switch Inspection and Testing

The high temperature limit switch has to be regularly tested. Heaters have one manual reset, 180F (82C) high temperature limit switch.

Location: heater

Setting: 180F (82C)

8.35.9.1 Visual Inspection

Check for signs of obvious damage. Check to make sure limit switch is securely mounted.

8.35.9.2 Heater High Temperature Limit Switch Testing Process

1. Turn system off.
2. Verify that discharge duct is not too hot. Measure discharge duct surface temperature with a non contact thermometer. Duct temperature should be less than 160F (71C) before you start working on it.
3. Use a certified temperature meter to measure heater discharge temperature.
4. Drill hole for a temperature sensor probe into discharge duct 3"-4" (7.5cm - 10cm) from heater discharge opening.
5. Install temperature sensor into hole. Sensor should be close to edge of discharge opening. If sensor is protruding far into discharge opening, it will read a warmer temperature than the temperature the high temp limit is reading.
6. Turn on equipment in Bake Mode with Heat.
7. Decrease setpoint temperature to about 140F (60C).

8. Increase temperature setpoint towards 180 F (82C). Increase temperature only at a rate of 5.25F (15C) per minute. Do not increase temperature faster. You will get a false tripping point. Temperature sensor needs time to absorb and react to the increasing discharge temperature.
9. Monitor discharge temperature. Document the discharge temperature at which the high temperature limit switch is activated. Flame controller will turn off burner when high temperature limit switch is activated. Observe flame controller LED indicators to see when controller turns off the flame.
10. Remove temperature sensor probe from discharge of heater.
11. Seal temperature probe opening.
12. Compare temperature limit switch set points to actual reading. If there is more than a +- 8F (13C) difference, replace the switch.
13. Document process and setpoints in writing.

8.35.9.3 Spray Booth High Temperature Limit

If you are upgrading an existing, non heated spray booth, verify with the AHJ that you have all the required interlocks in place for the conversion. The spray booth generally are required to have a 200F (93C) manual reset high temperature limit switch installed and interlocked with the heater. Spray booth oven temperature shall not exceed 200F (93C) as per NFPA33.

8.35.10 Mode #2 (Spray Mode) Air Flow Switch

The Mode #2 air flow switch is not part of our heater package. The Mode #2 air flow switch shall be provided by the installer.

The Mode#2 air flow switch proves that there is sufficient ventilation of the enclosure. This air flow switch is used in three different scenarios: normal Spray Mode, automatic Spray Mode and Preignition Purge Mode.

Mode #2 Air Flow Switch Setpoint test

1. Verify that Spray Mode ventilation rate is within specifications for the particular spray booth.
2. Use the spray booth manufacturer's or the air flow switch manufacturer's instructions to make sure switch operates correctly. Verify that air flow switch turns on/off at the specified air flow setpoint.

Test of Operation: Mode #2 AFSW in Normal Spray Mode

Normal Spray Mode is when the operator has to turn the Mode Selector switch to the Spray Mode position in order to be able to spray (to activate the compressed air solenoid valve). The Mode#2 air flow switch has to prove in order for the system to enable the air solenoid valve.

1. Turn Mode Selector switch to Spray Mode.
2. Turn Off/fan/Heat switch to Fan.
3. Connect an empty spray gun to the compressed air outlet in the booth.
4. Pull spray gun trigger and verify that compressed air is coming out of spray gun.
5. Remove X6 from I6 on the PLC.
6. Pull spray gun trigger. There should be no compressed air coming out of spray gun.
7. Reconnect X6.
8. Make repairs if faults are found.
9. Document process and results in writing.

Test of Operation: Mode #2 AFSW in Automatic Spray Mode

1. If the Automatic Spray Mode feature installed, the Mode Selector switch stays in Prep Mode.
2. Turn Off/fan/Heat switch to Fan.
3. Connect an empty spray gun to the compressed air outlet in the booth.

4. Pull spray gun trigger and verify that compressed air is coming out of spray gun.
5. Wait for long enough for the booth to transition into full Spray Mode air flow.
6. Pull trigger again to verify that compressed air is coming out of the gun.
7. Remove X6 from I6 on the PLC.
8. Pull spray gun trigger. There should be no compressed air coming out of spray gun.
9. Reconnect X6.
10. Make repairs if faults are found.
11. Document process and results in writing.

Test of Operation: Mode #2 AFSW in Preignition Purge Mode

1. Turn mode selector to Spray Mode.
2. Turn Off/Fan/Heat switch to Off.
3. Wait at least 70 seconds.
4. Turn Off/Fan/Heat switch to Heat.
5. System should switch to Preignition Purge Mode. Measure for 120V on X4 and N. There should be 120V on X4 and N.
6. Turn Mode Selector to Bake Mode. Wait until Spray Purge Mode expires and system switches into Bake Mode air flow.
7. Measure for 120V on X4 and N. There should be 0V on X4 and N.
8. Make repairs if faults are found.
9. Document process and results in writing.

8.35.11 Burner Differential Air Pressure

The burner differential air pressure switch monitors the pressure drop over the burner. The correct pressure drop over the burner is necessary for proper fuel combustion. The following test establishes the correct minimum differential pressure over the burner.

The burner differential air pressure switch is factory calibrated and sealed. Field adjustment is not possible. If switch fails test, contact factory for replacement.

Test Procedure

1. Go through ignition sequence. Document burner status (did burner light or did not light). Burner should be lit.
2. Remove combustion air pressure tubing from + port of air pressure switch. Flame controller should turn burner off.
3. Repeat ignition sequence. Burner should not light.
4. If burner lit, check actual burner differential pressure.
5. If actual differential pressure is within specifications, replace combustion air flow switch.

8.35.12 Low Air Flow Switch

Standard discharge pressure (0.5"wc [x12.5Mbar])

During a reduced air flow mode while the booth is occupied (Prep Mode) the heater shall maintain the minimum air flow rate specified below.

Model	CFM		HP @ 0.5" ext.	Max Input Btu/hr	Allowed Temp Rise (F)		Gas pressure inwc	Burner Length (in)	Blower Size
	Max	Min			NG	LP			
R-400	12,600	2,900	10	459,400	28	28	5	6	18x18
R-1 NOx	10,600	9,600	10	646,100	50		4.3	Riello RX250	18x18

R-1	12,600	2,900	10	1,427,800	100	100	5	24	18x18
R-1+	16,500	3,500	15	1,713,900	90	90	7	30	20x20
R-2	26,900	5,700	20	2,785,200	90	90	9	42	25x25
R-3	41,400	8,800	30	4,284,900	90	90	11	60	30x30
R-5	47,200	12,000	50	4,885,200	90	90	14	72	36x36

The low air flow switch shall turn off the burner if air flow drops below the specified minimum air flow rate. The standard pickup location is in the heater discharge.

However, if there is increased or decreased static pressure in the heater discharge, the switch may provide a false reading. For example, too much ductwork, too many elbows, or a discharge damper can all produce excessive pressure in the heater discharge area. If there are any dampers installed in the discharge area, the pickup tube has to be extended or relocated. The pickup location has to be downstream of any and all damper(s) between the heater and the spray booth plenum. The low air flow switch has to be re calibrated.

Low air flow switch recalibration process

15. Relocate low air flow switch pickup tube downstream of damper(s).
16. Turn on system in the low air flow mode (Prep Mode).
17. Determine ventilation rate through heater by measuring air flow rate in either intake or exhaust stack.
18. Make necessary air flow rate adjustments to maintain not less than the minimum air flow rate specified for heater.
19. Disconnect air flow tubing from low air flow switch.
20. Connect a manometer to air flow tubing.
21. Measure air pressure with manometer.
22. Check to make sure that low air flow switch has a range that includes air pressure reading.
23. Recalibrate or replace air flow switch.
24. Turn on heater.
25. Make sure burner lights.
26. Remove air flow tube from low air pressure switch.
27. Burner should turn off.
28. Document the process and the setpoints.

8.35.13 Fire Suppression

When fire suppression is activated, the heating system (burner) and the compressed air supplying of the spray gun shall be turned off. Spray booth lights are enabled during fire suppression activation. This means that the spray booth lights will be on if the Light switch is in the ON position.

Consult your fire suppression company to determine what ventilation fan operation is required with the system they are installing on the spray booth.

Standard Ventilation Fan Operation: Ventilation Fans On

In the standard configuration, when the fire suppression system is activated, ventilation fans shall remain operational as per NFPA33.

Optional Ventilation Fan Operation: Ventilation Fans Off

Some fire suppression systems may require turning off the ventilations fans. If this is required, consult the wiring diagrams how to implement this option.

Test Procedure

1. Simulate a fire suppression activation event by removing the H2 wire that send 120V through the fire suppression circuit. Y1 and Y2 should turn off.
2. Measure for 120V between Y1 and N. Compressed air solenoid should be disabled.
3. Measure for 120V between Y2 and N. flame controller should be off.
4. During standard ventilation fan operation there should be 120V either on Y4.
5. During the optional ventilation fans off operation, all ventilation fans should be off. Measure for 120V on Y3, Y4, and Y5. There should not be 120V on Y3, Y4 or Y5.
6. Document process and results in writing.

8.36 Shielded Cable Installation

Any analog signal carrying cable should be twisted pair shielded cable.

Keep shielded cable separate from current carrying conductors.

Do not to run parallel with high voltage current carrying conductors to avoid inducing voltage.

Only ground the shield at one end of the circuit to avoid a ground loop. Ground shield end at GTP.

Cross high voltage current carrying conductors at a right angle.

Never coil up excess wire in a loop. Instead make a long loop over several feet.

Maximum recommended cable length using 0-10VDC is 50' (15m).

Maximum recommended cable length using 4-20mA is 50' (15m).

8.37 Heater Application Questions

If in doubt regarding the application, consult the heater manufacturer.

9 Exhaust VFD Programming

9.1 Manual Booth Pressure Balancing

ABB ACS310		
1301	0	Min analog
1302	100	Max analog
1401	8	Supervisory - over limit
1611	3	Long view (for basic display)
2007	0	Min speed
2008	60	Max speed
1105	60	Max speed
2102	2	Start/Stop (ramp to stop)
2202	10	Accel
2203	40	Decel
3201	103	
3202	1	Low limit
3203	2	High limit
2606	8	CARRIER FREQUENCY - DO NOT CHANGE UNLESS NOISY
		HOLD ENTER BUTTON FOR 2 SECONDS TO PROGRAM!
1103	1	Speed reference from remote source
2003	?	FLA of motor
9909		kW rating of motor
		Factory reset: ????

WEG CFW500		
P100	10	Acceleration
P101	30	Deceleration
P133	1	Minimum speed (has to be less than value in P217)
P217	2	Enable sleep mode
P218	1	Off delay before VFD enters sleep mode (s)
P220	1	Remote control
P275	2	above 2Hz
P288	5	13 to 11 closes above 5Hz
P401	???	Motor rated current
		Factory reset: P204 = 5

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WEG CFW700		
P000	5	Unlock drive
P100	10	Acceleration
P101	30	Deceleration
P133	1	Minimum speed (has to be less than value in P217)
P217	2	Enable sleep mode
P218	1	Off delay before VFD enters sleep mode (s)
P220	1	Remote control
P275	2	above 2Hz (relay output close)
P288	5	13 to 11 closes above 2Hz
P291	18	Stopped where VFD enters sleep mode
P401	???	Motor rated current
		Jumper 23-24, Run 34-37
		Factory reset: P204 = 5

Hyundai N700E-xxxxx		
A01	1	Frequency source (control terminal input)
A02	1	Run command source (control terminal input)
A04	60	Maximum frequency setting
A65	1	Cooling fan runs only when VFD runs
B01	2	
B25	1	Coast to stop
C01	0	Terminal 1: RUN FW
C13	0	Alarm terminal AL1 close (to AL0) when VFD runs
F02	10	Acceleration time 1
F03	30	Deceleration time 1
H05	??	Motor rated current. Set to not more than 1.25*FLA
		B12 = 1 Factory reset

With clean filters, the exhaust VFD should be able to balance the booth pressure at about 45Hz-50Hz.

10 Intake VFD Programming

ABB ACS310		
9901	0	
9902	1	ABB 2 wire
1611	3	Long view (for basic display)
1201	13	
1202	30	Prep speed – DI3
1203	60	Spray speed – DI4
1205	50	Bake speed – DI5
1401	8	Relay output closes when drive runs
2102	2	Start/Stop (ramp to stop)
3201	103	
3202	1	Low limit – under 1Hz
3203	2	Anything over 2Hz it will close
2007	0	Min speed
2008	60	Max speed
1105	60	Max speed
2202	20	Accel
2203	10	Decel
1103	1	Speed reference from remote source
2003	?	FLA of motor
9909		kW rating of motor
HOLD ENTER BUTTON FOR 2 SECONDS TO PROGRAM!		

WEG CFW500		
P100	20	Acceleration
P101	10	Deceleration
P124	0	Multi speed 1 (run FWD)
P125	40	Multi speed 2 (Bake speed) = DI4 terminal 7
P126	60	Multi speed 3 (Spray speed) = DI3 terminal 5
P128	30	Multi speed 4 (Prep speed) = DI2 terminal 3
P133	0	Min speed
P134	60	Max speed
P220	3	
P222	8	
P263	1	
P264	13	

P265	13	
P266	13	
P275	2	
		Factory reset: P204 = 5

WEG CFW700		
P1003	3	Application – run multi speed app
P202	0	OR 1
P1012	900	Multi speed 2 (Prep speed in RPM) = DI4 terminal 40
P1013	1750	Multi speed 3 (Spray speed in RPM) = DI3 terminal 17
P1015	1750	Multi speed 4 (Bake speed in RPM) = DI2 terminal 18
P133	0	Min speed
P220	3	
P222	7	
P263	1	
P266	20	DI4
P267	20	DI5
P268	20	DI6
P275	2	
P1001	1	Run program
		Factory reset: P204 = 5

Hyundai N700E-xxxxx		
A01	1	Frequency source
A02	1	Run command source. Control terminal.
A11	25	Mode 1 intake speed. Prep Mode
A12	60	Mode 2 intake speed. Spray Mode
A14	60	Mode 3 intake speed. Flash/Bake (skip A13 – Binary input!)
B25	1	Coast to stop
C01	0	Terminal 1: FW
		Terminal 2: first speed
C02	2	START PROGRAMMING WITH C04 NOT C02 FOR PRESET SPEEDS!!!
C03	3	Terminal 3: second speed
C04	4	Terminal 4: third speed
C07	0	Terminal 1: Normally closed
F02	20	Acceleration
F03	10	Deceleration

H05	??	Motor rated current. Set to not more than 1.25*FLA
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WWE		
F01	0	
F02	4	
F10	60	Spray speed
F11	30	Bake speed
F21	30	Accel
F22	10	Decel
F52	3	Terminal X1
F53	4	Terminal X2
F60	4	Relay terminals Tc1 to Tb1: Close when VFD runs
F48	??	Motor rated current. Set to not more than 1.25*FLA
F134	DEF60	Factory reset

Jumper CM to FWD

CM to X1 is Spray

CM to X2 is Bake

11 Automatic Booth Pressure Balancing

The panel may be ordered with an automatic spray booth pressure balancing option. A digital pressure gauge is connected to the exhaust VFD to balance booth pressure without user intervention.

Sensocon Series A4 Programming		
Setup Menu		
Ctrl	2SP	Control type is 2 setpoints
Set1	db	Set 1 dead band
1 act	dir	Direct acting (on rising pressure)
SP1 D	0.00	
Set 2	db	Alarm inhibit off
2 act	rev	Reverse acting (on decreasing pressure)
SP2 D	0.00	
Res	3 dig	resolution is 3 digits
Mode	Pres	
Units	inWc	
Main Menu		
SP1	0.03	
SP1db	0	
SP2	-0.03	
SP2db	0.00	

WEG CFW500 (Exhaust VFD)		
P100	25	Acceleration
P101	25	Deceleration
P133	30	Minimum speed
P220	1	Remote
P222	7	Electronic pot
P263	1	DI1 is Start/Stop
P264	11	DI2 is accel EP
P265	12	DI3 is decel EP
P275	11	DO1 closes when VFD is running

ABB ACS310 – Auto Balance (Exhaust VFD)		
1611	3	Long view (for basic display)
9902	4	Motor pot
1401	8	Relay output closes when drive runs
1201	0	No constant speed in use
1805	9	Supervisory 1 under
2007	25	Minimum Hz (limit)
2008	60	Maximum Hz (limit)
1104	25	Minimum speed (scaling)
1105	60	Maximum speed (scaling)
2102	1	Coast to stop
2201	5	DI5 on when Accel2/Decel2
2202	5	Accel 1 (to min speed)
2203	2	Coast to stop, NO Decel 1 (from min speed)
2205	25	Accel2 (to min speed)
2206	25	Decel 2 (from min speed)
3201	103??	
1103	1	Speed reference from remote source

ABB ACS310 – Auto Balance (Intake VFD – Burner on/off)		
1611	3	Long view (for basic display)
9902	4	Motor pot
1401	8	Relay output closes when at 3202 Hz
1201	0	No constant speed in use
1805	9	Supervisory 1 under
2007	10	Minimum Hz (limit)
2008	60	Maximum Hz (limit)
1104	10	Minimum speed (scaling)
1105	60	Maximum speed (scaling)
2102	1	Coast to stop
2201	5	DI5 on when Accel2/Decel2
2202	5	Accel 1 (below min speed)
2203	2	Coast to stop, NO Decel 1 (from min speed)
2205	25	Accel2 (above min speed)
2206	25	Decel 2 (above min speed)
3201	103	
3202	19	VFD relay out NO closes when VFD reaches 3202
3203	20	VFD relay out NO closes when VFD reaches 3203
1103	1	Speed reference from remote source

ABB ACB530 – Auto Balance (Intake VFD – Burner on/off)		
9902	4	Motor pot
9904	3	V/F – Scalar Control
1103	5	
1104	10	Minimum speed (scaling)
1105	60	Maximum speed (scaling)
1201	0	No constant speed in use
1401	8	Relay output closes when at 3202 Hz
1402	8	
1601	0	Not selected
2001	0	Minimum RPM
2002	1750?	Name plate motor RPM
2007	10	Minimum Hz (limit)
2008	60	Maximum Hz (limit)
2102	1	Coast to stop
2201	5	DI5 on when Accel2/Decel2
2202	5	Accel 1 (below min speed)
2203	2	Coast to stop, NO Decel 1 (from min speed)
2205	25	Accel2 (above min speed)
2206	25	Decel 2 (above min speed)
3201	103	Output frequency – Supervisory 1
3202	11	VFD relay out NO closes when VFD reaches 3202
3203	11	VFD relay out NO opens when VFD reaches 3203
3401	103	Hz? Output frequency –Signal 1

11.1.1 Auto Balancing – Setup and testing

We use a pressure switch to set up a deadband. As long as the pressure is within the lower and upper limits, nothing happens and the VFD keeps the speed it is running at. If the pressure is lower than the lower limit, a set of dry contact (SP2) close and the VFD will decelerate. If pressure is higher than the high limit, another set of dry contacts (SP1) close and the VFD will accelerate. When neither contact is closed, the VFD holds the frequency it is running at.

There are two steps to trouble shooting auto balancing issues.

1. Check VFD operation:

- Disconnect Accel and Decel wires.
- Tighten down terminal where Accel and Decel wires were. Otherwise your jumper will not make proper connection.
- Turn system on.
- VFD will increase speed to the previously saved speed or to the programmed minimum VFD speed.
- Make sure VFD Hz reading is not changing.
- Jumper exhaust VFD common to Accel. Put jumper wire on top of the common and the Accel terminals. Observe Hz increasing. If VFD is at maximum Hz speed will not increase any further. Take off wire. VFD Hz reading should freeze. VFD should hold Hz.
- Jumper exhaust VFD common to Decel. Put jumper wire on top of the common and the Decel terminals. Observe Hz decreasing. Take off wire. VFD Hz reading should freeze. VFD should hold Hz.

If VFD does not do the above, do a factory reset and reprogram VFD.

2. Check Pressure switch operation (Sensocon A4):

- Disconnect spray booth pressure sensing tube.
- Connect a short piece of tubing to the High side of the Sensocon.
- If you programmed the Sensocon to keep booth pressure positive or negative, reprogram it to keep pressure neutral.
- Pressure sensor should show approximately 0.00.
- SP1 and SP2 lights both should be off. If either of them is on, check programming. It may be necessary to reset and reprogram the pressure switch.
- Blow into the sensor tube. SP2 light should turn on and VFD should start accelerating.
- Stop blowing into tube. SP2 should turn off. Pressure reading should be within the lower and the upper limit on display and VFD should hold speed.
- Suck on sensor tube. SP1 light should turn on and VFD should start decelerating.
- Stop sucking on sensor tube. SP1 light should turn off. Pressure reading should be within the lower and the upper limit on display and VFD should hold speed.

12 Training Program

All Operators must complete an initial training program before working with or near this equipment. After the initial training Operators shall receive regularly scheduled retraining and testing.

A training log must be kept. The training log must include:

- training sheet
- tests taken by every person tested

Training Topics

1. System start-up
2. System shutdown
3. System lockout

12.1 System Start-up

1. Turn on power to equipment.
2. Turn on gas supply.
3. Turn Mode Selector switch to desired mode.
4. If heat is not desired, turn Off/Fan/Heat switch to the Fan position.
5. If heat is desired, turn Off/Fan/Heat switch to the Heat position.

12.2 System Shut Down

12.2.1 Normal System Shutdown

1. Turn Off/Fan/Heat switch to the Off position.
2. Turn off electricity of system
3. Turn off gas supply.

12.2.2 Emergency Stop

1. Turn Off/Fan/Heat switch to the Off position.
2. Turn off electricity of system
3. Turn off gas supply.

12.3 Lockout Procedure - *Sample*

Lockout Procedure for

(Name of Company for single procedure or identification of equipment if multiple procedures are used).

Purpose

This procedure establishes the minimum requirements for the lockout of energy isolating devices whenever maintenance or servicing is done on machines or equipment. It shall be used to ensure that the machine or equipment is stopped, isolated from all potentially hazardous energy sources and locked out before employees perform any servicing or maintenance where the unexpected energization or start-up of the machine or equipment or release of stored energy could cause injury.

Compliance With This Program

All employees are required to comply with the restrictions and limitations imposed upon them during the use of lockout. The authorized employees are required to perform the lockout in accordance with this procedure. All employees, upon observing a machine or piece of equipment which is locked out to perform servicing or maintenance shall not attempt to start, energize, or use that machine or equipment.

Type of compliance enforcement to be taken for violation of the above.

Sequence of Lockout

(1) Notify all affected employees that servicing or maintenance is required on a machine or equipment and that the machine or equipment must be shut down and locked out to perform the servicing or maintenance.

Name(s)/Job Title(s) of affected employees and how to notify.

(2) The authorized employee shall refer to the company procedure to identify the type and magnitude of the energy that the machine or equipment utilizes, shall understand the hazards of the energy, and shall know the methods to control the energy.

Type(s) and magnitude(s) of energy, its hazards and the methods to control the energy.

(3) If the machine or equipment is operating, shut it down by the normal stopping procedure (depress the stop button, open switch, close valve, etc.).

Type(s) and location(s) of machine or equipment operating controls.

(4) De-activate the energy isolating device(s) so that the machine or equipment is isolated from the energy source(s).

Type(s) and location(s) of energy isolating devices.

(5) Lock out the energy isolating device(s) with assigned individual lock(s).

(6) Stored or residual energy (such as that in capacitors, springs, elevated machine members, rotating flywheels, hydraulic systems, and air, gas, steam, or water pressure, etc.) must be dissipated or restrained by methods such as grounding, repositioning, blocking, bleeding down, etc.

Type(s) of stored energy - methods to dissipate or restrain.

(7) Ensure that the equipment is disconnected from the energy source(s) by first checking that no personnel are exposed, then verify the isolation of the equipment by operating the push button or other normal operating control(s) or by testing to make certain the equipment will not operate.

Caution: Return operating control(s) to neutral or "off" position after verifying the isolation of the equipment.

Method of verifying the isolation of the equipment.

(8) The machine or equipment is now locked out.

Restoring Equipment to Service. When the servicing or maintenance is completed and the machine or equipment is ready to return to normal operating condition, the following steps shall be taken.

(1) Check the machine or equipment and the immediate area around the machine to ensure that nonessential items have been removed and that the machine or equipment components are operationally intact.

(2) Check the work area to ensure that all employees have been safely positioned or removed from the area.

(3) Verify that the controls are in neutral.

(4) Remove the lockout devices and reenergize the machine or equipment.

Note: The removal of some forms of blocking may require reenergization of the machine before safe removal.

(5) Notify affected employees that the servicing or maintenance is completed and the machine or equipment is ready for use.

[54 FR 36687, Sept. 1, 1989 as amended at 54 FR 42498, Oct. 17, 1989; 55 FR 38685, Sept. 20, 1990; 61 FR 5507, Feb. 13, 1996]

13 Inspection, Testing and Maintenance

Inspection, testing, maintenance, alterations, component replacement has to be recorded. Records of inspection, testing and maintenance shall be kept for not less than 3 (three) years or until the next scheduled inspection, testing or maintenance whichever is longer.

Sample Inspection Sheet is at the end of this manual. Note problems found. Write a separate report if necessary. Do not commission system if problem(s) are not corrected.

13.1 Electrical Components

Electrical components have to be checked at least once a year. Look for discoloration around wire terminals indicating overheating, lose components, etc. Repair or replace components as necessary.

Wire terminals of all high voltage components should be re-torqued to specifications 30 days after installation and at least one time every 12 months thereafter. Torque specifications are in the following table.

Torque Specifications (07-18-2013)					
		in-lb	Nm	in-lb	Nm

Terminal block		4	0.45		
Ground Block		7	0.79		
Ground lug-G wires		NO SPEC	#VALUE!		
Ground lug to plate		NO SPEC	#VALUE!		
Circuit breaker	EATON	21	2.37		
Circuit breaker	CHINT	17.8	2.01		
TECO PLR		5.4	0.61		
Relay: 781 & 782 series		9	1.02		
Contact block	CSW (22mm)	7	0.79		
Contact Block	CSW30 (30mm)	7	0.79		
LED lamp Block		15	1.69		
PSU-24VDC	RS-15-24	8	0.90		
Transformer		20	2.26		
Flame cont. base		12	1.36		
Pwr. Dist. Blck.		Line Side		Load Side	
		in-lb	Nm	in-lb	Nm
EDISON	PB1043	120	13.56	25	2.82
Contactor	Model#	Main Terminal		Coil Terminal	
		in-lb	Nm	in-lb	Nm
Fuji	SC-E02	13	1.47	9	1.02
Fuji	SC-E03	13	1.47	9	1.02
Fuji	SC-E04	13	1.47	9	1.02
Fuji	SC-E05	13	1.47	9	1.02
Fuji	SC-E1	22	2.49	9	1.02
Fuji	SC-E2	22	2.49	9	1.02
Fuji	SC-E3	70	7.91	17	1.92
Fuji	SC-E4	70	7.91	17	1.92
TECO	CU-22	18	2.03	9	1.02
TECO	CU-9	18	2.03	9	1.02
Overload	Model#	Main Terminal: T1, T2, T3		Aux. Terminal: 98, 97, 95, 96	
		in-lb	Nm	in-lb	Nm
Fuji	TK-E02	13	1.47	9	1.02
Fuji	TK-E2	22	2.49	9	1.02
Fuji	TK-E3	71	8.02	9	1.02
Fuji	TK-E5	71	8.02	9	1.02
Fuji	TK-E6	89	10.06	9	1.02
Fuji	TK-E6H	89	10.06	9	1.02
TECO	RHU-10/20A1	20	2.26	9	1.02

TECO	RHU-10/30A1	20	2.26	9	1.02
VFD	Model #	Main Terminal		Control Terminal	
		in-lb	Nm	in-lb	Nm
Worldwide Electric	WWEVFD 0.5-5hp 1ph and 3ph	13.8	1.56	5.4	0.61
Worldwide Electric	Ground terminal		0.00		0.00
Worldwide Electric	WWEVFD 7.5-20hp	20.8	2.35	5.4	0.61

13.2 External and Internal Visual Inspection

Always lock out/tag out system before inspection. Heater housing and components should be visually inspected every year for corrosion, structural integrity, loose fasteners, and loose components. Inspect all rivets for wear. Access the inside of heater. Hold onto rivets and move them side to side and up and down to see if vibration caused wear on the rivet body. Replace rivet if it can be moved in any direction.

13.3 Recirculating Duct: Access to Inside and Cleaning

This heater may only recirculate during non occupied modes.

Airborne particulate matter can accumulate in the recirculating duct system during recirculating mode creating a fire hazard.

The recirculating ductwork shall be equipped with a recirculation filter that filters out airborne particulate matter before the heater. The recirculation filters have to be approved by the AHJ.

The recirculating ductworks shall be equipped with doors, access panels or other means that facilitate the inspection, maintenance, cleaning, and access to fire protection devices.

The recirculating ductwork should be inspected every six months for deposits. Clean recirculating ductwork according to NFPA654 and the requirements of the AHJ.

13.4 Manual Shutoff Valves

Manual shutoff valves shall be exercised at least once per year.

13.5 Safety Valves

13.5.1 Safety Valve Leak Check

Gas tightness of safety valves shall be checked at least an annual basis.

V4295A,S; V8295A,S SOLENOID GAS VALVES

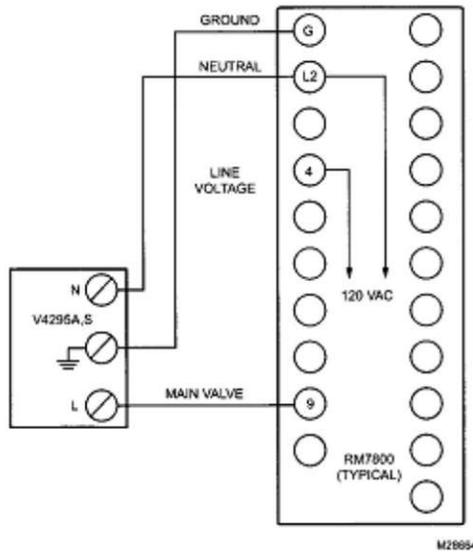


Fig. 6. Wiring, V4295A,S.

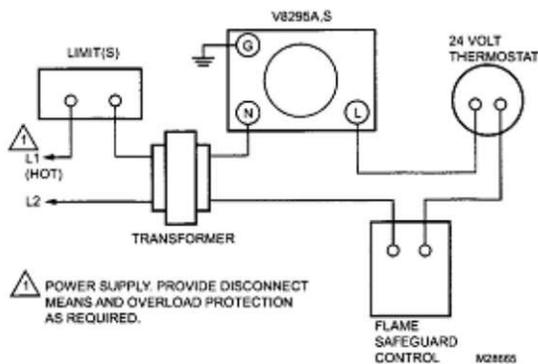


Fig. 7. Wiring, V8295A,S.

OPERATION

The V4295A and V8295A Normally Closed series gas valves are Class B fail safe shut off valves. The valve is opened by energizing the direct ON/OFF operator. The direct ON/OFF operator consists of a coil and stop sleeve assembly. Inside the stop sleeve assembly is a plunger which is able to move up and down, thus opening or closing the valve. The plunger glides on two anti-friction bearings. A strainer, made of AISI 303 stainless steel, is incorporated into the valve.

CHECKOUT AND TROUBLESHOOTING

⚠ WARNING

Do not allow fuel to accumulate in the combustion chamber. If fuel is allowed to enter the chamber for longer than a few seconds without igniting, an explosive mixture could result.

⚠ CAUTION

1. Do not put the system into service until you have satisfactorily completed all applicable tests described in the Checkout section of the instructions for the flame safeguard control and any other test required by the burner manufacturer.
2. Close *all* manual fuel shut off valves as soon as trouble occurs.

CHECKOUT

1. Check the performance of the valve by measuring the pressures at the inlet and outlet pressure taps. The pressure reading at the outlet tap may be slightly higher than a downstream measurement due to dynamic gas flow effects. The measurement at the outlet tap is for reference only.
2. Shut off gas supply to valve and make sure valve is closed when setting up pressure measuring equipment.
3. Set thermostat or controller to energize the valve and check final outlet pressure.
4. Start the system and observe its operation through at least one complete cycle to ensure the valve functions as described in the section "Operation" on page 6.

Valve Leak Test (Fig. 8)

This is a test for checking the closure tightness of the gas safety shutoff valve. It should be performed only by trained, experienced flame safeguard control technicians during the initial startup of the burner system or whenever the valve is replaced (see Service Information section). It is recommended that this test also be included in the scheduled inspection and maintenance procedures.

1. De-energize the control system to make sure no power goes to the valve (C, Fig. 8).
2. Close the upstream manual gas cock (A).
3. Make sure the manual test petcock (F) is closed in the leak test tap assembly (D).
4. Remove the leak test tap plug and connect the test apparatus to the leak test tap (D).
5. Close the downstream manual gas cock (E).
6. Open the upstream manual gas cock (A).
7. Run the V4/8295A Valve to its open position (through the safety system); then immediately de-energize the system to close the V4/8295A Valve.
8. Immerse a 1/4 in. (6 mm) tube vertically 1/2 in. (13 mm) into a jar of water.
9. Slowly open the manual test petcock (F).

10. When the rate of bubbles coming through the water stabilizes, count the number of bubbles appearing during a ten-second period. Each bubble appearing represents a flow rate of 0.001 cfh.

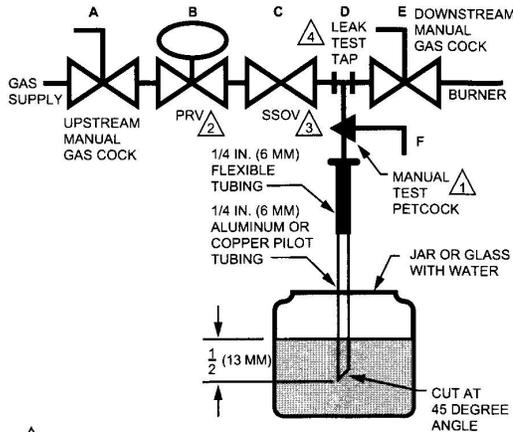
IMPORTANT

To meet U.S. requirements, make sure leakage does not exceed the rates in Table 6.

Table 6. Valve Allowable Leakage Rate.

V4295A/V8295A Pipe Size (in)	Medium	Allowable Leakage SCCH*	Maximum Number of Bubbles in 10 Seconds	Minimum Number of Seconds for 10 Bubbles
3/8 & 1/2	0.64 gas	294	7	13
	1.57 LP	188	4	20.4
3/4 & 1	0.64 gas	301	7	12.7
	1.57 LP	192	5	19.9
1-1/4 & 1-1/2	0.64 gas	532	13	7.2
	1.57 LP	341	8	11.2
2	0.64 gas	578	15	6.6
	1.57 LP	370	9	10.3
1-1/2	0.64 gas	752	19	5.1
	1.57 LP	481	12	8
3	0.64 gas	925	24	4.1
	1.57 LP	592	15	6.5

* Based on air at standard conditions, test pressures provided by ANSI Z21.21, Section 2.42 and a maximum of 235 cc/h per inch of seal-off diameter (not pipe size).



- ⚠ CAN ALSO BE A PERMANENT PETCOCK.
- ⚠ PRV = PRESSURE REGULATING VALVE.
- ⚠ SSOV = SAFETY SHUTOFF VALVE.
- ⚠ USE ONLY ONE OF THE DOWNSTREAM TAPS ON THE SSOV. M9547F

Fig. 8. Valve leak test.

NOTE: For international leak test requirements, contact the appropriate approval agency.

After the Test

1. Close the upstream manual gas cock (A).
2. Close the manual test petcock (F), remove the test apparatus, and close the leak test tap (D).
3. Make sure the downstream manual gas cock (E) is closed.
4. Open the upstream manual gas cock (A) and energize the V4/8295A Valve through the safety system.
5. Test with rich soap and water solution to make sure there is no leak at the leak test tap (D) or any pipe adapter/valve mating surfaces.
6. De-energize the V4/8295A Valve (C).
7. Open the downstream manual gas cock (E).
8. Restore the system to normal operation. If two safety shutoff valves are used, check each valve separately for closure tightness.

TROUBLESHOOTING

⚠ CAUTION

Use utmost care during troubleshooting. Line voltage is present at the actuator for V4295A,S and present in controller circuits. Low voltage (24 Vac) is present at the actuator for V8295A,S and present in controller circuits.

IMPORTANT

Do not assume that the valve must be replaced until all other sources of trouble have been eliminated.

CAUTION

Line voltage (120 Vac) should be present when the primary safety control energizes the V4295A,S valve actuator. 24 Vac should be present when the primary safety control energizes the V8295A,S valve actuator.

- b. If there is no voltage at the actuator, first ensure line voltage power is connected to the master switch, the master switch is closed and overload protection (circuit breaker, fuse or similar device) has not opened the power line.
 - c. If there is still no voltage at the actuator, make sure all appropriate contacts in the thermostat (or controller), limit(s) and flame safeguard control are closed. If one or more are open, determine the cause(s) and correct condition(s) before proceeding.
 - d. If there is proper voltage at the actuator but the valve still does not open, first check that the gas pressure is normal.
 - e. If the valve still does not open, replace valve.
2. **If the valve will not close when one or more of the appropriate contacts in the thermostat (or controller), limit(s) or flame safeguard control is open:**

- from the actuator. If the valve closes now, the actuator may not be wired properly.
- c. Look for a short in the electrical circuit.

SERVICE INFORMATION

CAUTION

1. Only qualified service technicians should attempt to service or repair flame safeguard control and burner.
2. Line voltage is present in the electrical circuits to the valve. Open the master switch before replacing the valve.

CAUTION

1. Label all wires prior to disconnection when servicing valves. Wiring errors can cause improper and dangerous operation.
2. Verify proper operation after servicing.

Scheduled inspection and maintenance

For periodic inspection and maintenance, set up a schedule and follow it. Include the burner, valves and all other burner controls. It is recommended that "Valve Leak Test (Fig. 8)" on page 6 be included in the schedule. Refer to the flame safeguard control instructions for more information.

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13.5.2 Safety Valve Replacement

Safety valves shall be replaced when their leakage rate exceeds the manufacturer's specifications. Please refer to the Safety Shutoff Valve Leak Down Test Section for how to perform leak down testing of the valves.

13.5.3 Pilot Solenoid Valve

13.6 Condensation in Gastrain

On some heater models the pilot line may exit at the bottom of the gastrain. In this case a moisture trap is required by the standard. A T will be installed where the pilot line turn parallel with the gastrain. There is a plug in the bottom of the T to be able to drain moisture that collects at this low point in the gastrain. It is the operator's responsibility to establish a regular interval for draining the accumulated moisture. This time interval depends on the gas supply and on the heater use. This service time interval is location specific. The operator shall check the drain after four (4) weeks of operation. Based on the first check, the operator shall set a time interval for periodic checks of the drain. The operator shall revise this time interval as local conditions necessitate it.

13.7 Safety Component Setpoint Verification

Follow the procedures outlined in the Installation and Commissioning section. Document results in writing. Keep this documentation for not less than three (3) years.

13.8 Determining the Differential Pressure

Burner high fire gas pressure adjustment procedure

1. Close manual safety valve between pressure regulator and first safety solenoid valve downstream from regulator.
2. Open manual safety valve between modulating valve and burner.
3. Locate outlet pressure tap on the first safety valve upstream of burner.
Orient valve with coil on top. Side pressure ports are inlet pressure ports. Bottom pressure port is outlet pressure port.
4. Remove ¼" plug from outlet pressure port and connect manometer.
5. Turn on equipment in Spray Mode.
6. Make sure combustion blower is running.
7. Pull pin that holds modulating valve actuator to valve body. Take actuator off. Make sure you secure actuator with bailing wire to the gastrain. Modulating actuator wires are not designed to hold the weight of the actuator. Actuator wires can get damaged if actuator is not supported properly. Use a large flat head screw driver to turn modulating valve into the fully open position. Slot on valve body will be parallel with the gastrain when ball valve is in the fully open position.
8. Monitor pressure reading.
9. Record reading. This is the burner negative pressure value.
10. Complete the following manifold pressure calculation to find out the pressure reading that is necessary to obtain correct high fire:

Burner negative pressure + maximum manifold pressure (from name plate) = high fire gas pressure

This is the high fire gas pressure the burner needs for firing at the highest capacity.

Sample calculation:

Burner negative pressure = -0.4" WC (1mbar)

Maximum manifold pressure = 3.5" WC (8.7mbar)

High fire gas pressure = -0.4 + 3.5

High fire gas pressure = 3.1" WC (7.7mbar)

11. Heater should be still running with modulating valve in the high fire position and with the pilot on. Use large screw driver to turn modulating valve into the closed position. Make sure slot is perpendicular to valve body.

12. Open manual safety valve downstream of regulator.
13. Use large flat head screw driver to slowly start opening modulating valve. DO NOT OPEN IT COMPLETELY!
14. Make sure burner lights in a low fire state.
15. Use large screwdriver to fully open modulating valve. Slot on top of valve should be parallel with valve body.
16. Monitor gas pressure on the outlet side of the first safety valve upstream of the burner.
17. Adjust high gas pressure regulator to achieve the correct gas pressure. This is the value you calculated in Step 9.
18. Verify that discharge air temperature does not exceed the maximum of 185F (85C).
19. If discharge air temperature exceeds maximum, decrease high fire gas pressure until discharge air temperature drops below the maximum allowed discharge air temperature.
20. Turn equipment off. Lockout tagout.
21. Turn off manual shutoff valve immediately downstream of regulator.
22. Remove manometer and install ¼" plug back into pressure tap of safety valve.
23. Turn valve into the closed position. While in the closed position, slot on valve will be perpendicular to valve body.
24. Reinstall modulating valve actuator.
25. Remove lockout tagout and power up equipment.
26. Document process and setpoints in writing.

13.9 Burner Maintenance

13.9.1 General

Periodic maintenance will insure continued trouble-free operation of your Series NP-LE AIRFLO® burner system. At least a yearly inspection is recommended for make-up air heating installations and more frequently for process applications in year-round operation. Your own experience is the best guide in determining frequency of inspection. As a minimum, the following procedure should be followed:

- Shut the system down totally. Disconnect or lock out power supply so there can be no accidental start-up during inspection.
- Inspect the burners carefully, including upstream and downstream sides of mixing plates as well as burner body face. Any accumulation of scale or foreign material on either side of the mixing plates should be removed with a wire brush. Check visually that no holes in the mixing plates are blocked. See 12.8.3 for inspection and maintenance instructions for gas ports.
- If any mixing plates are loose or missing fasteners, tighten/replace as necessary. Always use zinc plated or stainless metric fasteners.
- Put system back into operation and, if possible, view from downstream side while cycling burner through full firing range. This will give a visual check for blocked burner ports.
- Observe flame pattern and, if necessary, take steps to correct velocity and/or air distribution problems.

13.9.2 Repair/Replacement Procedures

If adverse operating conditions or accidental damage make it necessary to replace either individual mixing plates or complete burner sections, follow this procedure:

- Identify necessary replacement parts, then order required quantities of each. Consider carefully the economics of installing a complete replacement burner instead of replacing individual parts. Once exposed to actual flame temperatures, burner castings harden and the removal and replacing of fasteners can be time consuming and difficult. Accessibility may also be severely limited requiring removal of complete assembly in any case.
- When necessary parts have been received, remove damaged mixing plates or burner sections, taking care not to damage remaining portion of burner. If new burner bodies are being installed, place body gasket on the mating flanges of loose cast iron bodies. (This is necessary to provide a gas-tight seal after assembly.) Insert new section into place, making sure that both flanges are square and flush, then bolt sections together.
- Install new mixing plates, back up bars and plate support brackets to the new body castings.
- If end plate sets must be installed, put in position between mixing plates and insert fasteners loosely. Do not tighten at this time.
- Tighten burner body bolts making sure that mating cast iron flanges remain square and flush.

- Align mixing plates and check that body gaskets are in position and properly aligned. Tighten all mixing plate mounting screws and bolts.
- Double check that all fasteners are secure.
- Return burner to operation, observing flame carefully at all firing rates.



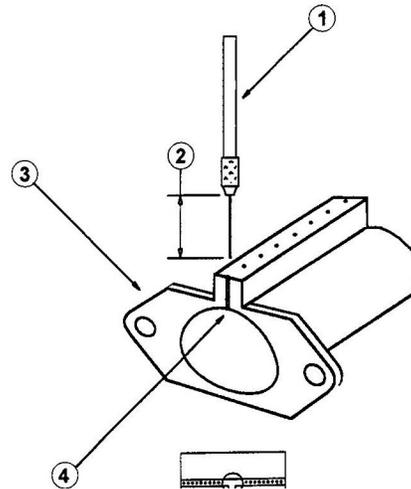
WARNING: Do not enlarge burner ports or performance may be drastically affected.

13.9.3 Inspection and maintenance of gas ports

- Conduct initial inspection within the first month after commissioning. Visually check the gas ports of new burner assemblies for any piping scale or debris. Use pin vise with drill bit to remove.
- Annual inspections are normally adequate once the initial piping debris is removed. The operating conditions of the burner will determine how frequently maintenance is actually required.
- Use of an electric drill motor is not suggested unless both pin vise and drill (as shown below) can be chucked up in a vari-speed drill unit. Use caution, because it is easy to snap the bits off in a port when using a drill motor. Removal of broken bits from the gas ports is difficult.
- Contact your MAXON representative to answer questions or address any problems.

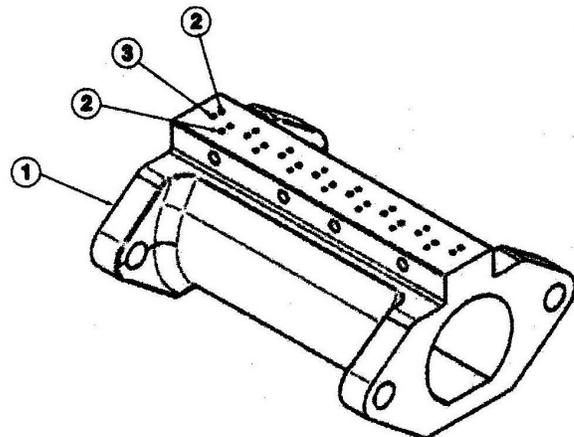
13.9.4 NP1-LE & NP2-LE AIRFLO® Burner Gas Ports

- 1) Pin vise
- 2) 1 inch
- 3) NP-LE AIRFLO® burner body (mixing plates not shown)
- 4) Gas ports - all are #43 drill size (exception is several #47 holes at the intersection of 12x6 tee's and 36 BI's)
- 5) #47 holes here
- 6) #43 holes



13.9.5 NP2-LE AL AIRFLO® gas ports

- 1) NP2-LE AL AIRFLO® burner body (mixing plates not shown)
- 2) Outside rows - #47 holes
- 3) Inside row - #43 holes



13.10 Blower

1. The blower should be checked at least once per year.
2. Noises: The technician should check for any unusual noises the blower may make.

3. **Visual inspection:** The blower should be visually inspected. Special care has to be taken for recirculating systems. With recirculation filter failure it is possible that paint overspray will deposit onto the fan and motor. All overspray has to be cleaned off the equipment. Overspray is a fire hazard since it is flammable.
4. **Belts:** Belts should be replaced every 12 months. Belts have to be checked for proper tension and for cracking. Also proper belt alignment has to be verified.
5. **Pulleys and Sheaves:**
6. The drive system also has to be inspected. Re torques pulleys and sheaves.
7. **Bearing lubrication:** Bearings should be lubricated according to the schedule below with the proper lubricant.

WARNING
FAN WARRANTY REQUIRES LUBRICATION AS FOLLOWS:
GREASE LUBRICATION SCHEDULE
 Ball Bearings Used on Fans

FAN SHAFT SIZE (INCHES)	OPERATING SPEED (RPM)									
	500	1000	1500	2000	2500	3000	3500	4000	4500	5000
	LUBRICATION INTERVAL (in MONTHS)									
1/2 thru 1	6	6	6	6	6	6	4	4	2	2
1 1/16 thru 1 7/16	6	6	6	6	6	6	4	4	2	1
1 1/2 thru 1 3/4	6	6	6	4	4	2	2	2	1	1
1 15/16 thru 2 3/16	6	6	4	4	2	2	1	1	1	-
2 1/4 thru 2 7/16	6	4	4	2	2	1	1	1	-	-
2 1/2 thru 3	6	4	4	2	1	1	1	-	-	-
3 7/16 thru 3 1/2	6	4	2	1	1	1	-	-	-	-
3 15/16 thru 4	6	4	2	1	1	-	-	-	-	-

Relubricate bearings with a good quality Lithium or a Lithium complex base grease formulated using a high quality Mineral oil, which conforms to the NLGI grade 2 consistency.

- If bearings operational temperature is below 0° F, or above 200° F, contact factory for proper lubrication.
- When relubricating bearings, add a sufficient amount to cause some purging of grease at the bearing seals.
- For periods of extended shutdown & storage, lubricate bearings & rotate shaft monthly to prevent corrosion.

13.10.1 Stands and Roof Curbs

The annual inspection of these accessories should include but not limited to checking for:

- corrosion
- physical damage to the parts
- loose fasteners

13.10.2 Dampers

- Check physical integrity.
- Check for excessive wear of bushings
- Check for rubbing and wear on components
- Check for excessive dirt and contamination
- Check damper actuator for free movement
- Check damper actuator wire torque.

13.10.3 VFDs

Follow the VDS manufacturer’s maintenance and inspection schedule. Maintenance and inspection schedule may be found in VFD operation manual. If manual is not on site, visit VFD manufacturer’s web site and download the manual. Document in writing all VFD maintenance and inspection actions.

14 Low Nox Burner Notes: Riello Rx250

The information below is general info for all Riello RX burners. Some information is specific to the RX250.

Follow the Riello manual specific to your burner model when commissioning the heater. Some of the information below is additional information not contained in the Riello manual.

Natural gas

Model	CFM		HP @ 0.5" ext.	Max Input Btu/hr	Allowed Temp Rise (F)		Gas pressure inwc	Burner Length (in)	Blower Size
	Max	Min			NG	LP			
R-400	12,600	2,900	10	459,400	28	28	5	6	18x18
R-1 NOx	10,600	9,600	10	646,100	50		4.3	Riello RX250	18x18
R-1	12,600	2,900	10	1,427,800	100	100	5	24	18x18
R-1+	16,500	3,500	15	1,713,900	90	90	7	30	20x20
R-2	26,900	5,700	20	2,785,200	90	90	9	42	25x25
R-3	41,400	8,800	30	4,284,900	90	90	11	60	30x30
R-5	47,200	12,000	50	4,885,200	90	90	14	72	36x36

Burner adjustment: NG

Flame can be adjusted by two parameters.

1. **Gas flow limit screws.** The low fire (V1) and the high fire (V2) gas flow limit screws control the ratio of gas to combustion air in low fire and in high fire.
2. The **combustion blower speed settings** control the ignition firing rate (P0), the minimum firing rate (P1) and the maximum firing rate (P2) of the burner. Through P1 you can adjust the minimum combustion blower speed. The slower the combustion blower speed, the less air/fuel mixture is delivered to the burner. The less air/fuel mixture is delivered to the burner, the lower the firing rate is. P2 sets up the maximum firing rate by adjusting the maximum combustion blower speed. The higher the combustion blower speed, the more air/fuel mixture is delivered. The more air fuel mixture is delivered, the higher the firing rate is.

Ignition Adjustment

1. Turn system on in Bake Mode
2. Press flame controller buttons A and + simultaneously for more than five seconds. Display will start blinking after you held A and + for more than five seconds. This will enable you to fine tune P0, P1, and P2. Flame controller will pause at these values so you can change them if necessary.
3. Release A and +.
4. Lower setpoint temperature below process temperature to make sure burner will stay in low flame.
5. Unscrew low fire gas adjustment screw (V1).
6. Flame controller will proceed through the startup phase. The display values show the point where the burner is during the startup phase. Please refer to the Riello manual page 15, Fig. 10 (Program Sequence) for the explanation of the code sequence.

7. Flame controller will display the P0 (ignition mode combustion fan speed) alternately with a three digit number. The three digit number is the combustion fan speed during the ignition process. Burner will stay in this stage until value is confirmed. Values can be left the same or changed.
8. If burner does not light or if flame is not even across the burner, increase P0. You may have to adjust V1 also (Step 13).
9. If flame is sloppy decrease P0.
10. At this point it does not really matter how flame looks if burner is lit.
11. When done, press the **Info** button for three seconds to store the new value in memory.
12. When value is stored, burner will proceed to the next step.
13. When burner is trying to light, start screwing in V1 until burner lights.
14. Flame may be sloppy. This is OK. We will return to the ignition adjustment one more time at the end of this process.

Low Fire Adjustment

15. Wait for burner to go to P1 (low fire fan speed).
16. Adjust the low fire screw (V1) to get the proper flame appearance. Adjust flame down to the minimum possible size while maintaining good combustion. Flame should be stable at end of tube. Flame should be small blue “darts” coming out of combustion tube. Combustion surface should be fully lit.
17. Check your temperature rise. For RX250 low fire will be not less than 150,000Btu. Calculate your temp rise to make sure low fire is properly set. Adjust P1 with the + and – buttons to set up the lowest possible temperature rise.
18. Press **Info** to store the P1 value on the screen.

High Fire Adjustment

19. When low fire adjustment is complete, raise temperature setpoint to force burner into high fire.
20. Burner will display P2 blinking alternately with the high fire combustion blower speed value.
21. As burner is ramping up to the high fire maximum speed, adjust the high fire adjustment screw (V2) as necessary. If flame is “lazy” unscrew V2 to lean mixture out. If flame is “spotty” turn screw to give the mixture more gas.
22. Flame should look like blue darts. Base of darts should be stable on the combustion surface.
23. Observe burner sleeve for several minutes. Under no circumstances should the burner sleeve glow or become “cherry red”. If burner sleeve overheats, it will warp.
24. Adjust V2 with the + and – buttons to set maximum temperature rise.
25. Measure gas head pressure at maximum delivery and adjust to match the value in the Riello manual.
26. Press the **Info** button to store the P2 value on the screen.

15 Low NOx Burner – Rammstein

Combustion blower programming

WEG CFW500 – Low NOx Combustion Blower		
P100	10	Acceleration
P101	10	Deceleration
P133	15	Minimum speed (has to be less than value in P217)
P134	60	Max speed
P288	5	13 to 11 closes above 5Hz
P401	???	Motor rated current
		Factory reset: P204 = 5

16 Control System Operation

The mode the system is in is indicated on the display of the operator panel. The system has the following modes:

Prep Mode (Option)

Spray Mode

Spray Purge Mode

Preignition Purge Mode

Flash Off Mode (Option)

Bake Mode

Cool Down Mode

16.1 Prep Mode (Option)

Turn selector switch to the Prep Mode position. Exhaust fan(s) turns on. Lights are on unless Light switch is in the Off position. Heat can be turned on or off by switching between Heat and Fan positions.

Prep Mode Cycle Time

Manual mode. Time cannot be adjusted. System will stay in Prep Mode until system is manually switched into another mode.

Prep Mode Temperature

The temperature setpoint is the same as the Spray Mode temperature setpoint.

Turn Temperature Up/Down switch to the left to decrease setpoint temperature.

Turn Temperature Up/Down switch to the right to increase setpoint temperature.

The maximum setpoint temperature is 90F (32C).

16.2 Spray Mode

Depending on the options purchased, Spray Mode can be started two different ways.

1. Manual Spray Mode

Manual Spray Mode begins when the selector switch is turned to the Spray Mode position. The system ramps up to full air flow and to 100% fresh air ventilation. Spray Mode ends when the Spray Mode selector switch is turned to another position.

2. Automatic Spray Mode

If system was purchased with the optional Auto Spray Mode, then Spray Mode starts when the spray gun trigger is pulled. The automatic Spray Mode feature is activated from Prep Mode. The operator never has to switch the mode selector switch to Spray Mode. The system automatically changes into Spray Mode when the spray gun trigger pull is sensed. The trigger pull is sensed through a compressed air flow switch. When the spray gun trigger is pulled, the system ramps up to full air flow and 100% exhaust.

Spray Mode Cycle Time – Manual Mode

Manual mode. Time cannot be adjusted. System will stay in Spray Mode until the selector switch is turned to another position or the spray gun trigger is released if automatic Spray Mode feature was installed.

Spray Mode Temperature

Turn Temperature Up/Down switch to the left to decrease setpoint temperature.

Turn Temperature Up/Down switch to the right to increase setpoint temperature.

The maximum setpoint temperature is 90F (32C).

Spray Mode temperature setpoint is referenced during the following modes:

Spray Purge Mode

Prep Mode

Flash Off Mode Over

Cool Down Mode

16.3 Spray Purge Mode

Spray Purge Mode starts when Spray Mode is over. Depending on the options purchased the system will recognize the end of Spray Mode in two different ways.

1. Spray Mode is over when the Mode Selector switch is turned from the Spray Mode position to another mode.

Purge Mode starts automatically.

2. With the automatic Spray Mode option the system enters the Spray Purge Mode every time the trigger of the

spray gun is released. If the trigger is pulled again before the purge countdown is complete, the purge countdown re starts when the trigger is released again.

Purge Mode Cycle Time – Timed Mode

Timed mode. Time cannot be adjusted by operator. Installer has to program Prep Mode cycle time to ensure that booth will perform not less than three (3) air volume changes during the Purge Mode. When Spray Purge Mode countdown timer is zero, system will switch into the mode selector switch is pointing to.

Spray Purge Mode Temperature

Spray Purge Mode temperature is the same as the Spray Mode temperature set point.

16.4 Flash Off Mode (Option)

The system enters Flash Off Mode when the operator turns the selector switch to the Flash Off position and Spray Purge expires. If installed, the waterborne paint drying system starts. If the Heat switch is on, the temperature controller will call for heat.

Lights automatically turn off in Flash Off.

Compressed air is automatically shut off to prevent spraying operations.

If a spray booth oven door is opened, the PLC will reference the Spray Mode temperature setpoint. The operator will have to close the door, go to the control panel and press the Reset button to reactivate the Flash Off Mode temperature setpoint.

When Flash Off Mode is complete system will go to Flash Off Mode Over and reference the Spray Mode temperature setpoint.

Flash Off Mode Cycle Time - Timed mode

Turn Time Up/Down switch to the left to decrease cycle time.

Turn Time Up/Down switch to the right to increase cycle time.

Flash Off Mode temperature

Turn Temperature Up/Down switch to the left to decrease setpoint temperature.

Turn Temperature Up/Down switch to the right to increase setpoint temperature.

The maximum setpoint temperature is 170F (77C).

16.5 Bake Mode - Timed Mode

The system enters Bake Mode when the operator turns the mode switch to Bake Mode. The temperature controller will call for heat. If installed, the waterborne paint drying system starts.

Lights automatically turn off in Bake Mode.

Compressed air is automatically shut off to prevent spraying operations.

If a spray booth oven door is opened, the PLC will reference the Spray Mode temperature setpoint. The operator will have to close the door, go to the control panel and press the Reset button to reactivate the Bake Mode temperature setpoint.

System will enter Cool Down Mode when Bake Mode is complete.

Bake Mode Cycle Time - Timed mode

Turn Time Up/Down switch to the left to decrease cycle time.

Turn Time Up/Down switch to the right to increase cycle time.

Bake Mode temperature

Turn Temperature Up/Down switch to the left to decrease setpoint temperature.
Turn Temperature Up/Down switch to the right to increase setpoint temperature.
The maximum setpoint temperature is 170F (77C).

16.6 Cool Down Mode - Timed Mode

The system automatically enters Cool Down Mode when Bake Mode is finished.

Cool Down Mode Cycle Time - Timed mode

The operator cannot change the Cool Down Mode cycle time. The installer needs to set the cycle time upon installation.

Cool Down Mode temperature

Cool Down Mode temperature is not operator adjustable.

17 PLC Programming

There are three groups of variables that can be changed in the program.

1. Operator programmable

These parameters are time and temperature values related to certain modes. The operator uses the Time Up/Down and the Temperature Up/Down switches on the face of the control panel to change these parameters.

2. Installer/dealer programmable

These parameters have to be adjusted in the field to match the particular system the heater is integrated into. These parameters can be reprogrammed in the field through the Setup Screens. The Setup Screens are accessible through the blue colored user programmable buttons on the PLC.

3. Factory programmable only

These are parameters that generally do not require field adjustment.

17.1 Setup Screens

If you have any questions about the Setup Screens, contact technical support. Entering incorrect setting in this section may create hazardous conditions to personnel and equipment. Do not change any settings in this section unless you are qualified to do so. Qualified means that you are familiar with spray booth operating theory, you know the relevant codes and regulations, and you know spray booth operating parameters and the way these parameters effect the safety of spray booths.

Accessing Setup Screens

1. Power up control panel.
2. Off/Fan/Heat switch has to be in the OFF position.
3. Open control panel door.
4. Press the blue Up and the Down arrow buttons simultaneously for 3 seconds.
5. Setup Screen #1 appears on the display.
6. Use the Left and Right arrow buttons to switch among screens.

There are five Setup Screens in the PLC.

Screen #1: Max valve Open

To setup the maximum temperature rise in Prep Mode and in all other modes.

D04: Prep Mode modulating valve maximum signal to limit Prep Mode temperature rise.

D05: Modulating valve signal maximum for all other modes. Used to limit valve opening angle for propane fuel applications.

To access the Setup Screens:

1. Power up control panel.
2. Off/Fan/Heat switch has to be in Off position.
3. Open control panel door.
4. Hold down the blue up and down arrow buttons simultaneously on the PLC for 3 seconds
5. Setup Screen #1 will appear.
 - D04 = maximum modulating valve signal in Prep
 - D05 = maximum modulating valve signal in all modes except Prep
 - 01000 = 10Vdc
 - 00000 = 0Vdc
6. Press SELECT. Black rectangle will appear over first digit on D04.
7. Press arrow buttons over digit you want to change. For example, D04 = 00200 (2VDC) and you are not getting the desired temperature rise. You want to increase the signal value to 3VDC (= 00300).
8. Move black square with arrow button to the number "2".
9. Press SELECT again. The black square changes into a cursor.
10. Press the up arrow once to increase value to 3.
11. Press the OK button to change cursor back to black rectangle.
12. Press down arrow if you have to access D05.
13. Switch system into Heat to test temperature rise of heater.
14. Document process and setpoints in writing.

Screen #2: PrePurge and Spray Purge Timers

Using the instructions in this manual, calculate the minimum PrePurge and the Spray Purge durations. Do not program a shorter duration than the minimum.

Screen #3: Cool Down and Flame Delay Timers

Cool Down Mode time:

This value should not be less than the time it takes to cool down the painted objects below 160F (71C).

Flame Delay:

The Flame Delay timer is activated if the operator turns the Off/Fan/Heat switch from Heat to Fan and back to Heat. When he turns the switch from Heat to Fan, the flame controller closes the safety valves. The modulating valve starts to close. The analog valve actuator takes 35 seconds to move from fully open to fully closed. The digital valve actuator takes 65 seconds to move from fully open to fully closed. We don't want to relight the burner if the valve is not in the low fire position. Therefore we use the Flame Delay timer to delay re lighting the burner until the modulating valve reaches the low fire position.

Screen #4: Temperature Setpoints

DR6C: Temperature offset

The booth temperature is usually 10F-15F lower than the heater discharge air temperature. We can even out this temperature difference by entering in a value here. The PLC will subtract the value of DR06 from the value it displays.

DR66: This value sets up the maximum temperature the operator is able to increase the Prep/Spray Mode temperature setpoint. This value is generally set at 90F (32C) for operational purposes. For setup purposes this is used to raise the Prep Mode temperature setpoint high enough to be able to check and set the Prep Mode temperature rise value (Screen #1 D04).

C07: This value sets up the maximum temperature the operator is able to increase the Flash Off Mode temperature setpoint.

D07: This value sets up the maximum temperature the operator is able to increase the Bake Mode temperature setpoint.

Screen #5: Automatic Spray Mode.

You have to have a compressed air flow switch installed in order to use this feature.

1. Scroll to the fifth Setup screen.
2. Press SEL: M07=OFF
3. Press SEL again: M07=OFF
4. Press the UP arrow: M07=ON
5. Press ESC
6. Press ESC again

You can now turn the system on.

17.2 Reloading the PLC program

The software in the PLC can be upgraded from a PM05 programming chip.

1. Turn off the control panel circuit breaker to power down panel. Verify that PLC screen turned off.
2. Programming port is located below buttons on PLC. Pry out dust cover from programming port with a small screw driver.
3. Insert programming chip. It only fits one way.
4. Power up PLC by turning on circuit breaker.
5. Press ESC.
6. In menu select STOP with the up/down arrows and press OK
7. Select YES and press OK.
8. Scroll down to **READ** and press OK.
9. Select YES and press OK.
10. Scroll up to RUN and press OK.
11. Press ESC once.

Make sure that in step #8 you select READ. If you select WRITE and finish the programming process, you will overwrite the program on the chip! You will not download the program from the chip!

18 Troubleshooting

18.1 Burner

Flame Controller Does not Start Ignition		
No power to flame controller.	Measure for 120VAC from T3	Trace down power.

	to N.	
Preignition Purge Cycle did not complete. No power to flame controller.	Check to make sure Mode#2 air flow switch closes and stays closed for the full duration of the Preignition Purge cycle.	Check display during Preignition Purge to see if air flow switch turns off. If it turns off: - not enough ventilation air flow - defective air flow switch - air flow switch is out of calibration
Combustion blower auxiliary contact is open.	Measure for 120VAC from T6-1 to N.	If no power, check to see if auxiliary closes when contactor is turned on. If contactor does not turn on, trace down power.
Combustion air pressure switch is open.	Measure for 120VAC from T6-2 to N.	Is blower motor on? Does contactor pull in auxiliary contact? Is there an air leak? Disconnect pressure tubing from switch and measure for about 1 in wc air pressure.
High temperature limit switch is open.	Measure for 120VAC from T6-3 to N	Press reset button on high temp limit switch.

Flame controller lockout

Check for spark	Check to see if there is spark during ignition. Use sight window.	
No spark	Check to make sure there is 120VAC on T10 to N during ignition.	If no 120VAC, trace down power.
	Check ignition wire.	
	Check connection of ignition wire and igniter.	
	Check connection of ignition wire and transformer.	
	Check to make sure igniter is properly gapped.	

No Pilot Flame

No gas.	Open inlet shutoff valve	
	Open pilot shutoff valve.	
	Check for 120VAC on pilot solenoid terminals during ignition.	
Insufficient gas pressure.	Measure pilot inlet gas pressure upstream from pilot valve.	
	Measure pilot outlet gas pressure on top of the outlet of the pilot solenoid valve.	

Pilot lights but goes off and flame controller goes into alarm.	Check for sufficient signal on flame amplifier.	No 5VDC on flame amplifier. Replace UV minipeeper.
Poor Flame Quality		
Flame longer than 16"-18" (41-46cm)	Combustion air pressure is low	
	Gas pressure it too high	

18.2 No heat

Combustion blower is not running.

One or two manual gas valves are closed.

Pilot line manual gas valve closed.

Flame controller alarm (no pilot flame)

Safety valves are closed

No combustion air

Low combustion air pressure

Modulating Valve Does not Open

1. Cycle power to the system at the main disconnects. There may be multiple disconnects.
2. Make sure temperature setpoint is set higher than process temperature.
3. Make sure there are no ALARM messages on screen.
4. Make sure Off/Fan/Heat switch is set to Heat.
5. Check for 24VAC to power the valve. Make sure green light is on solid on top of actuator.
6. Make sure RUN light is on on analog expansion module in remote control panel.

No Main Flame		
No gas.	Make sure manual shutoffs are on.	
	Make sure safety valves open	Is there 120V on T9 terminal block after pilot is lit?
Combustion blower is off	Verify that combustion blower is running	
Low combustion air pressure	Check burner differential air pressure	
Incorrect gas pressure.	Verify that gas pressure is correct after regulator.	Measure gas pressure on first safety valve inlet test port.
Incorrect low flame adjustment.	Adjust low fire setting.	
No modulation. Burner stays in low flame.	Is temperature setpoint higher than process temperature?	
	Identify is valve has analog or digital actuation signal and measure for 0-10VDC or 24VAC.	If no signal, trace signal back to remote panel.

7. Make sure C1 and V1 on the analog output module (2AO) has some DC voltage.
8. If there is DV voltage on C1/V1, check to make sure the same control voltage is present at valve. Measure voltage at junction block where pigtail from valve actuator is joined to control wires coming from the terminal blocks.
9. Make sure thermocouple is connected correctly to the temperature controller module (4PT).
 - A1-BRWN,
 - B1-BLK,
 - b1-BLU.
10. Check thermocouple.
 - a. Measure resistance between BWN and BLU. At 75F you should have about 110 Ohms of resistance.
 - b. Measure resistance between BRWN and BLK. At 75F you should have about 110 Ohms of resistance.
 - c. Measure resistance between BLU and BLK. You should see a shorted circuit.
11. If thermocouple was disconnected, you have to cycle power to PLC.
12. Turn circuit breaker off in remote control panel.
13. Wait about 30 seconds and turn power back on.

19 Limited Warranty

19.1 Terms of Warranty

Systems made by Rammstein Air, hereinafter called "Seller," are warranted to the original end user, hereinafter called "Purchaser" against defects in workmanship or materials under normal usage for a period of twelve (12) months, from the installation date of the system or fourteen (14) months from the shipping date of the system, whichever comes first. This limited warranty applies only to the original Purchaser, who acquired the System from Seller or from Seller's distributor.

This limited warranty shall not apply to:

- A. Equipment that is not installed and commissioned by a qualified spray booth contractor in accordance with "Seller's" installation instructions.
- B. Equipment that is not installed in accordance with all Local, State and/or Federal laws or regulations.
- C. Equipment that has been altered in any way, from its original factory configuration.
- D. Equipment that is not registered through the www.rammsteinair.com web site within thirty (30) days of installation.
- E. Any part or component, which has been abused or failed as a result of poor maintenance, installation or neglect.
- F. Any labor costs Purchaser incurs in the process of removing the defective part and installing the replacement part.
- G. Damage caused by acts of God, such as Lightning, Earthquakes, Tornadoes and Storms of any kind.
- H. Filters are considered consumable items and are not covered by any warranty.

Purchaser shall obtain a Return Merchandise Authorization (RMA) number from Seller before returning any parts to Seller. Purchaser is responsible for shipping the parts to Seller's location at 23433 Keator Road, Apple Valley, CA 92307. Purchaser is responsible for all shipping costs of the replacement parts from Seller's facility at 23433 Keator Road, Apple Valley, CA 92307 to Purchaser facility.

The foregoing warranty shall be exclusive and in lieu of any other warranty, express or implied, including warranties of merchantability and fitness for a particular purpose and all other warranties otherwise arising by operation of law, course of dealing, custom, trade, or otherwise.

Additional Warranty Terms: Variable Frequency Drives (VFD)

The terms of this Warranty apply to VFDs with the following additional restrictions.

1. When requesting a VFD replacement under warranty, Purchaser shall pay a VFD deposit based on the following:
 - 5hp VFD \$350
 - 7.5hp VFD \$550
 - 10hp VFD \$700
 - 15hp VFD \$1,000
 - 20hp VFD \$1,400
2. Seller will return the VFD to the VFD manufacturer. The VFD manufacturer will determine if the VFD failure is covered under warranty.
3. If the VFD is covered under the VFD manufacturer's warranty terms, Seller will refund the VFD deposit to Purchaser.
4. If the VFD is not covered under the VFD manufacturer's warranty terms, Seller will keep the VFD deposit. Seller will consider the VFD deposit to be full payment for the replacement VFD Seller sent to Purchaser.

This limited warranty gives Purchaser specific legal rights, which vary from state to state. To the extent allowable under law, "Seller's" liability for consequential and incidental damages is expressly disclaimed. "Seller's" liability in all events is limited to, and shall not exceed, the original purchase price. In the event of a dispute, the controversy will be decided by binding arbitration by the Los Angeles County Arbitration Association.

19.2 Warranty Activation - Information Needed for Warranty Activation

Date of installation

Name of facility

Contact person at facility

Phone Number of facility

Street address

City

State

Postal code

Country

Distributor

Contact person at distributor

Telephone number of distributor

Installer company (if different from distributor)

Name of installer

Telephone number of installer

Control panel serial number

Voltage

Amperage draw of motor

Elevation of facility

Labels installed according to the Labeling Requirement section.

19.3 Warranty Registration – Registration Web Site

Please log onto our web site to register your system warranty: www.rammsteinair.com. Please click the Warranty Registration button on the left.

20 Inspection, Testing, Maintenance Sheet Sample

Electric Heater Safety Interlock Inspection Sheet																
Inspection Schedule	Date Inspection is Completed	Inspector (sign name in top half of box and print name on bottom half of box)	Explosion relief of spray booth oven	Air flow switch		Automatic high temperature limit switch	Manual high temperature limit switch in heater		Manual high temperature limit switch of spray booth		Compressed air flow switch	Compressed air solenoid valve	Blower motor interlock auxiliary contactor	Exhaust damper operation		
				Set point	Test		Set point	Test	Set point	Test					Set point	Test
Startup																
6 months after startup																
1 year after startup																
2 years after startup																
3 years after startup																
4 years after startup																
5 years after startup																
6 years after startup																
7 years after startup																
8 years after startup																
9 years after startup																

21 Connection Diagrams

22 Schematic Diagram (Ladder Form)

23 Cycle Chart (or printed sequence of switching action)

24 Wiring Diagrams

24.1 Standard

24.2 Options

25 Technical Support

25.1 Installation and Commissioning - Manufacturer

Rammstein Air

23433 Keator Road

Apple Valley, CA 92307

Tel.: 909-331-5593

25.2 Everyday Operations, Maintenance - Dealer

Dealer's name:

Dealer's contact number: