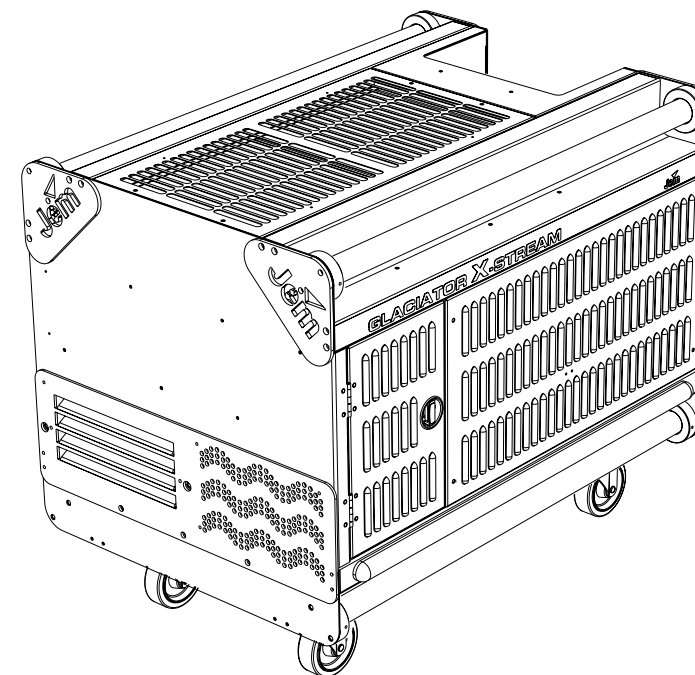




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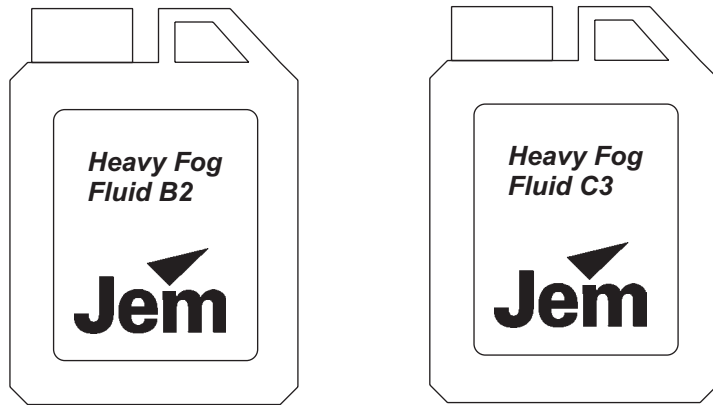


USER GUIDE  
VERSION 1.0



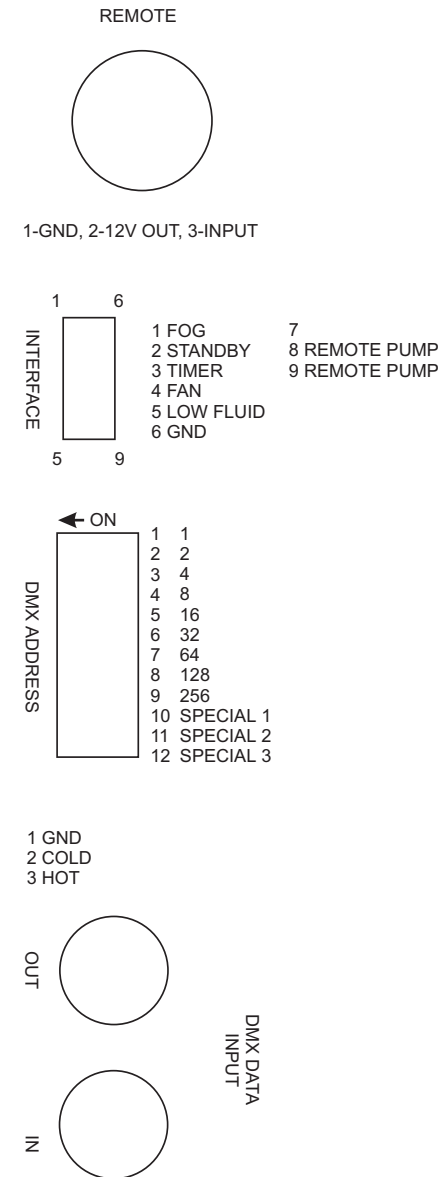
*Heavy Fog*  
**Glaciator**  
**X-Stream**

**Fluids Suitable for this system:**



**NOTE!** The warranty on this machine is conditional on the use of genuine JEM / Martin fluid only. Other fluids may represent a health hazard when used in this machine, and may damage the internal components.

**CONNECTIONS**



**FUSE RATINGS**

The Heavy Fog Glaciator uses six fuses. They should be replaced with the value and type detailed below:

- DMX receiver low voltage 2AT
  - Power PCB 15AT
  - Compressor control relay 3.15AT
  - Local/Remote relay 3.15AT
  - Condenser fan relay 3.15AT
  - External pump signal 1AT
- These fuses are located internally and should not be accessed without first disconnecting the power supply.

**FILTERS**

The Heavy Fog Glaciator uses a washable synthetic fibre filter in the air intake for the condenser unit (located at the top of the machine). This can be removed for cleaning by removing the ventilation grill above it (four M5 screws). Use the following guidelines for when to check the filter.

- Normal Conditions:** Inspect and clean/replace every 250 hours
- Severe Conditions:** Inspect and clean/replace every 150 hours

**SPECIFICATION****HEAT EXCHANGER**

- 3.5KW heater (@240V)
- Wide bore steel vaporizing coil
- Ceramic thermal trip for over-temperature protection
- Electronic Temperature control using thermocouple

**FLUID SYSTEM**

- Oscillating piston high pressure fluid pump
- Low fluid detection by electronic sensor
- 5L fluid container (1.3 US Gal.)
- Maximum fluid consumption 120mL/minute

**REMOTE CONTROL OPTIONS**

- DMX512 decoder:
  - Required Channels = 2
  - Output is proportional for all levels above 12%
  - Channels supported = 1 to 511
  - Valid start codes = 0 (dimmer data only)
  - Full framing error detection implemented
- Analogue control via standard JEM Multifunction Controller.
- PLC interface for simple switching control of the system.

**CONTROL PANEL**

- 2 x LED displays with 4 button keypad
- Output level control from 0 to 100% for Fog
- Timer range:
  - Delay time (toF) 0 seconds - 90 seconds
  - Run time (ton) 0 seconds - 90 seconds

**REFRIGERATION UNIT**

- 1 HP compressor with PWM electronic control
- Uses refrigerant R404A (1.2 Kg)

**OUTPUT CONNECTION**

- Ducting adaptor to accept 150mm (6") flexible ducting

**POWER REQUIREMENTS (dependant on model)**

- Input voltage **230V,50Hz** single phase (32A supply)
- Input power (max) 4.893KW @ 230V
- Current (max) 22.2A
- Input voltage **208V,60Hz** single phase (32A supply)
- Input power (max) 4.325KW @ 208V
- Current (max) 21.9A
- Power connection is via 32A 3 pin IEC appliance inlet (230V machines) or fixed cable (208V machines).

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## INTRODUCTION

The Heavy Fog Glaciator X-Stream is the latest product in the new generation range of JEM professional machines. Designed for touring and installation in a variety of applications, it has provision for easy integration into most common control systems currently used in the entertainment industry. As well as providing remote control options via DMX, the machine comes with a comprehensive control panel for local operation and display of operating parameters.

The Heavy Fog effect is provided by cooling the smoke output from the main heat exchanger until it is at a temperature lower than the ambient in which the machine is operating. Air is added to the smoke, prior to cooling, from the fan mounted in the rear of the machine. This increases the volume of the effect and allows the output to be pushed through ducting.

A fluid container with 5L capacity (1.3US Gal.) is provided for Heavy Fog fluid. To allow reliable unattended operation, the fluid level is monitored electronically, and the machine shut down if necessary.

All machines come with robust carrying handles, and heavy duty braked castors. A ducting adaptor as an accessory.

## FEATURES

Tubeless condenser	Electronic low fluid detection
5L fluid capacity/Remote fluid	High pressure piston pump.
Pump Ramping system for continuous operation	LED displays for FOG and ICE controls.
Electronic expansion valve	Fog and Density controls for easy set-up.
3.5KW heat exchanger	Accurate timer
DMX512 interface (two channel)	Remote interface.
Integrated PLC interface	Two speed condenser fans for reduced noise
Non-volatile memory for user settings	

## BASIC FAULT FINDING

The Heavy Fog Glaciator is a complex machine and will require a competent service technician to repair any major faults. However, the following guide will allow the user to overcome the more common problems.

SYMPTOM	CAUSE	CURE
No fog output when the machine is fired using the Fog or Timer switch.	Machine is not ready	Allow time to reheat
	Fluid is below min level	Add fluid
	Standby switch is OFF	Set standby to ON
No fog output when using DMX to fire the machine.	Incorrect DMX address	Check settings
	Machine not ready	Allow time with DMX on
	No DMX termination	Fit 120 ohm resistor
Flu Lo is displayed on the Fog display	Fluid level is below min	Add more fluid
Machine is not ready after 20 minutes heating time	Standby switch is OFF	Set Standby ON
	Blown fuse on Power control PCB	Disconnect supply and replace fuse.
Fog disperses too quickly	Wrong grade of fluid used for the application	Choose a longer lasting fluid (see front cover)
	Density level too low	Increase density setting (Reduces fan speed)

**DISPLAY MESSAGES**

The following list shows the messages possible, and the context under which they are displayed. Only the messages available under normal operation are shown. Messages shown when using the menus, are detailed in other sections of this handbook.

**Fog Display**

Fog/oFF	Displayed when the Standby switch is set to OFF, indicating that the machine can not be fired and the heaters are OFF.
Fog/Err	Shows that the Standby switch is ON but the heater is not on. This is an error condition and should not normally occur.
Fog/Ht	Displayed when the heater is running but the machine is not ready.
Fog/rdy	The machine is ready to fire using the Fog or Timer switches.
FLu/Lo	Indicates that the fluid in the container is below the minimum level to operate the machine. Only visible when the machine has reached the ready state.
Fog/08	The FOG switch is being used to fire the machine. The number displayed is the current Fog output level in the range 0 to 20

**Ice Display**

dEn/oFF	Displayed when the Standby switch is set to OFF.
dEn/nor	Shows the current Density setting.

**SAFETY GUIDELINES**

Always use JEM/Martin approved fluid in the container supplied with the machine. Do not bypass the fluid sensor, this could cause damage to the machine.

Check the voltage is correct for use with the machine, the voltage setting is printed on the serial label.

The machine must be operated in a horizontal position and should not be suspended overhead.

Observe the warnings displayed on the machine (yellow labels).

Do not remove the covers or attempt to repair a faulty machine, an authorized JEM dealer should be contacted in the event of a faulty machine.

Always use smoke machines in well ventilated areas, over-use could affect sufferers of asthma or other chest conditions.

Smoke machines can cause condensation to form. Floors and surfaces may become slippery and should be checked regularly.

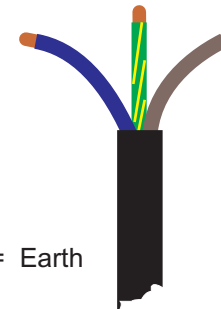
This machine is not waterproof, and should not be exposed to wet outdoor conditions. Do not spill fluid over the machine. If fluid is spilt, clean with a damp cloth and contact an approved JEM dealer for advice.

Refer servicing to qualified service personnel. Disconnect the machine from the power supply before removing any covers.

**Mains Cable Wiring Instructions**

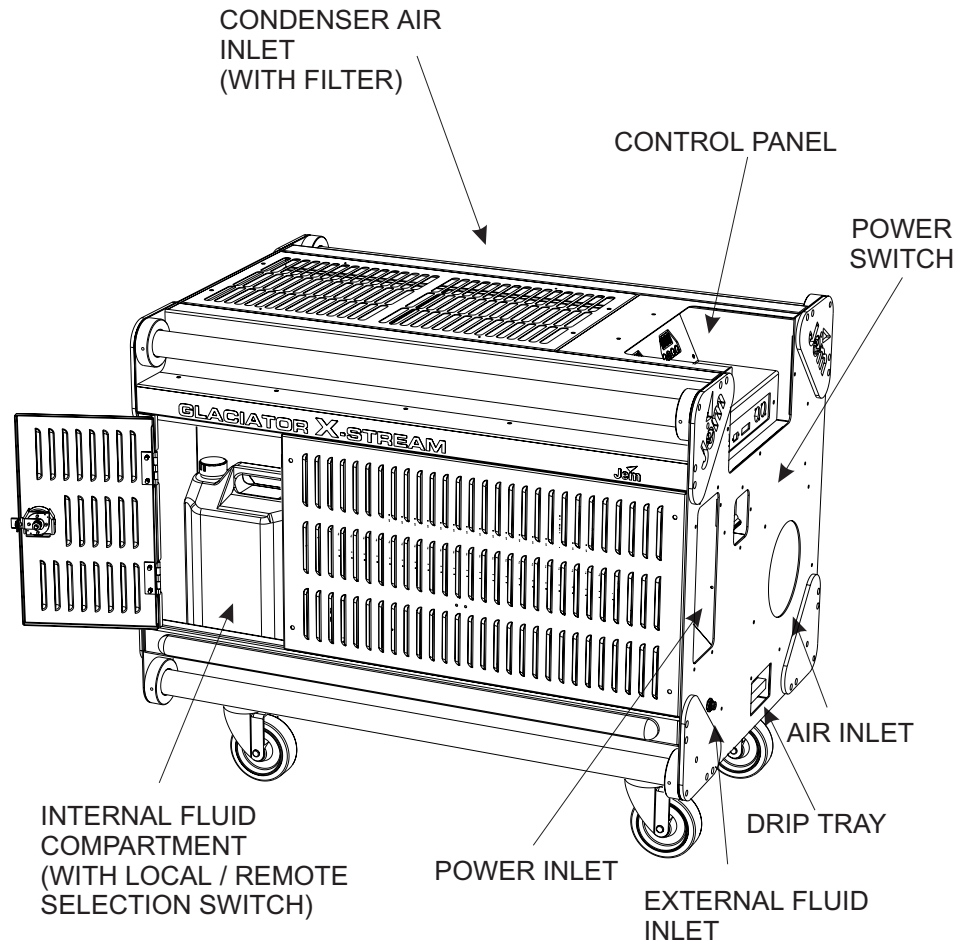
This equipment must be earthed.

Brown = Live  
Blue = Neutral  
Green / Yellow = Earth



The Heavy Fog Glaciator is fitted with an IEC 32A single phase connector. A suitable 32A,230V supply must be used.

On the 208V/60Hz version of the machine, the IEC connector is replaced by a fixed cable. To connect to US 208V supplies, the neutral conductor can be connected to the second phase of the 120V system, while phase 1 is connected to the Live conductor.

**MACHINE LAYOUT****INTERFACE OPTIONS FOR GLACIATOR X-STREAM**

The PLC interface connector is now fully operational on all models, without the need to fit an extra interface PCB to the machine. This allows installers to control the functions of the machine using active low signals from a PLC or other automatic control system. The fog and density levels must be preset on the display units, or alternatively, a 0-10v signal can be used at the remote interface connector (XLR3).

Since the interface has no opto-isolators, the external control system should use voltage free contacts or opto-isolated outputs to control the machine. The signals are active low, and need a threshold voltage of 1.5V or less @ 2mA to activate the functions. The internal circuits of the interface offer very little overload or interference protection, meaning that any control device should be located physically close to the machine. This will prevent problems due to long cable runs etc.

The special function pin 5, is now allocated to allow the machine to be shutdown by a remote fluid sensing system. The input is active low and has the same electrical specification as the other inputs.

To allow the external fluid system to use a remote pump, a 'normally open' contact is connected to pins 8 and 9.

**Pin Allocations:**

- |          |                             |
|----------|-----------------------------|
| <b>1</b> | <b>Fog</b>                  |
| <b>2</b> | <b>Standby</b>              |
| <b>3</b> | <b>Timer</b>                |
| <b>4</b> | <b>Fan</b>                  |
| <b>5</b> | <b>Shutdown (low fluid)</b> |
| <b>6</b> | <b>Ground</b>               |
| <b>7</b> | <b>N/C</b>                  |
| <b>8</b> | <b>Remote pump run A</b>    |
| <b>9</b> | <b>Remote pump run B</b>    |

**BASIC OPERATION**

The following instructions explain how to operate the basic functions of the machine. It is assumed that the machine is being started from cold.

Starting with all the control panel switches OFF, and the display showing 'OFF', go through the following sequence.

Set the Standby switch to ON.  
Fog display shows FOG/Ht  
Ice display shows Den/nor

Set the output to Fog = 8

Set the Ice switch to ON

When the machine is ready (after approx. 10 minutes heat-up time) fog can be produced.

Fog display shows FOG/Rdy  
Ice display shows Den/nor

If starting the machine for the first time, or after the fluid has been changed, the pump may need to be primed.

Do this by setting the Fog output to 20 and firing the machine for 10 seconds, or until fog is produced at the output.

If the pumps have not primed after 40 seconds, there may be a problem with the fluid system. Refer to the Fault Finding section of the handbook for advice. The unit may not prime properly if the ice system is not at -15 or below. This can be overcome by switching the ICE switch to off, and then priming the pump as previously described.

Set the Fog switch to ON to produce continuous output of Heavy Fog.  
Fog display shows FOG/08  
Ice display shows Den/nor

Set the Timer switch to ON to produce timed output (read the Timer section to see how to configure the timer). Note that the Fog switch overrides the timer switch.

Fog display shows ton/04, toff/03 etc  
Ice display shows Den/nor

**COMMISSIONING THE MACHINE**

Unpack the machine and look for any obvious signs of damage.

Place the machine on a level surface and fit a container of JEM/Martin approved fluid into the fluid compartment. Fit the fluid line and cap to the container.

Check the wiring instructions in the Safety Guidelines section of this handbook and connect the machine to the power supply.

Set the power switch to the ON position, and look for the start-up message on the displays.

Set all the switches on the control panel to OFF and refer to the Basic Operation section of this handbook for information on how to use the main functions of the machine. Read the Safety Guidelines before using the machine.

**REMOTE CONTROL OPTIONS**

The Heavy Fog Glaciator provides the user with 3 ways to implement a remote control on the machine. The main control panel is fixed and can not be removed for remote operation.

All the remote interfaces are located on the panel adjacent to the control panel.

The options are:

**DMX 512 Digital Interface.**

The interface uses the two XLR 3 connectors marked DMX on the interface panel, and uses the usual DMX electrical standards (RS 485). The inputs are protected against overvoltage and an output connector is provided to allow multidrop operation of the link.

**Remote Interface.**

The remote interface uses an XLR 3 connector to allow a standard JEM remote to fire the machine.

Full proportional control of the Fog output can be achieved, but the Density level must be set on the control panel.

**PLC Interface.**

This connection is an option available to installers who wish to control the machine using the outputs from a standard Programmable Logic Controller (PLC). The interface allows 'voltage free' control signals to switch the Fog, Standby, Timer and Ice functions. The output levels and timer settings must be made using the control panel. See the section called **Interface Options** for more information.

## DMX OPERATION

The machine may be operated using the industry standard DMX 512 digital control protocol. This allows the control of the fog system to be easily integrated with the lighting system in most installations.

DMX may be used without changing any of the settings on the main control panel. When the system detects a valid DMX data stream on the input, the control will default to the DMX system levels. Any attempts to control the machine from the control panel will have no effect until the DMX signal is removed. The displays will show the current input values for Fog and Density.

To ensure correct operation of the displays, the standby switch should be set to the ON position when using DMX.

The machine requires two channels, with the address of the first channel set on the DIP switch. The channels control the FOG and Density settings in the following manner.

### Channel 1

FOG output level  
0 - 32 zero output (dead-band)  
33 - 255 proportional output level control  
Implemented in 20 discrete steps

### Channel 2

Compressor switching and Density setting  
0 - 32 Compressor off  
33 - 65 Low (Lo) density  
66 - 98 Normal (Nor) density  
99 - High (Hi) density

The system implements true proportional control of the fog output rather than the simple switching functions found on other equipment. The output levels of FOG and FAN are linked during DMX operation via the Density setting.

The DMX base address can be set to any channel in the range 1 - 511 using the DIP switches. The channel number must first be decoded into binary format before being set into the switches.

**ICE:** Setting this switch to ON, will start the compressor. There will always be a delay of up to 20 seconds to allow pressure equalisation. This function is independent of the status of the STANDBY switch.

## THE TIMER

The timer system is implemented in software using the machine's main control PCB. As such, the timing is crystal controlled and will be of good accuracy when compared to the usual analogue timers commonly found on fog machines. The timer is enabled by setting the Timer switch on the control panel to ON.

Pressing the Timer switch will cause the timer to start from the beginning of the ON period and run through to the end of the OFF period, the cycle will then repeat until the Timer switch is set to OFF. The timer will only function when the Standby switch is set to ON and the machine is ready (RdY). Switching the Timer to OFF at any time during the cycle will halt the operation.

While the timer is running, the left-hand display will show the elapsed time in seconds. The display will alternate between the period name (ton/toF) and the elapsed time in seconds.

To set the time periods, use the Menu key on the left-hand display to set the 'ton' menu as current. Press the Enter key to see the current value for the On Time (ton), and make adjustments using the Up/Down keys. Now press enter to store the value and use the menu key to select the Off Time (toF) menu. Adjust the value as for the On Time, and then enable the Timer switch on the control panel to test the settings.

The current Fog and Density levels will be used by the timer system when in the ON period.



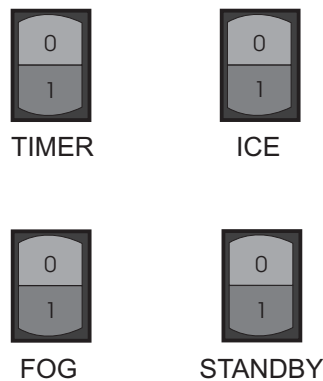
## CONTROL PANEL FUNTIONS

The control panel provides a means to enable the various functions that control the Fog and Ice operation. The switches have a maintained action, and are used to set the operating mode of the machine. The settings for Fog and Density levels are made using the LED display keypad.

The Lo,Nor & Hi density settings are used to relate the fan speed to the current level of fog output. Use Lo density when using ducting to get maximum thrust from the fan , and use Hi density to create a very dense effect (although with reduced volume).

The ramping control system may override the density setting if required.

The layout of the control panel is shown in the following drawing.



The switches are used to set the operating mode of the machine and are used individually or in combination. The functions available are explained below.

**FOG:** Gives Fog output at the level currently set using the display system. The machine must be Ready before fog can be produced.

**STANDBY:** The standby switch brings the machine into operating mode and will start the heater. This switch must be ON to use the Fog switch or the Timer. When Standby is OFF, the machine will display OFF on both displays. With standby ON, and the machine ready, Rdy will be on the Fog display.

**TIMER :** When the machine is Ready, (at operating temperature), the timer switch will start the timer running using the settings from the display.

The machine uses a 'pump ramping' technique to allow continuous operation. This means that transmitting DMX 100% will cause the machine to run at full output until the temperature falls and the output is automatically reduced. The output will remain at this level until the DMX signal is reduced, or the fluid is exhausted. There is no possibility of damage, since the electronic fluid level sensor will shut the machine down.

The fan output level is affected by the ramping system via the Density setting.

The onboard timer functions are not accessible via the DMX system. Any timing of the output must be done using the programming capabilities of the DMX console being used to control the system.

Setting of the base address of the DMX control system via the Dip-switch, requires the decimal address to be converted to a binary (base 2) number. Many pocket calculators can perform this conversion, or the user can read off the settings from a printed conversion table.

An alternative is to use a simple process of subtracting the largest of the binary weightings that leave a positive result.

Example:

Decimal 289.

Largest subtraction possible is 256, leaving 33.

Now,  $33-32 = 1$ , and  $1-1 = 0$ .

So, we need a binary representation with 1's in the positions corresponding to weightings of 1,32,256.

Or, 100100001, where 256 is the leading column.

The weighting on the Dip-switch is reversed, so the number 100001001 is entered from left to right.

The binary weightings on the Dip-switch read as follows ( from left to right):

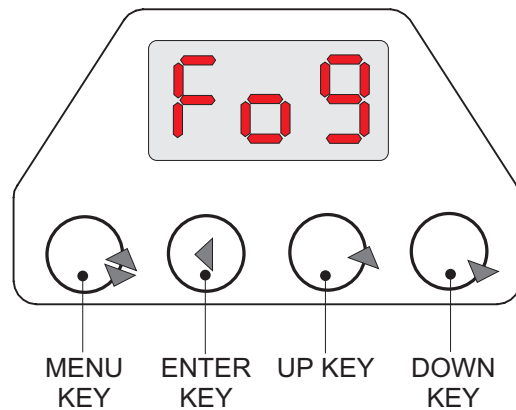
**1,2,4,8,16,32,64,128,256**

The remaining 3 switches are marked S1,2,3, and are function switches that enable special operating modes on the machine.

## THE DISPLAY

Two LED displays are used in the Heavy Fog Glaciator to show status and control information. The left display shows all information for the fog generation functions of the machine, whilst the right display shows the information for the Ice functions.

Located below each display are 4 function keys that can be used to control the display and the settings on the machine. The functions of the keys are shown in the following drawing.



The message displayed will depend on the operating mode of the machine at the time. However, pressing the menu key at any time will cause the display to go into the edit mode, allowing the operating parameters to be adjusted. After approximately 15 seconds since the last keystroke, the display will leave the edit mode and revert to displaying the current status information.

Pressing the menu key will display the current menu function, whilst pressing and holding will scroll through the available menus. All keys work the same way, and can be operated with single keystrokes or held down to force the display to scroll through the available options/values. The scrolling function comes into operation 1 second after the key is pressed.

When the user has set the required menu function, pressing the enter key will display the current value associated with that menu item. The user can now use the UP/DOWN keys to move through the available options/values either by single keystrokes or by scrolling.

## EVAPORATOR FAN CONTROL

When the current firing cycle is over, the evaporator fan will run at maximum speed for 3 seconds to clear the remaining smoke from the evaporator compartment. To allow for machines with ducting on the output, a special extended run mode can be selected. By setting the special function switch 1 (s1) to ON (down), a 6 second run-on time for the evaporator fan can be selected. Remember that the density setting for ducting is 'Lo', since this gives the greatest fan speed for any given fog output level. The evaporator fan may run at other times to assist in the control of the refrigeration system.

## CONDENSER TEMPERATURE CONTROL

The radial blowers used to cool the condenser unit are powered from a 2 speed relay which is controlled by the machine's microprocessor. The speed of the fans is determined by the temperature of the condenser unit and the thermal load on the evaporator. The control software uses a timer to prevent short-cycling of the speed controller. Under almost all ambient conditions, the fans should run at low speed when the machine is idling, but when fired, the system will switch to high speed. The high speed running will continue after the end of the current firing cycle, and is timed according to the temperature of the condenser unit.

The filter material fitted to the condenser unit can be changed by removing the four screws securing the condenser top cover. The guidelines for filter change/cleaning are:

### Normal conditions:

Inspect and clean/replace every 250 hours.

### Severe conditions:

Inspect and clean/replace every 150 hours.

## REFRIGERATION SYSTEM CONTROL

The performance of the refrigeration system in the Heavy Fog Glaciator is the key to its heavy fog generating capability. The system is under the complete control of the main microprocessor which also co-ordinates all the other activities within the machine.

Four system temperatures are measured by the control system and are used to regulate the flow of refrigerant via the PWM expansion valve. Replacing the normal thermo-mechanical expansion valve with an electronically controlled valve brings the following benefits:

- Faster response to load changes
- Improved control when on light loads
- No adjustments required
- Greater tolerance to changes in gas charge
- Improved compressor starting when hot
- Power saving idle mode

When the refrigeration system is switched off using the ICE switch on the control panel it can only be started by setting the switch to ON. There will be a delay of 10 to 30 seconds while the system pressures equalise, followed by the motor starting. During the motor start cycle, the heaters are switched off to reduce the peak current draw.

If the ICE switch is ON, but the compressor is not running, the system is in power save mode. It will restart when the smoke system is fired (any signal source) or when the ice switch is cycled. The starting delay will depend on the current evaporator temperature, but will not prevent immediate production of fog at full output.

If the machine is not fired, the evaporator temperature will drop to  $-25^{\circ}\text{C}$  or lower and a timer will start. When the unit has been at this temperature (without being fired) for approximately 20 minutes, the system will shut down and enter the power saving mode. Power save mode will continue until the machine is fired, or the evaporator temperature reaches  $-4^{\circ}\text{C}$ .

To check the status of the refrigeration system at any time, use the ICE menu on the right hand display panel. The left hand panel will now display the name of the value, while the right hand display will show the temperature. Use the scroll keys on the right hand display to move through the available values.

To store the new value into non-volatile memory, the enter key must be pressed before moving on to another menu or leaving the edit mode.

When not in edit mode, the display will show information appropriate to the current operating mode. To do this, the display will alternate between two messages. The duration of the first message is typically 1 second, whilst the second message will be visible for 2 seconds. Some messages are compounded together to form one message, eg FLu/Lo indicating low fluid in the fluid container.

As an example, when the STANDBY switch on the control panel is set to OFF (0), the display will alternate between FOG and OFF. For more information about the messages to expect, see the sections covering the different control functions on the machine, eg 'THE TIMER'. The section entitled 'DISPLAY MESSAGES' contains a complete list of the messages and the circumstances under which they are displayed.

The menus available on each display and the functions they perform are as follows:

### Fog Display

#### Fog

Sets the current Fog output level in the range 0 to 20.

#### Ton

Sets the ON time of the Timer in the range 0 to 90 (seconds).

#### ToF

Sets the OFF time of the Timer in the range 0 to 90 (seconds).

### Ice Display

#### Den

Sets the output density level (Lo,Nor,Hi).

#### SuP

Sets the supply voltage in the range 200 to 250v.

#### Ice

Displays current system temperatures.

The software that controls the displays and the other functions of the machine is stored in 'Flash' memory on the DMX receiver PCB. As new features become available, this program code can be updated by using the Martin Uploader programming device for the AVR microprocessor.

## THE FLUID SYSTEM

The Heavy Fog Glaciator uses a 5L (1.3 US Gal.) container to give approximately 1.5 hours of continuous operation at full output. This will vary with power supply voltage, which will determine the maximum continuous output level. For longer run times, the remote fluid system can be used.

The machine control system uses a 'Pump Ramping' technique to allow continuous operation with moderate input power requirements. When the output level is set to maximum, the machine will give maximum output until the heat exchanger has used its energy reserves. The control system will then override the output level setting and reduce the pump speed to match the output to the available input power. This ensures that the output will be continuous, although at a reduced level.

Continuous operation gives rise to the possibility of pump damage if the machine runs out of fluid. This is overcome in the Heavy Fog Glaciator by using an electronic fluid sensing system, ensuring that the pump is shut down when the fluid level is too low. The Left-hand display will show a Lo Flu message to warn the user that the machine is shut down due to lack of fluid.

Variations in pump performance due to supply frequency differences (50/60Hz), are compensated for automatically. Supply voltage changes will also affect the pump performance, and can be catered for by using the Supply Voltage menu (SuP) on the right-hand display unit. Using the Menu key, select the SuP menu and press enter. Now adjust the voltage to match the local power supply voltage (valid range is 200 - 250V). Press the enter key to store the new setting in non-volatile memory. The pumps will now run at the optimum level for the conditions.

Remember that the type of fluid used will play a large part in determining the resulting effect. The list of fluids inside the front cover of this handbook shows the main fluids compatible with this machine. Choose a fluid suitable for the venue and type of effect you want to create. Generally, use the standard B2 fluid, but for longer lasting effects, contact a distributor for advice on using another fluid grade.

When operating the machine for long periods, there will always be a build-up of condensation in the evaporator unit. This will drain into the drip tray, which should be emptied regularly. For installation, an optional drain hose can be fitted.

## LOCAL/REMOTE FLUID SYSTEM

The Local / Remote fluid system used on the Glaciator gives users the flexibility of using either the built-in 5L container (with sensor), or a remote supply. The remote supply can be up to 100m away from the machine if a suitable slave pump is used at the reservoir.

An output, which is active when the machine is firing, is provided on the 9-way D-type connector (pins 8 & 9). This signal can be combined with the signal from a pressure switch, to control the remote pump which must have a maximum output pressure of 3 bar.

These contacts are voltage free, and allow the remote pump to be active only when the machine is fired. Since the contacts are voltage free, they can be connected in parallel with the signals from other Glaciators which share the same fluid supply. This forms a 'wired or' function, which enables the pump when any/ all machines are operated. The output must not be used to control mains (line/net) voltages directly.

To select between local or remote fluid, open the door of the fluid compartment and operate the toggle switch mounted in the top of the compartment side panel. The local fluid sensor will be disabled when in remote mode, but the remote system can shut the machine down by using pin 5 of the interface connector (9-way D-type). This allows a remote system to be constructed which includes a fluid sensor, thus preventing the system from running dry.

The input on pin 5 must be pulled low, relative to the ground on pin 6. Ground isolation should be provided between the two systems, by using relays or opto-isolators.

The remote fluid connection is a 6mm 'push fit' style pneumatic fitting, and should be used with nylon or PTFE tubing having a 10 bar pressure rating.

When using a remote slave pump, the suction line must be fitted with a suitable filter such as Martin part number 26480020.

The most suitable type of pump, is a diaphragm unit similar to 'FloJet' style 2100, which includes a pressure switch. To prevent the liquid being forced through the internal pumps, the maximum pressure in the feed line to the machine should be 3 bar (44psi).

For distances to the reservoir of less than 6m, a slave pump is not required. To prime the pumping system, the 'Ice' switch should be set to OFF, to allow the machine to run the pumps at maximum output. Alternatively, wait until the refrigeration system cools to below -10, at which point the pump ramping system will become inactive, and maximum output will be available.

**Note:** All pressures are quoted as gauge pressure.