

clēaire

ADVANCED EMISSION CONTROLS®

Skyline™

Owner's Manual



MADE IN CALIFORNIA

ATTENTION:

Keep a copy of this Owner's Manual in the equipment cab.

The instructions, specifications, and recommendations in this manual are based on current information when this manual was released. Cleaire Advanced Emission Controls, LLC reserves the right to make changes at any time without obligation. If you find differences between your system and the information in this manual, contact your Cleaire dealer or call Cleaire at 1-800-308-2111.

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Cleaire Skyline™ Owner's Manual

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GENERAL INFORMATION

Cautions

Please study this manual and understand the requirements for the Cleaire Skyline system before operating your equipment.

The pictures and descriptions in this manual are for a typical Skyline system. Some parts, components and configurations for your particular system may vary from those shown here depending on the equipment and application.

The use of parts which are materially different than the verified retrofit parts or systems may void the verification and the warranty.

The owner's obligations, routine observations and periodic maintenance requirements are described in this manual. Contact a Cleaire-authorized dealer if you need further assistance.

Safety Warnings

- **Before starting regeneration, park the equipment in a well ventilated location far away from any combustible material. Turn the engine off. Do not regenerate indoors.**
- **The system may be hot when not normally expected: During regeneration, the engine will be off, but the Skyline (including the downstream pipes) will be very hot.**
- **Do not touch any of the PM filter assembly components or exhaust tubing during regeneration or after engine operation. All surfaces can become hot and may cause burns.**
- **The PM filter stays hotter much longer than a stock muffler will after operating under heavy load, after the engine is turned off, and after a completed regeneration cycle.**
- **After operating under heavy load (for example, driving up to a mountain pass), the driver should be very careful if they need to pull off to the side of the road and leave the engine idling. The PM filter retains heat much longer than a muffler which makes it possible for very hot exhaust gases to exit the tailpipe for several minutes and be a potential source of ignition for combustible material (such as dry grass).**
- **Do not allow combustible material from the working environment to come in contact with the Skyline (for example, paper, trash, sawdust).**
- **The Skyline's regeneration system uses high voltage (see the "Specifications" on page 26). Only a technician qualified for high-voltage work should install or repair any of the high-voltage electrical components.**

Owner's Legal Obligations

Use of any alternative diesel fuels and or fuel additives not specifically listed in the CARB verification Executive Order (E.O.) is illegal and strictly prohibited. Operating with an unapproved alternative diesel fuel or fuel additive violates the E.O., negates the verification for that engine, and removes compliance status for the equipment. The E.O. for the Skyline is provided in this manual beginning on page 33. It also may be obtained from the CARB website at <http://www.arb.ca.gov/diesel/verdev/level3/level3.htm>.

The installation of the Skyline is based on the owner's understanding that adding a new part to or altering an original part of a certified configuration could be considered a violation of the tampering prohibition of the Clean Air Act. The owner understands that the installation of the Skyline will not violate tampering provisions of the Act, at the time of installation, because of the testing performed under the verification process—provided that the owner adheres to all installation instructions and meets all operating and maintenance requirements for the Skyline.

- **Specific events that require action by the owner or operator are given in the “Owner's Obligations” section on page 28.**
- **If any of these events occur, it is the owner's obligation to take the appropriate action. Failure to do so may be the basis for denying a warranty claim.**

Contact Information

Contact a Cleaire-authorized dealer for any sales or service support for your Skyline system. The tables below for contact information are provided for the customer to complete at their convenience. For more information, contact your local Cleaire product support representative, call Cleaire at 800-308-2111, or visit www.cleaire.com.

Dealer	
Address	
Contact person	
Contact person's phone	
Contact person's fax	
Contact person's email	

Name of local Cleaire product support representative	
Local Cleaire representative's phone	
Local Cleaire representative's email	

Installation

Cleaire recommends that a Cleaire-authorized technician install the Skyline system. The complete installation procedures are described in the Skyline Installation Manual. Copies of the manual are available upon request from your dealer or Cleaire. The installation warranty (page 32) is the responsibility of the dealer that installs the Skyline system.

Note: the power-supply station installation is the responsibility of the customer and their electrical contractor. Copies of the Power-Supply Station Installation and Maintenance Guide are available upon request from your dealer or Cleaire.

Attention:



A Cleaire-certified technician must commission the system; otherwise, that may be the basis for denying a warranty claim. Warranty registration is submitted by the Cleaire-authorized dealer.

Acronyms

AC	alternating current
BP	backpressure
CARB	California Air Resources Board
CO	carbon monoxide
DPF	diesel particulate filter
HC	hydrocarbons
LED	light emitting diode (system indicator light)
MLC [®]	the electronic controller in the Skyline system
<i>MLinC</i>	the software program used to communicate with the MLC
OEM	original equipment manufacturer
PM	particulate matter (diesel soot)
TC	thermocouple
ULSD	ultra-low sulfur diesel fuel
VAC	volts alternating current
VDC	volts direct current

SKYLINE SYSTEM DESCRIPTION

Product Summary

The Skyline has been verified by the California Air Resources Board to capture over 85% of the particulate matter (PM) from diesel engine exhaust (“Level 3 plus”). Features include:

- Stainless steel construction
- Particulate matter filter (PM filter)
- Modular design to facilitate installation, service and maintenance
- Filter regeneration when the equipment is parked (5-hour regeneration cycle)
- Cleaire MLC[®] (the system controller)
- Sound attenuation eliminating the need for a muffler or silencer

The Skyline (Figure 1) consists of three main subsystems: the PM filter assembly, the control system, and the regeneration system:

- The PM filter captures over 85% of the particulate matter (soot) from the diesel engine exhaust while the equipment is operating.
- The control system monitors the Skyline and engine during operation and controls the regeneration cycle, which cleans out the PM filter.
- The regeneration system operates while the equipment is parked and plugged into AC power.

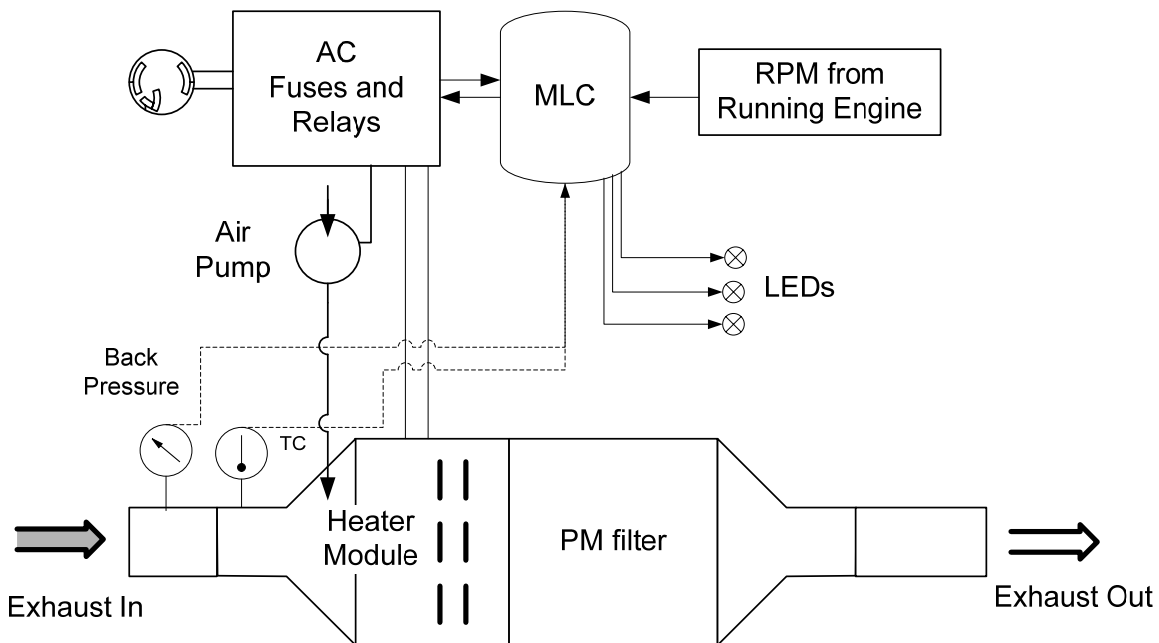


Figure 1: Skyline system schematic drawing.

PM Filter Assembly

The PM filter assembly (Figure 2) is the core of the Skyline system and it usually will replace the muffler. The assembly has important features highlighted below:



Figure 2: PM Filter Assembly.

Cleaire provides a mounting assembly specifically designed for the Skyline. **Although the PM filter assembly replaces the stock muffler, it is important to note that the PM filter assembly is heavier than a typical muffler.**

The PM filter includes ceramic materials; its care and handling require the following:

1. Do not drop or hammer.
2. Use appropriate equipment when lifting.
3. Protect from water intrusion.
4. Protect from accidental impacts.
5. Do not weld.
6. Protect flanges during transport (use the foam shipping covers).

**Attention:
Handle with care!**

The PM filter assembly creates backpressure on the engine

In the process of removing over 85% of the soot and ash from the exhaust, the PM filter creates backpressure on the engine. At times, the backpressure from the PM filter (and Skyline system as a whole) may be higher than the backpressure caused by a muffler. The actual amount of backpressure from the Skyline varies instantaneously depending on the engine speed and load and the soot and ash loading in the PM filter. The regeneration process removes the carbonaceous part of the soot and thereby lowers the backpressure.

Control System

The MLC controls the regeneration cycle and the system indicator lights (also referred to as the LED's). The meaning of each light and the appropriate actions for the operator to take in response to the lights are described in the "Operations" section of this manual (page 11).

The MLC also monitors engine conditions and the Skyline when the equipment is operating. The MLC turns on the flashing amber light to alert the operator when regeneration is required. In addition, the MLC continually logs operating data and records instances of unusual conditions.

If the operator neglects to regenerate the Skyline, the MLC will turn on a flashing red light. At this point, the operator may experience a loss of power from the engine. The flashing red light indicates that the Skyline is well past due for regeneration and that service is required immediately. Further prolonged operation could damage the emission control system and engine exhaust components.

The MLC and some electrical components of the Skyline system are housed in the Controls Box (Figure 3). The Air Pump Box (Figure 4) houses the regeneration air pump and the backpressure sensor. Note that both boxes can be connected to high voltage. Only trained technicians should open the boxes.



Figure 3: Controls Box.



Figure 4: Air Pump Box.

Low-Voltage Switch (Optional)

A low-voltage switch is an option for the Skyline for equipment that is operated intermittently. It is designed to disconnect power to the MLC in the event voltage drops to a set point. Once the engine is started, the low-voltage switch automatically resets and restores power to the MLC and Skyline system.

Regeneration System

The regeneration system cleans out the PM filter while the equipment is parked outdoors in a well ventilated location away from any combustible material. The primary components of the regeneration system are heating elements and an air pump. Over a controlled cycle, heat and air are provided to the PM filter to oxidize the collected soot. The regeneration process is controlled by the MLC. The operator must connect the power-supply receptacle (Figure 5) to the plug on the Skyline (Figure 6) whenever regeneration is needed. The engine starter is automatically locked out during the regeneration cycle so that the equipment cannot be accidentally driven off while plugged in.



Figure 5: Receptacle and power supply.



Figure 6: Power plug (on equipment).

Typical regeneration cycle

After the operator plugs in the Skyline in response to the flashing amber light, the MLC detects the AC power and initiates the regeneration cycle by turning on the electric heater and air pump. The pump blows air past the heaters to the PM filter causing the collected soot to oxidize. The heater turns off after four hours. The air pump continues to run another hour to cool down the PM filter. A complete cycle takes approximately five hours. If the equipment needs to be used before the regeneration cycle has completed, follow the guidance in the "Impact on Regeneration If Parked Less Than Five Hours" section on page 10.

Elapsed time between regenerations

Typically, the vehicle or equipment will operate approximately 8 to 32 hours between regeneration requests. The actual elapsed engine-on time between regenerations will depend on many factors including engine model, maintenance condition, engine load pattern, and operator behavior.

Immediate Regeneration Option

The MLC can be configured so that the Skyline is regenerated anytime it is plugged into AC power, whether or not the amber light is flashing. This setting is made through the *MLinC* program by a trained technician.

Impact on Regeneration If Parked Less Than Five Hours

If the equipment must be operated before the 5-hour cycle has been completed, then turn off the circuit breaker for the power supply and unplug the receptacle from the Skyline's plug before starting the engine. When the equipment returns from service, plug it in again (if the amber light is flashing) so the Skyline can go through a complete regeneration cycle. (Be sure the circuit breaker was turned back on.)



Attention: the PM filter assembly and exhaust may be very hot under these conditions. See the "Safety Warnings" section on page 2.

CARB-Verification Labels

The Skyline is provided with two CARB-verification labels. One is installed on the engine (Figure 7) and the other one is attached to the wiring harness at the Skyline's Controls Box (Figure 8). If either one is missing, order a replacement label from a Cleaire-authorized dealer and be sure to order the correct label for your application (see the table below the pictures).



Figure 7: Example (from Horizon) of CARB-verification label installed on engine.

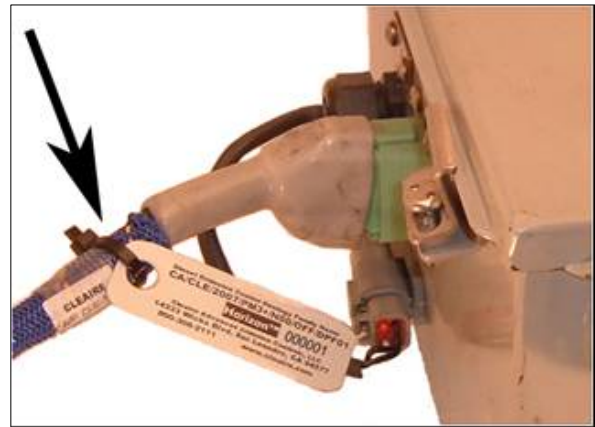


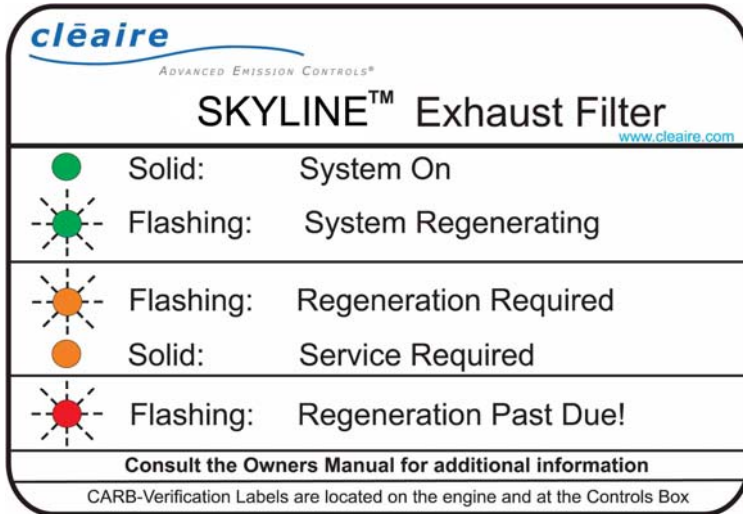
Figure 8: CARB-verification label attached to wiring harness at the Controls Box.

Product	Application	Verification Family Name	Label Part Number
Skyline	Off-road	CA/CLE/2007/PM3+/N00/OFF/DPF01	CUH-738-2

OPERATIONS

System Indicator Lights

The driver or operator must observe the Skyline system indicator lights on a regular basis and respond accordingly. Note: all the LED's will turn on briefly when the engine is first started. This allows a simple way for the operator to verify that all the lights are working.



The label placed next to the lights (Figure 9) provides a brief description of each light's meaning.

The light meanings are summarized in the table below (and are explained in greater detail after the table).

Figure 9: Label for system indicator lights (LED's).

Condition	Meaning	Action
1. Green LED is off (while engine is on)	Skyline needs service	Contact a Cleaire-authorized dealer for service.
2. Green LED is on solid	MLC [®] is on	No action required (unless indicated by the other lights).
3. Green LED flashing	Regeneration is in progress	Make sure engine is off. (Stay away from hot surfaces.)
4. Amber LED flashing	Skyline needs to be regenerated	With the engine off, connect the power-supply receptacle to the Skyline plug.
5. Amber LED on solid	Skyline needs service	Contact a Cleaire-authorized dealer for service.
6. Red LED flashing	Skyline is past due for regeneration	Follow the "Red Light – Flashing" instructions on page 13.

Green Light – Flashing

When the Skyline is regenerating, the green light flashes. A flashing green light indicates that regeneration is in progress and the equipment should not be operated.

CAUTION:

A flashing green light indicates that the system is regenerating and the Skyline is hot.

Amber Light – Flashing

If the amber light starts flashing, then the Skyline should be plugged in at the end of the shift. The complete regeneration process takes five hours.

ATTENTION:

A flashing amber light means that the Skyline should be plugged into the power-supply station.

Amber Light – On Solid

A solid amber light indicates a broken sensor, disconnected sensor or system fault. Contact a Cleaire-authorized dealer (or a properly trained technician under the owner's control) as soon as practical.

ATTENTION:

A solid amber light indicates that service is required.

Verify that all the wiring harness connections are properly attached. If the amber light stays on, have the system serviced as soon as possible. For some faults, the solid amber light can only be turned off by connecting the service computer to the MLC and performing software operations with the *MLinC* program.

The amber light will turn on solid for a few seconds after the engine starts. This allows the operator to confirm that the LED itself is good.

Red Light – Solid

A solid red light indicates that the MLC is damaged. Contact a Cleaire-authorized dealer (or a properly trained technician under the owner's control) as soon as practical.

Red Light – Flashing

A flashing red light alerts the operator that the Skyline is past due for regeneration. This condition may be caused by, but not limited to, excess diesel fuel, soot, engine lube oil, residual ash or foreign material in the exhaust system. See Figure 10 on page 14 for the proper response to the flashing red light.

WARNING:

***A flashing red light means that the Skyline is past due for regeneration.
Warranty coverage may be denied due to neglect.***

In some cases, the flashing red light will come on because the operator did not respond to the amber light (flashing or solid) in a timely manner. Ignoring the amber light (flashing or solid) to the point that the flashing red light comes on may be grounds for denying a warranty claim. In other cases, the flashing red light is a result of another failure in the system or engine such as a fuel injector failure.

In some applications, the particular engine and duty cycle cause the red light to routinely come on near the end of the route. In these cases, it is acceptable to finish the route and regenerate the Skyline when it returns to the yard. For all other cases, the engine, exhaust system and Skyline should be inspected for damage and repairs made as needed before the equipment is put back into use. Continuing to operate the engine with a flashing red light may result in damage to the engine, exhaust system or Skyline and may be the basis for denying a warranty claim.

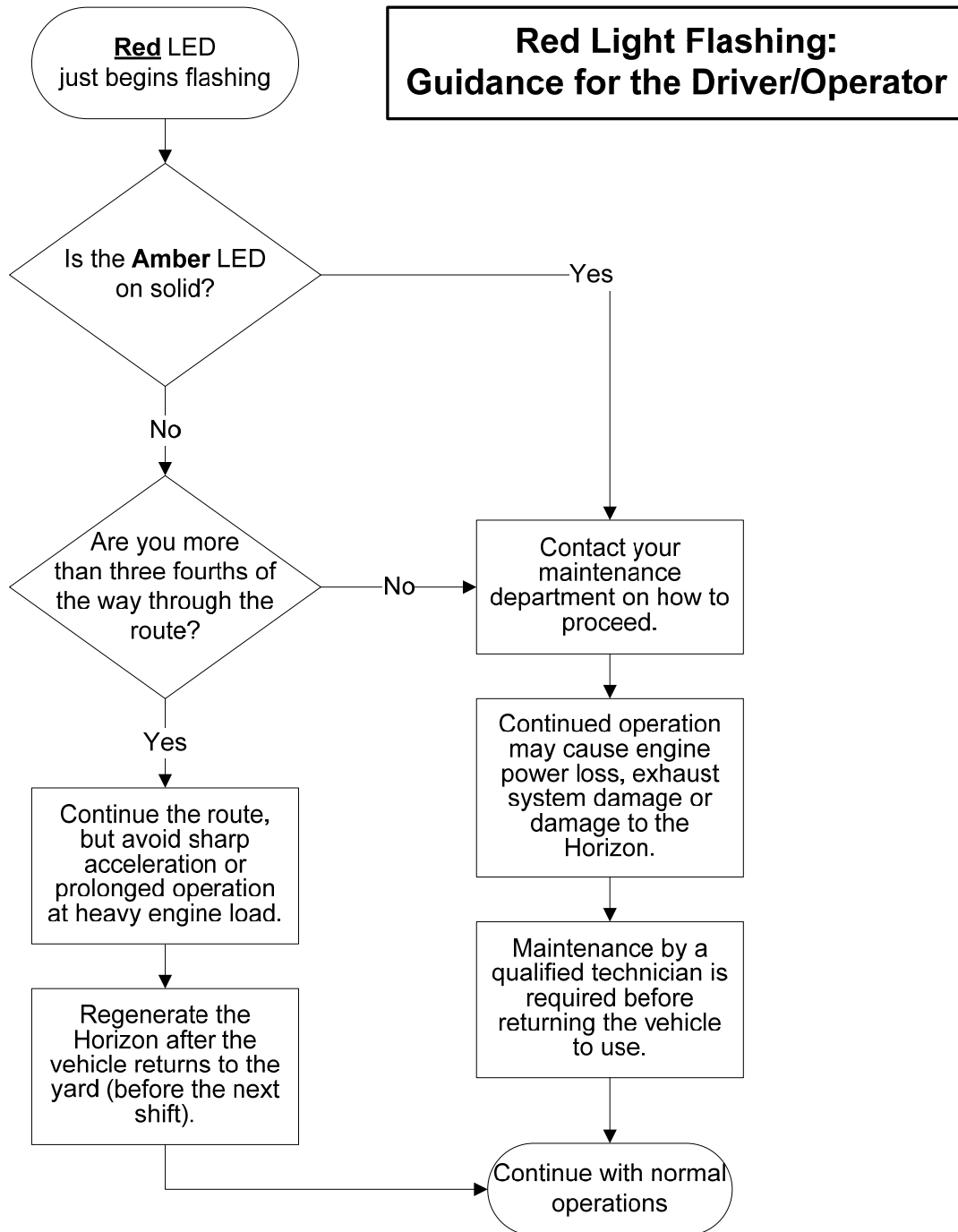


Figure 10: Red light flashing guidance for the operator or driver.

Regenerating the Skyline

The amber light flashes to alert the operator when regeneration is required. The regeneration system is described in detail beginning on page 9. Be sure to do the following:



- **Park the equipment in a well ventilated outdoor location away from any combustible material.**
- **Before plugging in the Skyline, always be sure the electric power cord, receptacle, and plug are in good condition and are not damaged.**
- **Be sure the power-supply is the correct voltage for the Skyline (208 VAC and 240 VAC power ARE NOT INTERCHANGEABLE). Damage to the system caused by plugging in the incorrect voltage may be grounds for denying a warranty claim.**
- **Push the receptacle completely onto the plug. If it does not seat fully, lubricate the plug and receptacle (see “Power Plug and Receptacle Lubrication,” page 18.)**
- **After regeneration is finished, be sure to screw the covers back on the plug and receptacle.**

After the equipment is parked, the operator should plug the power-supply station receptacle (Figure 5) into the Skyline power plug (Figure 6) on the equipment. A complete regeneration cycle takes five hours. The heating portion takes four hours and the equipment may be used after that time as long as the operator follows the steps in the “Impact on Regeneration If Parked Less Than Five Hours” section on page 10 and heeds the “Safety Warnings” on page 2.

Pay Attention to Skyline, Engine and Equipment

In addition to the green, amber and red indicator lights, the owner or operator should observe the Skyline, engine and equipment’s operation. Use the Troubleshooting Table (page 22) if you suspect the engine or Skyline are not operating properly. Contact a Cleaire-authorized dealer (or a properly trained technician under the owner’s control) when needed.

1. Inspect the Skyline’s power cord, receptacle, and plug for integrity each time they are used. Note anything abnormal and have repairs made if needed. Contact a qualified electrician or Cleaire-authorized dealer as needed. Also, be sure the warning tag is attached to the receptacle (Figure 11). If the tag is missing, order a replacement tag from Cleaire.



Figure 11: Power-supply receptacle with warning tag.

2. Contact a Cleaire-authorized dealer (or the owner's technician) if any soot emissions from the Skyline clamps or tailpipe are observed during engine operation.
3. Periodically inspect the exhaust system for integrity. Note anything abnormal and make repairs as warranted. For vertical exhaust stacks, **make sure the turn out stack or rain cap is in place** and functioning properly. Contact a Cleaire-authorized dealer as needed.

Conditions That May Damage the System

The operator should be aware of conditions that could result in damage or failure of the PM filter assembly or Skyline system. If any of these events occur, it is the owner's responsibility to have the Skyline inspected and, if necessary, repaired.



See the owner's legal requirements under the Clean Air Act and CARB regulations in the "Owner's Legal Obligations" section on page 3.

Mechanical damage can occur if any system component is mishandled or accidentally impacted. Internal damage to the PM filter assembly can occur from various forms of engine failure such as losing a turbo or head gasket. These events would cause foreign debris to enter the exhaust gas and then impact the PM filter assembly, likely causing some damage. Furthermore, losing a turbo, a failed injector, or a major oil leak could result in excessively high temperatures in the PM filter. If the engine loses the turbo, the driver should pull off the road as soon as possible and shut the engine off.

Engine oil consumption has an impact on the operation and maintenance of the Skyline. If engine oil consumption exceeds the engine manufacturer's specification, the engine should be repaired. Failure to do so may damage the Skyline and may be the basis for denying a warranty claim. High oil consumption will increase the rate of ash accumulation in the PM filter and will lead to more frequent maintenance. The "Engine Oil Consumption and Lube Oil Ash" section on page 24 explains the impacts of oil consumption and ash content on the operations and maintenance of the system.

Power washing the equipment should not be a problem for the PM filter assembly or Skyline system. Avoid pointing the high-power wash at any Skyline system components or connectors. However, depending on the power washing technique, it may be possible to loosen an electrical connector. If a connector comes loose, the amber LED might turn on. If the amber light comes on, follow the procedures in the Troubleshooting Table (page 22).

Turn out stacks or rain caps are required on vertical stacks to avoid water intrusion. Be sure the turn out or rain cap is in place and functioning properly. It is important that water does not enter the exhaust pipe where it could migrate to the PM filter. Avoid low hanging branches or other obstacles that could knock off the rain cap.

MAINTENANCE AND REPAIR

Maintenance Schedule

Cleaire recommends that a Cleaire-authorized technician or a properly trained technician under the owner's control perform the maintenance and repair of a Skyline. Preventative maintenance is required once a year, every 2,000 operating hours, or every 50,000 miles (whichever comes first) to ensure that the system is maintained in good operating condition.



The owner is legally required to keep the Skyline in good operating condition in order to comply with the Clean Air Act and CARB regulations (for systems operating in California). See the "Owner's Legal Obligations" section on page 3.

Failure to have the preventative maintenance performed may be the basis for denying a warranty claim. Maintenance or repairs done by anyone other than a Cleaire-authorized technician is the responsibility of the person or organization performing the work. The cost of parts and labor for preventative maintenance are not included in the purchase price of the Skyline system.

Preventative Maintenance

The preventative maintenance by a Cleaire-authorized technician includes:

- Download data from the MLC and review the Instant Report.
- Confirm the system indicator lights are functioning properly.
- Inspect the Air Pump Box and components. Replace the air filter.
- Inspect and clean the air-supply tubing.
- Inspect the Controls Box and components.
- Inspect the sensors and wiring harness.
- Inspect and clean the DPF.
- Inspect the heater module.
- Inspect exhaust tubing.
- Reinstall the PM filter assembly and confirm it is properly mounted.
- Upgrade the MLC program if necessary.
- Make repairs (if any of the above inspections showed repairs are needed).
- Perform comprehensive tests of the system's operations.

Power Plug and Receptacle Lubrication

Cleaire recommends that the owner lubricates the Skyline power plug and receptacle often. The connector pins and sockets should be inspected and cleaned, if necessary, of any sand, dirt, or corrosion before applying the lubricant. Lubricating the Skyline plug and receptacle on a regular basis makes it easy to plug and unplug and ensures good electrical contact. Cleaire recommends CorrosionX spray lubricant which is available in aerosol (P/N CUT-118-6) or pump (P/N CUT-118-16) containers (Figure 12).



Figure 12: CorrosionX spray lubricant.

Follow all the manufacturer's instructions. Lubricate both the plug pins and receptacle sockets as shown in Figure 13 and Figure 14. Wipe up any excess with a shop rag.



Figure 13: Lubricate the plug.



Figure 14: Lubricate the receptacle.

PM Filter Maintenance

It may be necessary to periodically clean the PM filter (in addition to the cleaning during preventative maintenance) depending on the equipment's driving cycle and the ash content of the diesel fuel and lube oil. The collection of inorganic ash results in an increase in backpressure from the PM filter over time. If ash in the PM filter results in high backpressure then the amber light will flash. If the light begins flashing soon after regeneration, then it is likely that the PM filter will need cleaning on the Cleaire filter-cleaning machine. Note: higher than normal oil consumption will increase the rate of ash accumulation in the PM filter, and thus may require more frequent maintenance.

Cleaire recommends the use of low ash engine oils. These products have been specifically designed for use with a PM filter, and can significantly reduce the build up of ash in the PM filter and extend the filter cleaning interval. See the "Engine Oil Consumption and Lube Oil Ash" section on page 24.

A Cleaire-authorized dealer can clean the PM filter. They also will ensure that the collected material (ash and soot) is properly disposed in accordance with all applicable Federal, State and local laws governing waste disposal.

The PM filter assembly is designed to process exhaust flow in only one direction. The order of the heater module and PM filter module within the assembly is critical for the proper operation of the Skyline system. If any sections are disassembled for maintenance (or any other reason), be sure that they are reinstalled in their proper position and flow direction.

Exhaust Tubing and Components

All tubing connections between the engine and the PM filter assembly should be maintained in a gas-tight and leak-free manner. Also, all tubing between the engine and PM filter assembly must be maintained in good condition. This requirement includes any other components such as exhaust brakes. Aluminized mild steel tubing or rusty tubing could flake off into the exhaust stream. If flaking occurs, the PM filter may plug, resulting in high backpressure and engine power loss. Cleaire recommends stainless steel tubing between the turbo and the PM filter assembly. **It is the engine owner or operator's responsibility to ensure that all tubing in this critical area be maintained in good condition.**

Service Calls

The MLC[®] controls the green, amber and red indicator lights to provide system status as described in the “System Indicator Lights” section (page 12). However, not all conditions will be detected by the MLC[®] (for example, a traffic accident that physically damages the PM filter assembly). Therefore, it is important that the owner and/or operator routinely observe the engine and Skyline operations in addition to watching the lights. See the “Operations” section (page 11) for routine observations that the driver and/or owner should perform and the “Owner’s Obligations” section on page 28.

Upon any indication of a malfunction, promptly contact a Cleaire-authorized dealer (or the owner’s technician). Please be prepared with the following information:

1. Fault information and descriptions in as much detail as possible.
2. The data plate part number and serial number (see Figure 15 and Figure 16).

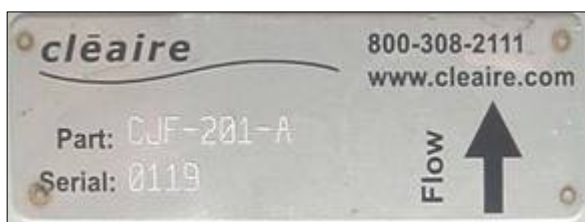


Figure 15: PM Filter (DPF) data plate.

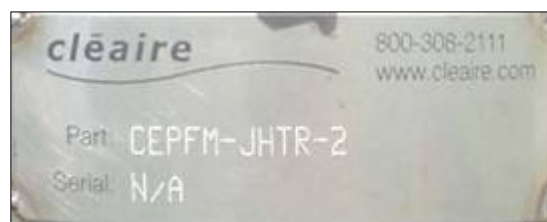


Figure 16: Heater Module data plate.

Parts List

A complete parts list was provided with the system. Contact your Cleaire-authorized dealer if you need a replacement list. The major parts are listed in the table below.

Skyline™ System Major Parts List

Item #	Qty	Part Number	Description
1	1	CJF-__ __ -__	Diesel particulate filter assembly
2	1	CJ__ __ -__ -AP__	Cone, inlet
3	1	CHZ-OCJ__ __ -__	Cone, outlet
4	1	CEPFM-JHTR-__ -__	Heater module
5	1	CMA-4	Sensor, thermocouple
6	1	CMKS-5.0B	MLC (electronic control unit)
7	1	CUE-45	Sensor, Backpressure
8	1	CCB3-1-__ __ __ -__	Controls Box
9	1	CEPFM-AC2-1	AC module
10	1	CPB1-__	Air pump
11	1	CUH-738-2	Label, Verification, Skyline (2 labels: 1 at controls box and 1 attached to engine)

Spaces represent variables depending on specific configuration and application.

Troubleshooting Table

Use the table below to diagnose and resolve potential Skyline operating problems. Most abnormal conditions will require service or repair by a Cleaire-authorized technician (or a properly trained technician under the owner's control).

See the "System Indicator Lights" section on page 12 for additional information.

Condition	Probable Cause	Remedy
1. Green LED off (while engine is on)	<ul style="list-style-type: none"> No power to MLC Loss of MLC program (if amber on and green off) Faulty LED or wiring 	<ul style="list-style-type: none"> Check fuse, wires and power source (battery). Contact a Cleaire-authorized dealer for repair.
2. Amber LED flashing again soon after a regeneration	<ul style="list-style-type: none"> PM filter is loaded with ash Engine operating conditions have changed to cause increased soot emissions 	<ul style="list-style-type: none"> Try regenerating again. If the problem persists, clean the PM filter. Check engine for excessive smoke or a bad injector.
3. Unusual exhaust noises	<ul style="list-style-type: none"> Loose tubing connection(s) Loose clamp(s) Crack in exhaust tube Crack in PM filter Engine turbo problem 	<ul style="list-style-type: none"> Tighten connection(s). Replace damaged tube. Contact a Cleaire-authorized dealer for repair.
4. White smoke during startup	<ul style="list-style-type: none"> Normal condensation inside the PM filter 	<ul style="list-style-type: none"> No action required.
5. Light soot dusting in exhaust tube	<ul style="list-style-type: none"> Normal condition 	<ul style="list-style-type: none"> No action required.
6. Visible emissions (white or black smoke during normal operations)	<ul style="list-style-type: none"> Engine problem resulting in oil or coolant loss PM filter failure Normal at first start up after regeneration or cleaning 	<ul style="list-style-type: none"> Contact a Cleaire-authorized dealer for repair. None required (if only visible at first start up after regeneration or cleaning).
7. Engine surges or has power loss	<ul style="list-style-type: none"> Engine malfunction (most likely cause) Overloaded PM filter (amber or red LED will have been flashing for some time if this is the cause of engine surging or low power) 	<ul style="list-style-type: none"> Repair the engine. If the engine passes all its diagnostic tests and regenerating the Skyline does not solve the low power problem, then contact a Cleaire dealer for service. (PM filter will likely need cleaning.)

There is additional troubleshooting information in the Horizon and Skyline Service Manual and the Horizon and Skyline Troubleshooting Manual. These manuals are for trained technicians.

Repair and Maintenance Clarifications

The warranty (page 30) includes a section titled “Owner’s Warranty Responsibility” which clarifies that the owner or operator is responsible for making sure that the maintenance described in this owner’s manual is performed. In addition to the annual maintenance, the amber light is another indicator that maintenance or repair is required.

ATTENTION:

The amber light indicates that service is required.

Cleaning the PM filter is a maintenance item and is not covered under warranty. If a repair is required, it may be covered under the installation or product warranty depending on the cause.

The table below provides a summary of service types (maintenance or repair) and what organization is responsible for the cost of the service.

Service Type (and subtype)		Definition/Example	Cost Responsibility
Maintenance	(unplanned)	High backpressure from PM filter overloaded with ash.	Owner
	(regularly planned)	High backpressure from PM filter overloaded with ash.	Owner
	(comprehensive preventative maintenance)	Clean out ash from the PM filter. Perform multi-step complete system check out.	Owner
Repair	(warrantable)	System or component fails in normal application.	Cleaire
	(warrantable)	System or component failed because it was installed improperly.	Installer
	(non-warrantable)	System or component damaged through abuse, neglect, or misapplication. Warranty period has lapsed.	Owner

Engine Oil Consumption and Lube Oil Ash

Claire recommends that Skyline owners monitor the oil consumption of their engines and know the ash content of the engine oil to ensure that the PM filter is scheduled for cleaning before it becomes overloaded with ash. This section of the manual provides information to extend the filter cleaning interval of the PM filter.

PM filters are designed to capture all solid particles coming from the tailpipe. While most of the captured material can be readily regenerated (oxidized) inside the filter, the PM filter will accumulate incombustible materials, collectively called “ash,” which cannot be regenerated and must be removed through offline cleaning.

The majority of the ash comes directly from oil consumed during engine operation, though small amounts of ash also come from the fuel and engine wear. Most of the ash that accumulates in PM filters is part of the lube oil additive package, and since the PM filter will capture all solid materials coming from the engine exhaust, all the ash from oil consumption will ultimately end up in the PM filter. Thus, the ash content of the lube oil and the oil consumption rate become critical factors in determining the rate of ash accumulation in the filter.

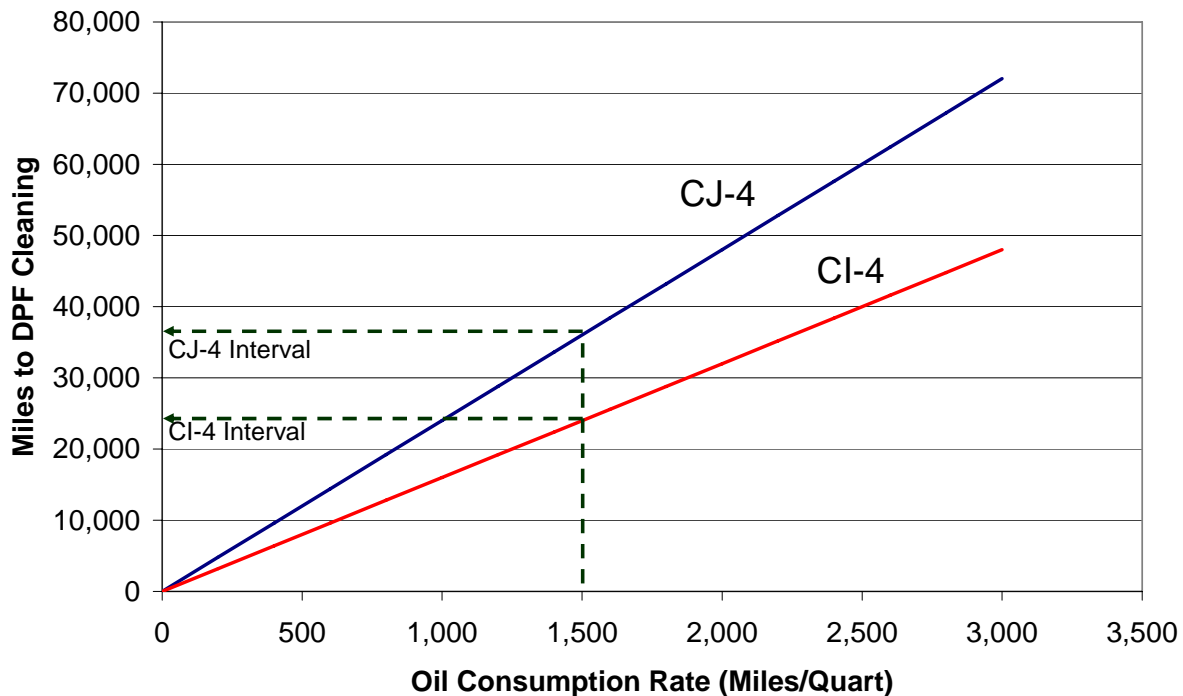
It is important to note that once the PM filter captures approximately 200 grams (about 7 ounces) of ash, it will no longer be possible to remove all the ash from the filter using existing cleaning techniques. Therefore, it is important to proactively clean your PM filter based on 1) oil consumption rate, and 2) lube oil ash content.

Pre-2007, CI-4 oil typically contains between 1.2 and 1.5% ash by weight. The new CJ-4 oils, designed specially for diesel engines with PM filters, contain approximately 1.0% ash, and will therefore result in a lower filter loading for a given amount of oil consumption. Given the ash content, the filter must be cleaned once the equipment has consumed the following amount of oil:

Every 24 Quarts with CJ-4
Every 16 Quarts with CI-4

Using the ash content of these oils, the service intervals shown in Figure 17 are recommended to ensure optimum performance and cleanability of the PM filter.

DPF Cleaning Interval for CI-4 and CJ-4 Oils



**Figure 17: PM filter cleaning interval as a function of oil consumption rate (for a typical well maintained engine).
(The relationship is similar for oil consumption in operating hours per quart.)**

The values presented above are provided as estimations and may not apply to all filters in all applications. Factors like engine duty cycle, soot composition, ash composition and others can also have an impact on the filter cleaning interval. Furthermore, the guide applies only to ash accumulation in the filter; if the engine does not meet the temperature requirements for regeneration or if there are excessive soot emissions (e.g., from a failed injector), more frequent filter cleaning may be required to remove the soot.

Claire, as an industry leader in filter cleaning techniques, continues its efforts to improve its cost-effective filter cleaning solutions. As these techniques improve, we expect to be able to clean filters with ash loadings greater than 200 grams, thereby extending the cleaning interval beyond the values described above.

In summary, to ensure that the PM filter is fully cleanable, Claire recommends that the customer monitor their oil consumption rate and schedule filter cleaning before the filter has accumulated 200 grams of ash. Customers can extend their filter cleaning interval by:

- Maintaining their engines to minimize oil consumption
- Switching to low ash oils

SPECIFICATIONS

Skyline System	
Total Weight	100 pounds
Materials of Construction	304 and 316 stainless steel and silicon carbide
Diesel Fuel Type (same as equipment fuel)	CARB #2 diesel, ULSD and biodiesel up to B20
Power Consumption (max. during regen.)	2.8 kW

Cleaire MLC[®]	
Voltage	9 to 15 VDC (12 V nominal)
Real time clock	Battery-backed
Diagnostic and Programming I/O	9-pin DBF Serial (RS-232) (adapter from harness required)
Inputs	
PM Filter Assembly Inlet Temperature	Type K thermocouple, ungrounded
Engine RPM Sensor (Frequency)	0.5 to 12 kHz
Engine Electrical Power (Battery Voltage)	9 to 15 VDC (12 V nominal)
PM Filter Assembly Backpressure Sensor	0 – 5 VDC
Outputs	
Power Relay	12 VDC
Two Power Output Lines	5 VDC
Regeneration in-progress indicator	Green LED flashing
Regeneration requested indicator	Amber LED flashing
Skyline system service indicator	Amber LED on solid
Excessively high backpressure indicator	Red LED flashing

Power-Supply Station*	
Required power delivery to Skyline plug	2800 watts
Nominal Voltage – standard system	208 VAC at 60Hz
Nominal Voltage – optional 240 system	240 VAC at 60Hz
Voltage Variance	+/- 5 V (at Skyline plug while under load)
Station Quantity	One for each Skyline that will be plugged in at the same time.

*Note: the power-supply station is the responsibility of the customer and their electrical contractor. Copies of the Power-Supply Station Installation and Maintenance Guide are available upon request from a Cleaire-authorized dealer. Voltages that do not meet the specification may damage the system. A transformer may be used to achieve the specified voltage.

OWNER'S OBLIGATIONS

The owner's actions in the table below are mandatory for proper system operation. Failure to do the required action(s) could be the basis for denying a warranty claim or a fine by CARB.

Event or Symptom	Owner's Action Item	Manual Section
Initial installation of Skyline system.	Review this manual and know the requirements for the Skyline system. Keep a copy of this manual in the equipment at all times. Be sure that drivers and maintenance staff understand each item in the "Operations" section.	This entire manual. "Operations" (page 11).
Flashing amber light (Skyline needs to be regenerated)	At the end of the shift, park the equipment, turn off the engine, and plug in the Skyline to the power-supply station.	"Regenerating the Skyline" (page 15).
Solid amber light (bad sensor or system fault).	Contact a properly trained technician as soon as practical.	"System Indicator Lights" (page 12).
Flashing red light.	Contact a properly trained technician as soon as practical.	"System Indicator Lights" (page 12).
Engine malfunction (such as turbo failure, injector failure, excess oil consumption, or leaky head gasket).	If the turbo fails, get off the road safely ASAP and shut the engine off. Contact a properly trained technician promptly. (Skyline or system components may be damaged from foreign material.)	"Conditions That May Damage the System" (page 15).
Road debris or other object impacts Skyline system or components.	Contact a properly trained technician promptly since system components may be damaged, including hidden damage to internal components.	"PM Filter Assembly" (page 6) and "Conditions That May Damage the System" (page 15).
Tubing or exhaust component (turbo or exhaust brake, for example) between the engine and the PM filter assembly is removed, replaced or in poor condition.	Ensure that the tubing or component is installed properly and that no debris could enter the exhaust stream. (Debris or foreign matter in the exhaust stream can damage the PM filter or system components. Also, exhaust leaks may result in poor system performance and safety hazards.)	"Exhaust Tubing and Components" (page 20).
For a vertical exhaust stack, the rain cap or turn out stack is knocked off or somehow missing.	Replace the rain cap or turn out stack immediately. If any water entered the exhaust pipe then contact a properly trained technician immediately.	"PM Filter Assembly" (page 6) and "Conditions That May Damage the System" (page 15).
Oil consumption is more than the engine manufacturer's specification.	Repair the engine so that oil consumption is within the manufacturer's specification.	"Conditions That May Damage the System" (page 15) and "Engine Oil Consumption and Lube Oil Ash" (p. 24).
Oil consumption rate.	Monitor and keep accurate records of the engine's oil consumption rate.	CARB Executive Order for the Skyline (p. 33).

WARRANTY

Product Warranty

YOUR WARRANTY RIGHTS AND OBLIGATIONS

Cleaire Advanced Emission Controls (Cleaire) warrants the diesel emission control system in the application for which it is sold or leased to be free from defects in design, materials, workmanship, or operation of the diesel emission control system which cause the diesel emission control system to fail to conform to the emission control performance level it was verified to, or to the requirements in the California Code of Regulations, Title 13, Sections 2700 to 2706, and 2710, for the periods of time listed in Table 1, provided there has been no abuse, neglect, or improper maintenance of your diesel emission control system, vehicle or equipment, as specified in the owner's manuals. Where a warrantable condition exists, this warranty also covers the engine from damage caused by the diesel emission control system, subject to the same exclusions for abuse, neglect or improper maintenance of your vehicle or equipment. Please review your owner's manual for other warranty information. Your diesel emission control system may include a core part (e.g., particulate filter, diesel oxidation catalyst, selective catalytic reduction converter) as well as hoses, connectors, a back pressure monitor (if applicable), and other emission-related assemblies. Where a warrantable condition exists, Cleaire will repair or replace your diesel emission control system at no cost to you including diagnosis, parts, and labor.

Table 1: Warranty Period

Engine Type	Engine Size	Warranty Period
On-Road	Light heavy-duty, 70 to 170 hp, Gross Vehicle Weight Rating (GVWR) less than 19,500 lbs.	5 years or 150,000 miles
	Medium heavy-duty, 170 to 250 hp, GVWR from 19,500 lbs. to 33,000 lbs.	
	Heavy heavy-duty, exceeds 250 hp, GVWR exceeds 33,000 lbs.	
	Heavy heavy-duty, exceeds 250 hp, GVWR exceeds 33,000 lbs., and the truck is: 1. Typically driven over 100,000 miles per year, and 2. Has less than 300,000 miles on the odometer at the time of installation.	2 years, unlimited miles
Off-Road (includes portable engines) and Stationary	Under 25 hp, and for constant speed engines rated under 50 hp with rated speeds greater than or equal to 3,000 rpm	3 years or 1,600 hours
	At or above 25 hp and under 50 hp	4 years or 2,600 hours
	At or above 50 hp	5 years or 4,200 hours

WARRANTY COVERAGE

For an engine used in an application listed in Table 1, the warranty period will be the years or hours or miles of operation shown in Table 1, whichever occurs first. If any emission-related part of your diesel emission control system is defective in design, materials, workmanship, or operation of the diesel emission control system thus causing the diesel emission control system to fail to conform to the emission control performance level it was verified to, or to the requirements in the California Code of Regulations, Title 13, Sections 2700 to 2706, and 2710, within the warranty period, as defined above, Cleaire will repair or replace the diesel emission control system, including parts and labor.

In addition, Cleaire will replace or repair the engine components to the condition they were in prior to the failure, including parts and labor, for damage to the engine proximately caused by the verified diesel emission control strategy. This also includes those relevant diagnostic expenses in the case in which a warranty claim is valid. Cleaire may, at its option, instead pay the fair market value of the engine prior to the time the failure occurs.

OWNER'S WARRANTY RESPONSIBILITY

As the vehicle, engine, or equipment owner, you are responsible for performing the required maintenance described in your owner's manual. Cleaire recommends that you retain all maintenance records and receipts for maintenance expenses for your

vehicle, engine, or equipment, and diesel emission control system. If you do not keep your receipts or fail to perform all scheduled maintenance, Cleaire may have grounds to deny warranty coverage. You are responsible for presenting your vehicle, equipment, or engine, and diesel emission control system to a Cleaire dealer as soon as a problem is detected. The warranty repair or replacement should be completed in a reasonable amount of time, not to exceed 30 days. If a replacement is needed, this may be extended to 90 days should a replacement not be available, but must be performed as soon as a replacement becomes available.

If you have questions regarding your warranty rights and responsibilities, you should contact Cleaire at 1-800-308-2111 or the California Air Resources Board at 9528 Telstar Avenue, El Monte, California 91731, or (800) 363-7664, or electronic mail: helpline@arb.ca.gov.

Installation Warranty

YOUR WARRANTY RIGHTS AND OBLIGATIONS

The Cleaire-authorized installer must warrant that the installation of a diesel emission control system is free from defects in workmanship or materials which cause the diesel emission control system to fail to conform to the emission control performance level it was verified to, or to the requirements in the California Code of Regulations, Title 13, Sections 2700 to 2706. The warranty period and the extent of the warranty coverage provided by the Cleaire-authorized installer must be the same as the warranty provided by Cleaire, and the same exclusions apply.

OWNER'S WARRANTY RESPONSIBILITY

As the vehicle, engine, or equipment owner, you are responsible for presenting your vehicle, engine, or equipment, and diesel emission control system to the Cleaire-authorized installer as soon as a problem with the installation is detected.

If you have questions regarding your warranty rights and responsibilities, you should contact a Cleaire-authorized installer or Cleaire at 1-800-308-2111 or the California Air Resources Board at 9528 Telstar Avenue, El Monte, California 91731, or (800) 363-7664, or electronic mail: helpline@arb.ca.gov.

Cleaire Warranty Clarifications

(Which do not limit or modify the provisions of the Product Warranty or Installation Warranty in any way)

The product warranty above is the sole warranty made by Cleaire Advanced Emission Controls, LLC. There are no other warranties, expressed or implied, of merchantability or fitness for a particular purpose.

For the purpose of the product warranty and installation warranty, abuse or neglect includes vehicle accidents, ignoring the system indicator lights, blending lubricating oil with fuel, or any engine failure or condition that are not proximately caused by the diesel emission control system that allows excess lubricating oil, coolant, contaminants or debris to enter the exhaust system. The owner shall not use any fuel additive or lube oil additive that is not approved by EPA or CARB for use in diesel engines equipped with catalytic mufflers.

Cleaire recommends that the verified diesel emissions control strategy be installed and serviced by Cleaire authorized personnel. Improper installation or service by unauthorized or untrained personnel may result in a denial of coverage under the product warranty or installation warranty.

CARB EXECUTIVE ORDER FOR THE SKYLINE



Linda S. Adams
Secretary for
Environmental Protection

Air Resources Board

Robert F. Sawyer, Ph.D., Chair
9480 Telstar Avenue, Suite 4
El Monte, California 91731 www.arb.ca.gov



Arnold Schwarzenegger
Governor

January 26, 2007

Mr. Tom Swenson
Cleaire Advanced Emission Controls
14775 Wicks Boulevard
San Leandro, California 94577

Reference No. RAS-07-02

Dear Mr. Swenson:

Using the Verification Procedure, Warranty and In-Use Compliance Requirements for In-Use Strategies to Control Emissions from Diesel Engines (Procedure), Air Resources Board (ARB) staff reviewed your application for conditional verification of the Cleaire Horizon Electric Particulate Filter (Horizon) for use with off-road diesel engines. Based on an evaluation of the data provided, and pursuant to the terms and conditions specified below, ARB hereby finds that the Horizon reduces emissions of diesel particulate matter (PM) consistent with a Level 3 device (greater than or equal to an 85 percent reduction). ARB also finds that the Horizon satisfactorily completed at least 33 percent of the durability demonstration period for off-road diesel engines. Accordingly, ARB determines that the system merits conditional verification and, subject to the terms and conditions specified below, classifies the Horizon as a Level 3 system for off-road applications that use diesel engines.

The Horizon is compliant with the 2009 nitrogen dioxide emissions limit and as such is designated as a "Plus" system per section 2702(f) of the Procedure.

The aforementioned conditional verification is subject to the following terms and conditions:

- The Horizon is conditionally verified for a period not to exceed three years from the date of this letter. For the Horizon to be considered for full verification, Cleaire must complete all remaining requirements as specified in the letter RAS-07-01 within three years of the date of this letter.
- Conditional verification is equivalent to verification for the purposes of satisfying the requirements of in-use emission control regulations.
- The engine must be certified to a PM emission level equal to or less than 0.4 grams per brake horsepower-hour.

The energy challenge facing California is real. Every Californian needs to take immediate action to reduce energy consumption. For a list of simple ways you can reduce demand and cut your energy costs, see our website: <http://www.arb.ca.gov>.

California Environmental Protection Agency

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Mr. Tom Swenson

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- The engine must be model year 2007 or older.
- The engine must not have a displacement greater than 15 liters.
- The engine must not employ exhaust gas recirculation.
- The engine must not have a pre-existing diesel oxidation catalyst from the original equipment manufacturer.
- The engine must not have a pre-existing diesel particulate filter from the original equipment manufacturer.
- The engine can be mechanically or electronically controlled.
- The engine should be well maintained and not consume lubricating oil at a rate greater than that specified by the engine manufacturer.
- Lubricating oil, or other oil, should not be mixed with the fuel.
- The product must not be used with any other systems or engine modifications without ARB and manufacturer approval.
- The other terms and conditions specified below.

It is also ordered and resolved that installation of the Horizon, manufactured by Cleaire Advanced Emission Controls, LLC, 14775 Wicks Boulevard, San Leandro, California 94577, has been found not to reduce the effectiveness of the applicable vehicle pollution control system, and therefore, the Horizon is exempt from the prohibitions in section 27156 of the Vehicle Code for installation on off-road equipment. This exemption is only valid provided the engines meet the aforementioned conditions.

ARB reserves the right in the future to review this conditional verification letter and the exemption provided herein to assure that the exempted and conditionally verified add-on or modified part continues to meet the standards and procedures of Title 13, sections 2222, et seq and sections 2700 through 2710, of the California Code of Regulations (CCR).

The Horizon consists of a non-catalyzed silicon carbide wall-flow diesel particulate filter, electric heating element, air pump, and an electronic control system. All necessary hardware and controls are installed on the vehicle, requiring only off-board electric power to supply energy to the heater. The major components of the Horizon are identified in Attachment 1.

No changes are permitted to the device. ARB must be notified, in writing, of any changes to any part of the Horizon. Any changes to the device must be evaluated and approved by ARB. Failure to do so shall invalidate this conditional verification.

Changes made to the design or operating conditions of the Horizon, as exempted by ARB, which adversely affect the performance of the vehicle's pollution control system, shall invalidate this conditional verification.

Mr. Tom Swenson

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Marketing of the Horizon using identification other than that shown in this conditional verification letter or for an application other than that listed in this conditional verification letter shall be prohibited unless prior approval is obtained from ARB.

This conditional verification shall not apply to any Horizon advertised, offered for sale, sold with, or installed on a motor vehicle prior to or concurrent with transfer to an ultimate purchaser.

ARB estimates that the Horizon has no significant effect on average fuel economy.

As specified in the Procedure, ARB assigns each diesel emission control strategy a family name. The designated family name for the conditional verification as outlined above is:

CA/CLE/2007/PM3+/N00/OFF/DPF01.

Additionally, as stated in the Procedure, Cleaire is responsible for honoring the required warranty (section 2707) and conducting in-use compliance testing (section 2709).

This conditional verification is valid provided that the diesel fuel used in conjunction with the device complies with Title 13, CCR, sections 2281 and 2282, and if biodiesel is used, the biodiesel blend shall be 20 percent or less subject to the following conditions:

- The biodiesel portion of the blend complies with the American Society for Testing and Materials (ASTM) specification D6751 applicable for 15 ppm sulfur content;
- The diesel fuel portion of the blend complies with Title 13, CCR, sections 2281 and 2282;
- The use of biodiesel applies to devices verified to reduce only diesel particulate matter; and
- Other alternative diesel fuels such as, but not limited to, ethanol diesel blends and water emulsified diesel fuel are excluded from this conditional verification.

Systems conditionally verified in this letter shall conform to all applicable California emissions regulations.

This conditional verification does not release Cleaire from complying with all other applicable regulations.

Violation of any of the above conditions shall be grounds for revocation of this conditional verification.

Mr. Tom Swenson

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Thank you for participating in ARB's diesel emission control strategy verification program. If you have any questions or comments, please contact Ms. Shawn Daley, Manager at (626) 575-6972 or by email to sdaley@arb.ca.gov.

Sincerely,

/s/

Robert H. Cross, Chief
Mobile Source Control Division

Attachment

cc: Ms. Shawn Daley, Manager
Retrofit Assessment Section

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clēaire

ADVANCED EMISSION CONTROLS®

Claire Advanced Emission Controls, LLC
14333 Wicks Blvd.
San Leandro, CA 94577-6719
1-800-308-2111