# SEF Muffler System Delivers the Highest PM Reduction


NOW AVAILABLE for EGR Engines up to 400 HP

## Level 3+ Retrofit Emissions Solution

Clean Diesel Group offers a semi-active DPF system that is effective on a broad range of vehicle duty cycles and engines. Just connect to the automated DPF Regeneration Station overnight for routine DPF cleaning.

SEF (Semi-active Electric Filter) Mufflers are designed and verified for on-road EGR and non-EGR 1991-2006 MY engines.*

*Engine families listed on CARB Verification Attachment 1

# A Semi-active DPF System

## Clean Diesel Group SEF Muffler System

The Clean Diesel Group SEF Muffler System is designed to reduce emissions from in-use diesel engines. Besides reducing diesel particulate matter (PM) emissions by over 90%, the SEF Muffler is also effective at reducing hydrocarbon and carbon monoxide emissions.

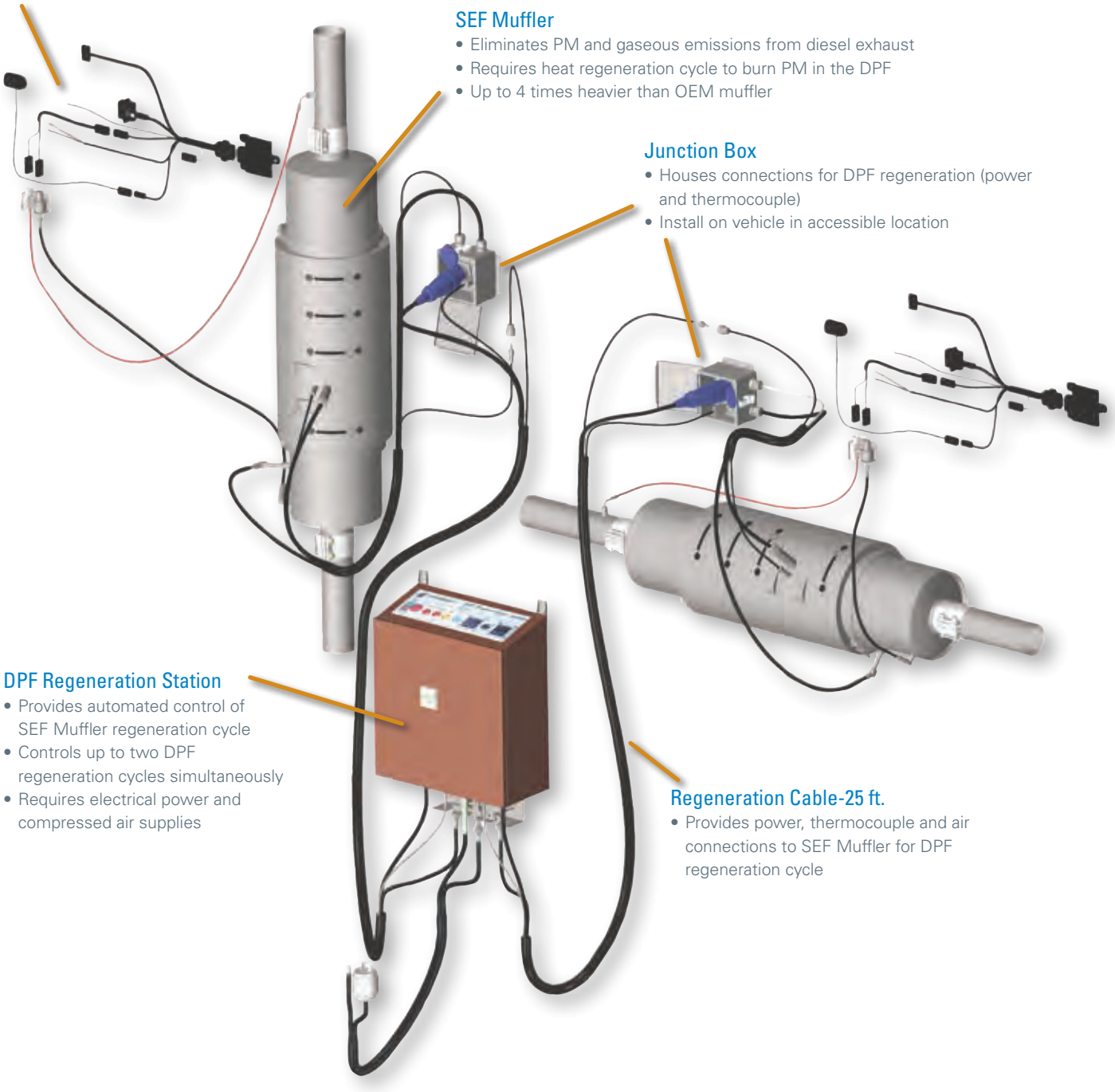
The SEF Muffler incorporates an electric heater to periodically burn PM captured in the DPF. The EDM informs the operator when DPF regeneration is needed. When connected via the junction box, a DPF Regeneration Station manages the regeneration cycle to ensure a safe and thorough burn.

**SEF = Semi-active Electric Filter**

### Emissions Device Monitor (EDM)
- Monitors status of SEF Muffler
- Indicates when DPF regeneration is required

### SEF Muffler
- Eliminates PM and gaseous emissions from diesel exhaust
- Requires heat regeneration cycle to burn PM in the DPF
- Up to 4 times heavier than OEM muffler

### Junction Box
- Houses connections for DPF regeneration (power and thermocouple)
- Install on vehicle in accessible location



### DPF Regeneration Station
- Provides automated control of SEF Muffler regeneration cycle
- Controls up to two DPF regeneration cycles simultaneously
- Requires electrical power and compressed air supplies

### Regeneration Cable-25 ft.
- Provides power, thermocouple and air connections to SEF Muffler for DPF regeneration cycle

# Ideal for Home-based Fleets

- Semi-active DPF technology – relies on an integrated electric heater to provide heat for DPF regeneration
- Ideal for colder duty cycles:  No specific minimum application temperature criteria; therefore no data logging required (recommended)
- Time between DPF regens depends on engine certification level (soot output rate), duty cycle and maintenance level
- DPF Regeneration Cycle – 4.5 hours for one vehicle; 7 hours for two vehicles
- Broad on-road engine coverage (1991-2006 MY) EGR and non-EGR engines.
- Designed for engines with less than 2700 cfm exhaust flow and less than 400 HP
- Typical SEF Muffler installation time is 5-9 hours

| Features | Benefits |
|---|---|
| Semi-active DPF system | • Permits off-cycle DPF regeneration<br>• Effective for colder engine duty-cycles<br>• Eliminates need for data logging |
| Non-catalyzed silicon carbide DPF substrate | • Better thermal cycling durability than ceramic substrates<br>• No $NO_2$ make |
| Ruggedized electric heater | • Provides uniform, reliable heat source for DPF regeneration |
| Compressed air for DPF regeneration | • Permits precise air-flow control to ensure reliable, consistent DPF regenerations<br>• Reduces system cost associated with separate blower |
| Thermal wrap insulates SEF Muffler | • Shortens regeneration cycle time<br>• Reduces energy usage, burn hazards, and temp gradients across DPF<br>• Stays on muffler at all times, easily removed for DPF access |
| DOC installed upstream of DPF | • Reduces CO and HC emissions<br>• Dries soot to extend time between regens<br>• Enhances flow distribution |
| Optimized flow distribution | • Provides uniform flow across entire DPF face<br>• Increases flow (hp) rating of muffler<br>• Extends time interval (T) between DPF regenerations<br>• Improves regeneration efficiency |
| Remote-mounted DPF Regeneration Station regenerates two DPFs simultaneously | • Reduces 'per vehicle' acquisition cost<br>• Eliminates exposure to vehicle shock increases reliability<br>• Reduces fleet regeneration time |
| Wide supply voltage range (208-240V, 1-ph) | • Increases range of acceptable power supply options<br>• Reduces installation costs |
| 25 ft. break-away cable design | • Reduces damage in event of 'drive-off' during DPF regeneration |
| Includes ground fault circuit interrupter | • Reduces risk of shock |
| Fewer components to install | • Reduces installation time/cost compared to competing systems |
| Modular design | • Permits installation flexibility and reduces installation time<br>• Reduces service time when cleaning the DPF |
| Updated EDM | • Date and time functionality<br>• "Freeze Frame" fault tracking (included with new software)<br>• "Real Time" display of backpressure and temperature<br>• Sensor rationality functionality |

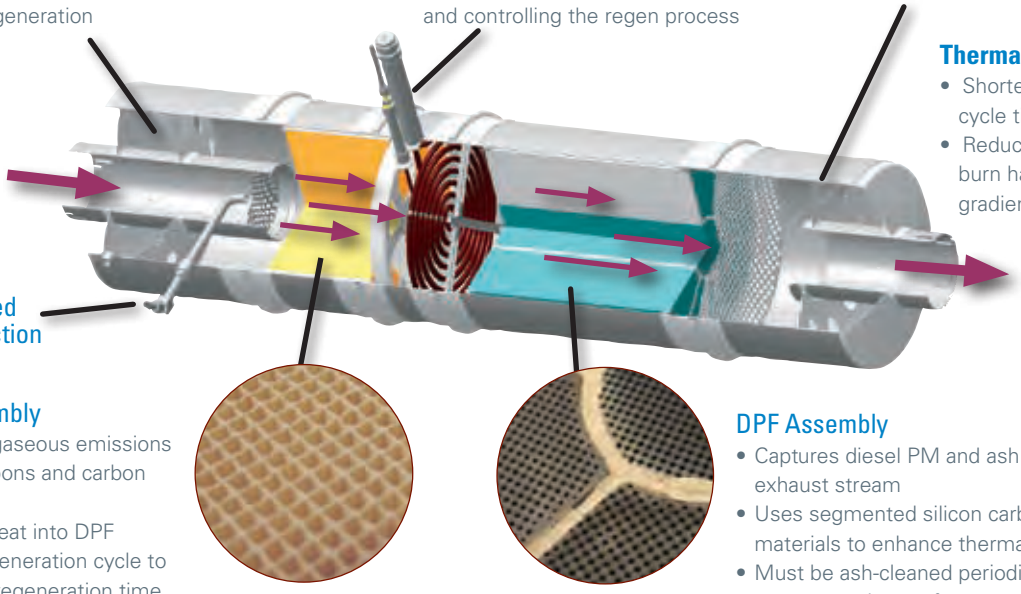
# A Closer Look at the SEF Muffler System

## Inside the SEF Muffler

### Inlet Assembly
- Includes components that enhance flow distribution and reduce backpressure
- Houses the compressed air connection for DPF regeneration

### Heater Assembly
- Provides the heat necessary to combust diesel PM during DPF regeneration cycle
- Houses the thermocouple for monitoring and controlling the regen process

### Outlet Assembly
- Includes components that enhance DPF regeneration efficiency



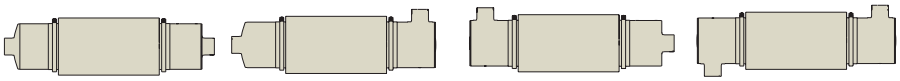

### Thermal Wrap (not shown)
- Shortens regeneration cycle time
- Reduces energy usage, burn hazards, and temp gradients across DPF

### DOC Assembly
- Reduces gaseous emissions (hydrocarbons and carbon monoxide)
- Reflects heat into DPF during regeneration cycle to minimize regeneration time

### DPF Assembly
- Captures diesel PM and ash from the exhaust stream
- Uses segmented silicon carbide DPF materials to enhance thermal durability
- Must be ash-cleaned periodically to prevent engine performance degradation

### Broad Selection

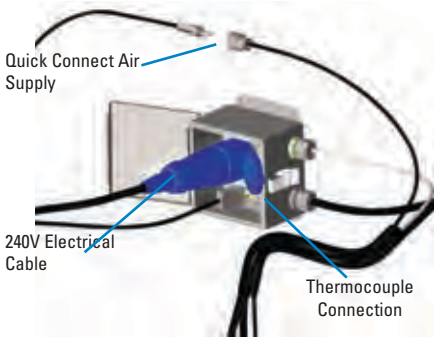
Four muffler styles with different inlet/outlet connections available to simplify installation



## Junction Box

Simple Connection for DPF Regeneration (hard-wired to SEF Muffler)

Grab the cable from the DPF Regeneration Station, open the door to the junction box and connect the air, power and thermocouple to permit regeneration.




The junction box comes hard-wired to the SEF Muffler via a 10 ft (3 m) cable. Ensure easy access during installation.

## EDM

Emissions Device Monitor

The Clean Diesel Group EDM tells the vehicle operator when DPF regeneration is required. It also records and monitors DPF operating conditions. Temperature and backpressure readings are continuously recorded to aid in analyzing vehicle operating trends and to support troubleshooting.

For more information on the Emissions Device Monitor, see Brochure F111276.

An EDM Kit is included with every SEF Muffler Kit. In-cab display shown.

No need for laptop connection, with Diagnostic Reset Tool (DRT) Part No. P231740

## More about the Automated, DPF Regeneration Station

Item No. X009584

### Operation of the DPF Regeneration Station

The DPF Regeneration Station is designed to clean a single DPF or two DPFs simultaneously. The automated cycle includes preheat, burn and cool-down phases. When two are regenerated simultaneously, the cycle time is reduced by overlapping the cool-down phase of the first cycle with the pre-heating and burn phases of the second cycle.

The length of the cleaning cycle is shown below.

| Trucks | Systems | Regen Time |
|---|---|---|
| Truck A | System A | 4.5 hours |
| Truck B | System B | 4.5 hours |
| Trucks A & B | Systems A & B | 7 hours |

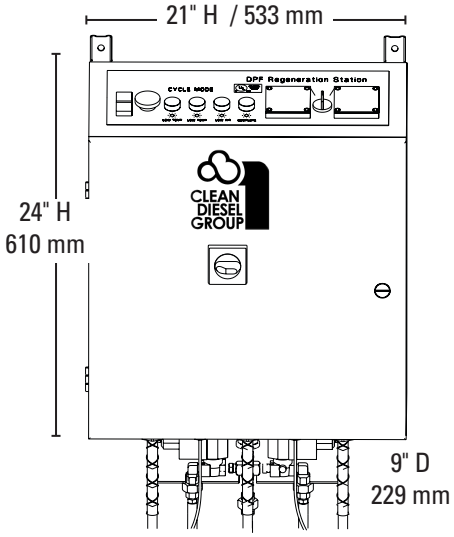
### Where to Install at Your Facility

The narrow profile of the DPF Regeneration Station allows for a variety of possible installations, including:

- On a free-standing pole or pillar
- Against a wall or fence
- At the corner of a building
- Free standing mobile cart


The simple, automated control panel of the DPF Regeneration Station.

### Installation Information



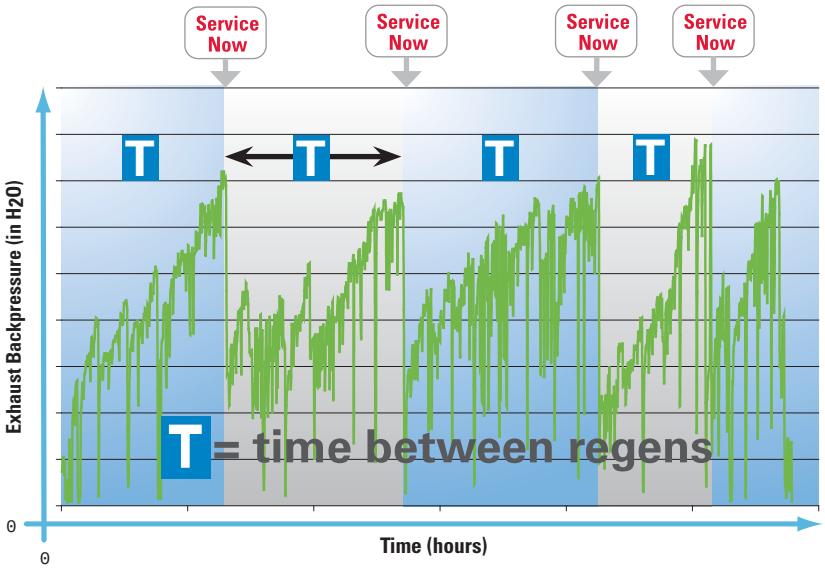

- Unit weight: 120 lbs. / 54 Kg (with cables)
- Height: Mount control face plate at eye level
- Station Dimensions: see illustration
- Clearance: (1) Allow 20" clearance for door to open; (2) minimum 12" clearance on three remaining sides
- Compressed Air: Requires a clean, dry source of 100 PSI @ 4.5 SCFM
- Electric Power: 208-240V/30A single-phase; Standard - 3-prong power cord; Optional - hard-wire directly to the unit
- External Mount: Install cover or awning to protect the control panel (not included)
- Cable Storage: Use cable hangers to prevent damage when not in use (not included)

# How Many Regen Stations Will You Need for Your Fleet?

## Extending Time Between Regens (T)

Under normal operating conditions, exhaust system backpressure increases over time as the SEF Muffler loads with PM. The EDM In-Cab Display (Service Now) will alert the operator to regenerate the DPF when it exceeds the preset limit. After the regen, the backpressure will reset to the initial levels.

The time between regens, T, is affected by several factors including muffler design, engine emissions rating and maintenance level. Older engines will have shorter regen intervals (T) because they emit more PM. Maintain the engine within manufacturer's specifications to maximize the regen interval.




**Typical SEF Muffler Backpressure**

Exhaust backpressure curve for a California School Bus
210 HP Engine with over 200 Hours over a 2-month period

## Fleet Examples

### School Bus Fleet
### 20 Vehicles

Fifteen 1994-2002 MY; Five 1991-1993 MY

**Assumptions:** The typical school bus operates at an average power level of 50 hp. According to the table above, each MY group has a different regeneration interval. Assume the buses are used six hours/day. The corresponding number of DPF Regeneration Stations is shown below.

| Engine MY | Regeneration Interval | | # Vehicles with SEF Mufflers | # of Regen Stations |
|---|---|---|---|---|
| | Hours | Days | | |
| 1994-2006 | 64.0 | 10 | 15 | 1.5 |
| 1991-1993 | 29.5 | 5 | 5 | 0.5 |
| **Net Regen Stations Needed** | | | | **2** |

# DPF Regen Stations & Fleet Type/Size

Determining the proper number of DPF Regen Stations to install for your fleet depends on many factors, including:

- the number of vehicles in the fleet equipped with SEF mufflers
- the soot output rate (0.25 or 0.1 g/bhp-hr) for those engines
- the average horsepower usage over the engine duty cycles
- the maintenance level of the engines

To estimate the optimum number, use the following procedure. First, find the soot output rate of the engines in your fleet. Next, find the average horsepower usage for each vehicle during its normal duty cycle (this information may be available from the Engine ECU). Use the tables below to help estimate the 'time between regens' (T).

The first table (Calculated) uses a formulaic approach to estimating the regen interval based on soot generation and filter size. This approach is useful, but has proven to be conservative and may result in an excessive number of stations. The second table (Experience) is based on actual field results. For best results, consider both values before finalizing the number. Actual results may vary.

### Calculated Time Between Regens, T

| Avg. HP over Duty Cycle* | | | 50 | 100 | 150 | 200 | 250 | 300 | |
|---|---|---|---|---|---|---|---|---|---|
| Soot Output Rate (g/bhp-hr) | MY 1994-2006 | 0.1 | 64.0 | 32.0 | 21.3 | 16.0 | 12.8 | 10.7 | T in hours |
| | MY 1991-1993 | 0.25 | 29.5 | 14.8 | 9.9 | 7.4 | 5.9 | 4.9 | |

### Experience-based Time Between Regens, T

| Avg. HP over Duty Cycle* | | | 50 | 100 | 150 | 200 | 250 | 300 | |
|---|---|---|---|---|---|---|---|---|---|
| Application | | | School Bus | Refuse Truck | Refuse Truck | Muni. Truck | Muni. Truck | On-Hwy | |
| Daily Usage | | | 3-6 hrs. | 8-10 hrs. | 8-10 hrs. | 3-6 hrs. | 3-6 hrs. | 8-10 hrs. | |
| Soot Output Rate (g/bhp-hr) | MY 1994-2006 | 0.1 | - | 80-200 | 55-130 | 20-80 | 16-50 | - | T in hours |
| | MY 1991-1993 | 0.25 | - | 20-50 | 15-30 | - | - | - | |

* Average horsepower estimates based on operating experience

Legend
- Good
- Marginal
- Not Recommended

## Refuse Truck Fleet
## 20 Vehicles

Fifteen 1994-2002 MY; Five 1991-1993 MY

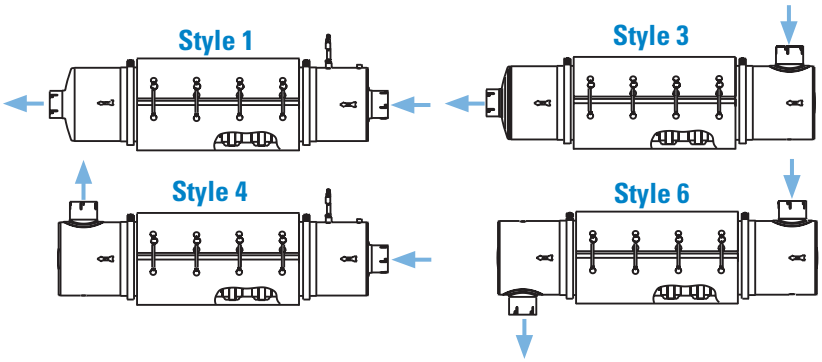
**Assumptions:** The typical refuse truck operates at an average power level of 100 hp. According to the table above, each emissions grouping has a different regeneration interval. Assume the trucks are operated eight hours/day. The corresponding number of DPF Regeneration Stations is shown below.

| Engine MY | Regeneration Interval | | # Vehicles with SEF Mufflers | # of Regen Stations |
|---|---|---|---|---|
| | Hours | Days | | |
| 1994-2006 | 32 | 4 | 15 | 3.75 |
| 1991-1993 | 14.8 | 2 | 5 | 2.5 |
| **Net Regen Stations Needed** | | | | **6 or 7** |

# SEF Muffler System Order Information

## Select the proper SEF Muffler model by:

1) Ensuring the engine family number is permitted by the CARB Executive Order
2) Ensuring the engine exhaust flow rate is less than 2700 cfm and horse power is less than 400 HP.
3) Selecting the muffler kit that best matches the existing muffler style and inlet/outlet dimensions, when possible.
4) For self application on 1991-2006 diesel engines, see the shaded columns in the SEF Muffler Kits chart below. Order kits based on engine horsepower. Use 5" inlet/outlet with higher horsepower engines.




## DPF Regeneration Station Part No. X009584

## SEF Muffler Kits*

| Muffler | Inlet I.D. | Outlet I.D. | Body Length | Body Dia.** | Inlet Assembly | Outlet Assembly | Kit No. 0-275 HP | Replacement DPF | Kit No. 275-400 HP | Replacement DPF |
|---|---|---|---|---|---|---|---|---|---|---|
| Style 1 | 4.0"" | 4.0" | 44.25" | 11.08" | P232153 | P232157 | X009568 | X009811 | X011243 | X011241 |
| | 4.0" | 5.0" | 44.25" | 11.08" | P232153 | P232160 | X009570 | X009811 | X011245 | X011241 |
| | 5.0" | 5.0" | 44.25" | 11.08" | P232156 | P232160 | X009576 | X009811 | X011251 | X011241 |
| Style 3 | 4.0" | 4.0" | 45.75" | 11.08" | P232154 | P232157 | X009572 | X009811 | X011247 | X011241 |
| | 4.0" | 5.0" | 45.75" | 11.08" | P232154 | P232160 | X009574 | X009811 | X011249 | X011241 |
| | 5.0" | 5.0" | 45.75" | 11.08" | P232155 | P232160 | X009581 | X009811 | X011254 | X011241 |
| Style 4 | 4.0" | 4.0" | 46.63" | 11.08" | P232153 | P232158 | X009569 | X009811 | X011244 | X011241 |
| | 4.0" | 5.0" | 46.63" | 11.08" | P232153 | P232159 | X009571 | X009811 | X011246 | X011241 |
| | 5.0" | 5.0" | 46.63" | 11.08" | P232156 | P232159 | X009577 | X009811 | X011252 | X011241 |
| Style 6 | 4.0" | 4.0" | 48.13" | 11.08" | P232154 | P232158 | X009573 | X009811 | X011248 | X011241 |
| | 4.0" | 5.0" | 48.13" | 11.08" | P232154 | P232159 | X009575 | X009811 | X011250 | X011241 |
| | 5.0" | 5.0" | 48.13" | 11.08" | P232155 | P232159 | X009580 | X009811 | X011253 | X011241 |

*Kits include EDM and Junction Box

** Muffler body dia. with wrap is 13.9". Muffler weight 120 lbs / 55 kg.

## Service Parts

### DPF Regeneration Station

| Description | Part No. |
|---|---|
| 25 ft. Regeneration Cable | P232342 |
| Instrument Cluster Lights/Switch Kit | P232343 |
| Temperature Controller | P232344 |
| Circuit Breaker and Mounting Base | P232345 |
| Air Manifold Assembly | P232346 |
| Fuses, 5-Pack | P232347 |
| Contactor | P232348 |
| Din-A-Mite Controller | P232349 |
| Relay | P232350 |

### SEF Muffler

| Description | Part No. |
|---|---|
| DOC Assembly | P236847 |
| Thermal Wrap | P232189 |
| V-band Clamp | P212925 |
| Heater Thermocouple | P232577 |
| DPF Assembly <275 hp (Spare)* | X011318 |
| DPF Assembly >275 hp (Spare)* | X011317 |

### Technician Service Tools

| DescriptionPart No. | |
|---|---|
| Diagnostic Reset Tool (DRT) | P231740 |
| EDM Service Tool Software + link-up cable | X007999 |
| EDM Service Tool Software + link-up cable + DRT | X009649 |

* See rules of Swapping and Redesignation in SEF Owner's Manual P232575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