

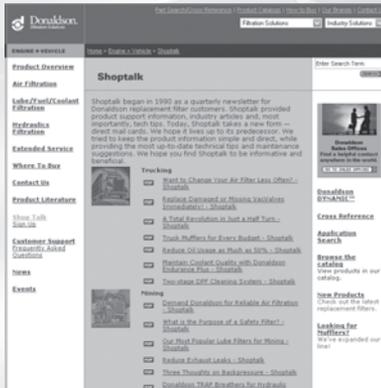
## Shoptalk - Free Subscription!

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Maintenance tips, cost reduction ideas and product features and benefits from the filtration and emissions experts - simple facts every diesel owner can use!

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## Purpose of an Exhaust System

Exhaust system design specifications are typically defined by the OEs. They are looking for a solutions that can redirect engine exhaust, reduce exhaust noise and most recently, reduce emissions (hydrocarbons, carbon monoxide, soluble organic fraction (SOF)).

Diesel engines are a reliable and efficient power source for vehicle and equipment manufacturers. Governmental regulations across the globe are driving diesel engine users to consider buying new vehicles or retrofitting their existing engines to meet the new emissions regulations.

## Muffler Design & Performance

Donaldson mufflers are designed and tested with specific focus on three performance variables: attenuation, backpressure and structural.

### Attenuation

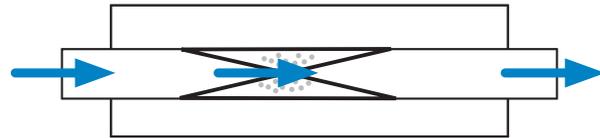
For exhaust systems, attenuation refers to the reduction in sound level measured between an engine without a muffler and the same engine with a muffler. This sound level is typically measured in a decibal scale (dBAs). Traditional mufflers use tubes, baffles, and expansion chambers and insulation to help control noise. Newer applications include emissions reduction devices installed in the exhaust system. Many of the devices also provide the needed noise attenuation either in part or in total.

Sound quality is an additional noise characteristic that is important to the end user. An example of a sound quality concern is the sound of fingernails on a chalk board – this screeching sound makes people wince, yet the measured sound level would not be significant. A low throaty rumble may seem even quiet (and almost desirable) but may be amplified and become annoying if it reverberates within the operator's cabin.

**Heavy-duty mufflers typically employ one of four sound reduction techniques including:**

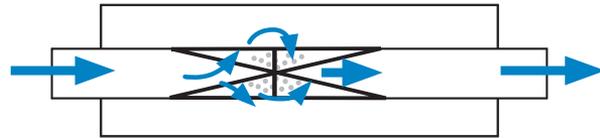
### Reactive silencing

What's important: the ratio of the body diameter to the tube



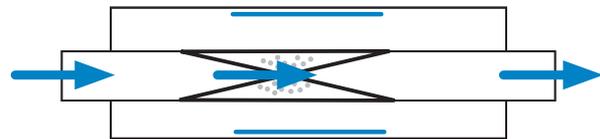
### Resistive silencing

Exhaust flow is forced through a small area. It removes energy to reduce noise level.



### Absorptive silencing

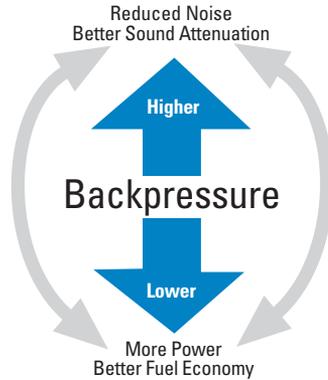
Transforms wave energy into thermal energy. Uses acoustic packing (or wrap) just inside the outer shell of the muffler.



Engine manufacturers generally expect a reduction in engine exhaust sound level of 15-25 dBA. The overall noise level of a vehicle or piece of stationary equipment is the actual regulated value. The overall noise level is typically measured while driving past a microphone at a specific speed and distance. Maximum noise levels in the U.S. are regulated by the U.S. EPA (Environmental Protection Agency).

## Backpressure

A key performance factor in selecting the proper muffler is backpressure. For the most efficient engine performance it is important to apply a muffler that minimizes backpressure.



Backpressure is the force necessary to flow gasses through the Exhaust system, or the resistance to exhaust flow. System considerations include friction and momentum effects - expansion / contraction / elbows, and velocity head loss at outlet.

To minimize backpressure, long tube lengths, small tube diameters, and sudden contractions should be avoided.

Backpressure can reduce horsepower and fuel economy. For example, turbocharged diesel engines lose about 0.5% in horsepower and fuel economy per inch Hg backpressure. To help you minimize backpressure, our selection guide provides exhaust flow ratings at 1", 2" and 3" Hg (mercury).

Conversion: 1.0" Hg = 13.6" H<sub>2</sub>O

Our muffler spec'ing section outlines the steps you need to take for proper muffler selection.

## Structural

Another performance factor is the structural durability of the system configuration. Position, mounting support, weight and the type of material that the unit is made from are the key sub-components of system structure.

For example, the original OE stanchion or chassis mounting components are adequate for a replacement muffler. If you apply a heavier muffler, like one with an emissions device inside, it's critical to upgrade the hangers, brackets and stanchion with more robust and heavier components. Most exhaust system problems encountered by Donaldson field service are due to improper bracketing and/or use of clamps – not the muffler or muffler construction.

## Exhaust Product Materials

There are a number of materials found in diesel exhaust applications. Some of the materials are appropriate for heavy duty applications and have the mechanical properties to provide good service life.

Since materials vary in strength, corrosion resistance, and price, a particular material may be preferred in individual applications and components. Some of the most common materials, their qualities, and their typical uses are listed in the following table.

Materials*	Used in	Qualities
Aluminized Mild Steel	Mufflers	Good Corrosion Resistance
	Exhaust Components	
Stainless Steel (with and without aluminized coating)	Flexible Tubing	Stronger Excellent Corrosion Resistance
	Mufflers	
	Exhaust components	
	Emissions Products	
Chrome	Accessories	Bright Mirror Finish
Galvanized	Flexible Tubing	Low Material Cost Temperature Limit 600°F
Cold Rolled	Accessories	Poor Corrosion Resistance Low Cost

Aluminized steel is the preferred material for traditional diesel exhaust applications. Aluminized steel is a low carbon steel with a thin layer of aluminum alloyed to the surface. The aluminum provides a barrier for protection of the base material. Aluminized steel parts have an ultimate service temperature of 1250°F with a continuous duty temperature limit of 1000°F. This material closely matches the expected service temperatures of diesel engine applications and has excellent corrosion resistance to acidic diesel exhaust gases. Aluminized steel parts provide good field life at a reasonable cost.

Series 400 stainless steels are used for many extended service life diesel applications, and often in gasoline applications due to their higher operating temperatures. This material family provides slightly better strength at exhaust system temperatures than aluminized steel.

Type 409 is the most common 400 series stainless

steel used in exhaust applications. Type 409 is stronger than aluminized but exhibits cosmetic problems at exhaust system temperature. At first exposure to high temperature it discolors. Over time it develops a nondestructive coating of surface rust. After an extended time in the field a 409 product will display external discoloration and look worse than a similar part made from aluminized steel, but will last much longer.

Another choice is 409 stainless steel with an aluminum coating. Aluminized 409 is used on diesel catalytic converter mufflers due to its excellent high temperature resistance and the corrosion protection of the aluminized coating. Aluminized 409 is found primarily on emission products or high temperature gasoline applications.

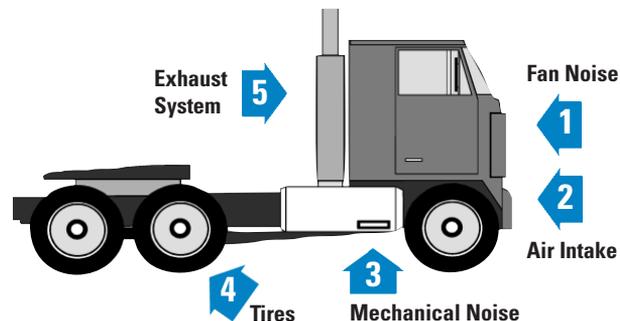
Series 300 stainless steels are also utilized in exhaust systems. The most common material is Type 304. This material has excellent corrosion resistance and very good high temperature strength and is used in some muffler applications where very high stresses occur. This is a premium material and is also used in many for gasoline applications. The most prevalent use of the material in heavy duty diesel applications is for flex pipe. Flex pipe produced from light gauge 304 stainless steel is an excellent choice considering all the factors of cost, durability, and service life.

Often chrome plated cold rolled steel parts are found on exhaust system parts. This material is a reasonable choice for cosmetic applications where a bright mirror finish is desired. Corrosion from the inside of the product can still occur. Chrome parts may be very challenging to produce. It is important to produce the parts with a high level of quality because surface irregularities are very visible to the end user.

An alternate choice for chrome parts is bright annealed stainless steel. This material provides a bright mirror like finish with excellent exhaust service life. Bright stainless steel is typically used for muffler heat shields and generally an expensive material choice.

## Noise Sources

### Five Major Sources of Noise in Trucks



### Easy Maintenance Tips Reduce Exhaust Noise

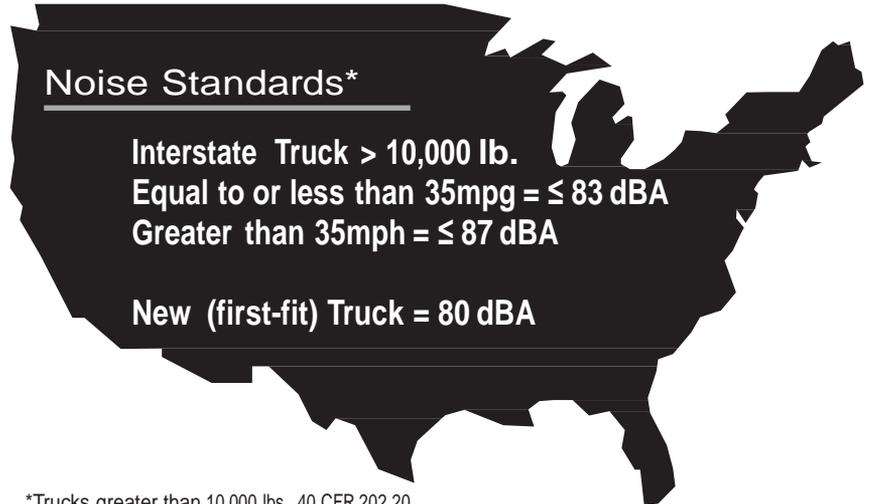
- 1 Check the exhaust tubing. Repair or replace worn or leaking components.
- 2 Make sure your exhaust system is properly supported.
- 3 Installing a resonator or wye connector muffler is an economical way to reduce noise.
- 4 Modify a single exhaust system to a dual.
- 5 Check stack and tailpipe position. A straight stack will be quieter than a curved stack on vertical exhaust systems. Turn your horizontal tailpipes toward the center of the road.



## Truck Noise Control

(from U.S. EPA Web site)

In the past, the Environmental Protection Agency (EPA) coordinated all federal noise control activities through its Office of Noise Abatement and Control. However, In 1981, the Administration at that time concluded that noise issues were best handled at the State or local government level. As a result, the EPA phased out the office's funding in 1982 as part of a shift in federal noise control policy to transfer the primary responsibility of regulating noise to state and local governments. However, the Noise Control Act of 1972 and the Quiet Communities Act of 1978 were not rescinded by Congress and remain in effect today, although essentially unfunded. View more information about resources on noise pollution.



\*Trucks greater than 10,000 lbs. 40 CFR 202.20

\*\* Noise is measured at 50 feet (15.2 m) from the centerline of the lane of travel

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## Interstate Motor Carrier Noise

The Federal Highway Administration's Office of Motor Carrier and Highway Safety Web site includes information on the Interstate Motor Carrier Noise Emission Compliance Regulations from the Code of Federal Regulations (49 CFR 325)

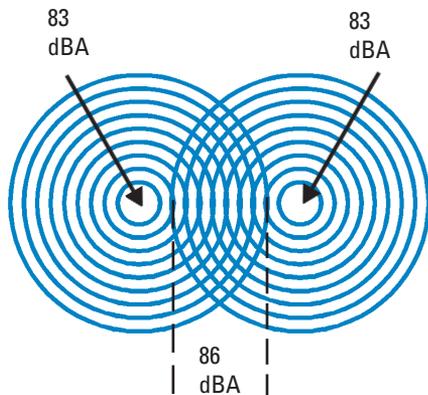
Subparts for compliance of the interstate motor carrier noise emission standards  
[http://www.fmcsa.dot.gov/rules-regulations/administration/fmcsr/fmcsrguidedetails.aspx?rule\\_toc=730&section\\_toc=730](http://www.fmcsa.dot.gov/rules-regulations/administration/fmcsr/fmcsrguidedetails.aspx?rule_toc=730&section_toc=730)

Part	Regulation
Subpart A	General Provisions
Subpart B	Administrative provisions
Subpart C	Instrumentation
Subpart D	Measurement of noise emissions; highway operations
Subpart E	Measurement of noise emissions; stationary test
Subpart F	Correction factors
<b>Subpart G</b>	<b>Exhaust systems and tires</b>

## Rules of Thumb

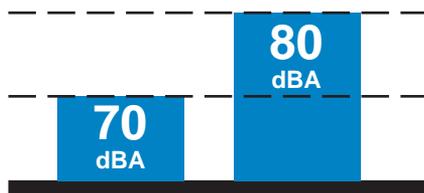
### Combining Two Equal Noise Sources Increases Sound Level by 3 dBA

Two equal noise sources combine to create a sound level 3 dBA greater than either source.



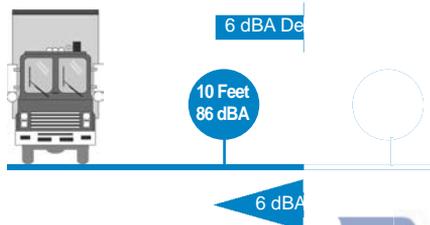
### Twice the Loudness is a 10 dBA Increase

The increases are not linear! Increasing noise by 10 dB sounds twice as loud.



### Sound Pressure Level Changes With Distance

Doubling the distance to a noise source decreases its sound level by 6 dB. Halving the distance to a noise source increases its sound level by 6 dB.



## Emissions Devices & Acoustic Silencing

Various emissions reduction technologies are applied to exhaust systems to meet new emissions standards. The additional components can significantly change or eliminate the traditional acoustic silencing components common in older muffler designs. Depending on the application, emissions reduction devices may totally eliminate the need for further sound control and for others, minimal acoustic silencing may be required. The sound attenuation of emissions devices varies depending on the filtering substrates and configuration of the overall system.

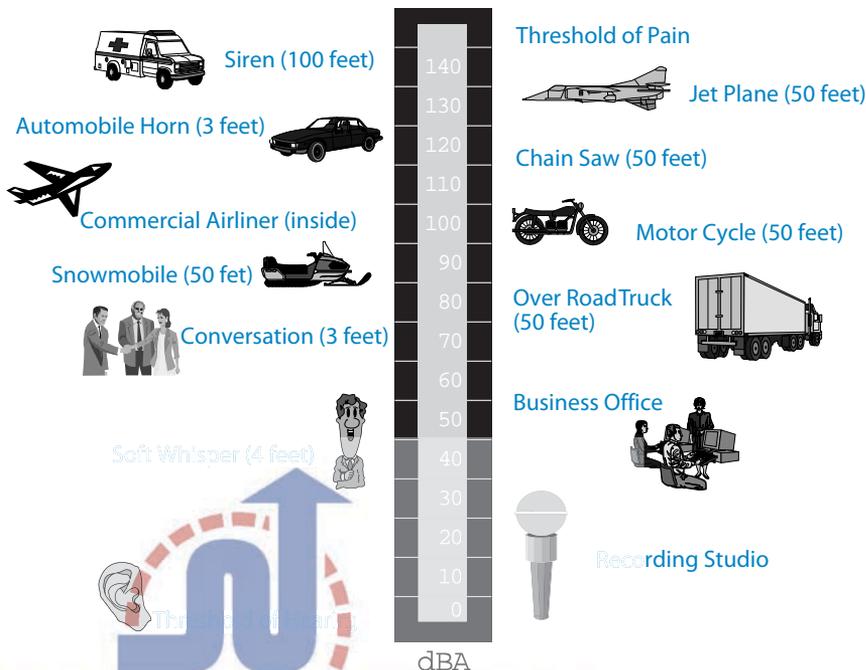


Typical emissions aftertreatment substrates (ceramic and metal)

## Familiar Sounds on the dBA Noise Scale

Other examples of sound levels:

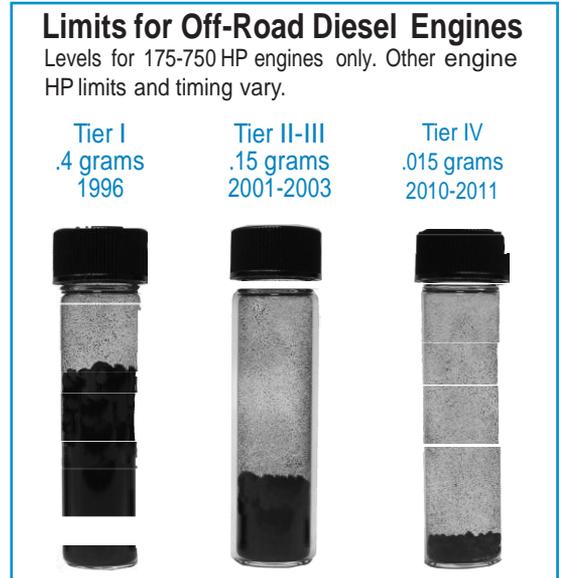
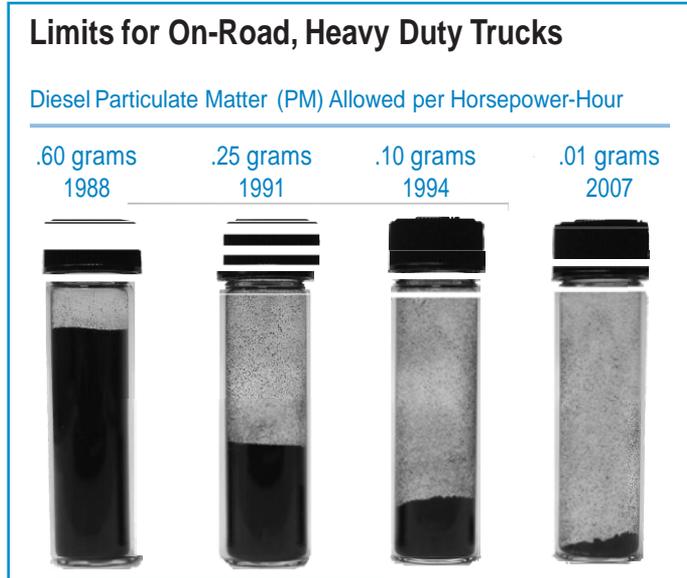
70 dB Traffic jam; 90 dB Heavy machinery, 130 dB Jet engine at 10 meters.



## Diesel Particulate Matter (PM) Allowed per Horsepower-Hour

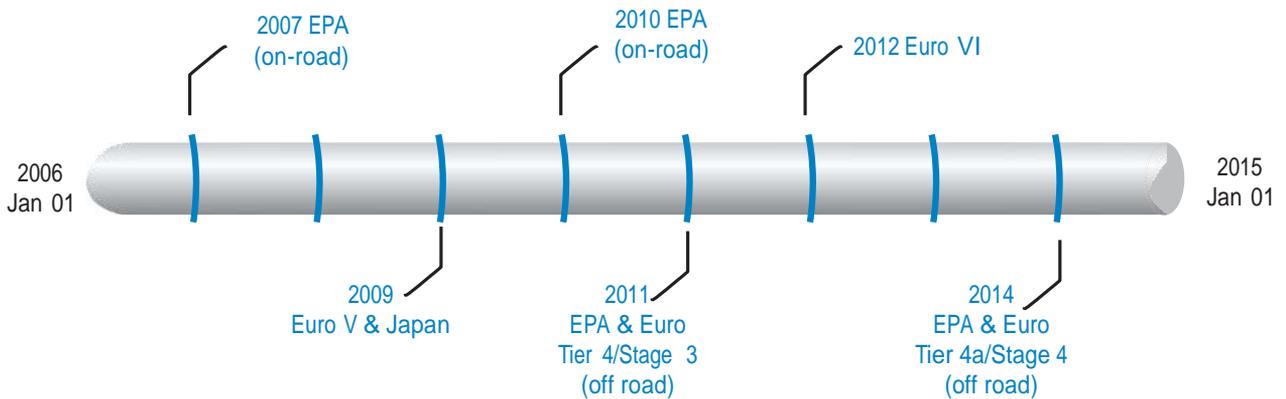
### What does "Diesel PM per Horsepower-Hour" Mean?

A 200 horsepower (HP) engine could release as much as 200 times the amount shown in one vial during one hour of operation or a 300 HP engine could release as much as 300 times the amount shown in one vial during one hour of operation.



Soot vials are shown smaller than actual size (2-3/8" height).

## Worldwide Emissions Mandates & Timing



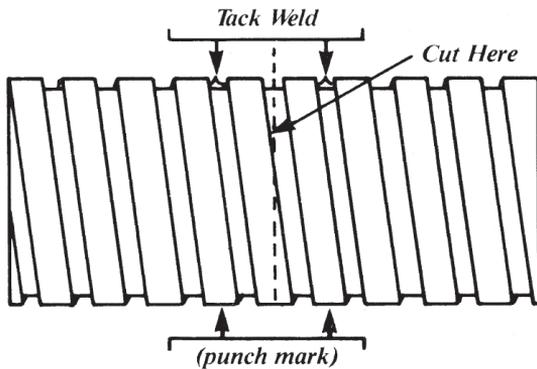
Flexible tubing can twist or unravel when cut, causing its diameter to change and making installation difficult. This occurs because flexible tubing must maintain flexibility in order to function properly, and, therefore, cannot be tightly wound in the manufacturing process. However, flexible tubing can be managed for trouble-free installation by following these guidelines.



## Cutting

### Step 1 - Prepare

Place a tack weld between convolutions on each side of the intended cut to keep ends from twisting or unraveling.



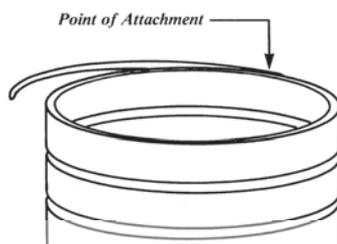
If a welder is not available, insert a mandrel or back-up pipe into the tubing and place a punch mark directly on convolutions on each side of the intended cut. Heavy-duty tape over a de-greased pair also works. Cut through tape and leave in place, clamp over tape.

### Step 2 - Cut

Place the tubing securely in a vice. Cut with a metal cutting band saw or a hacksaw with 32 teeth per inch.

### Step 3 - Trim

Each side of the cut will now have a spiral "tail" that must be removed to the point at which it is attached. Bend each tail until it breaks, or bend and use a cutting shears to remove.



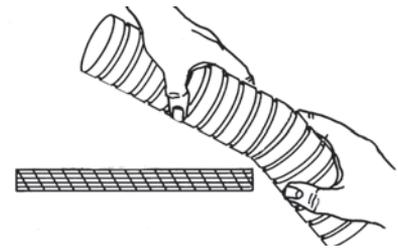
### Step 4 - Deburr

Deburr both cut surfaces with a hand-operated drum sander or file.

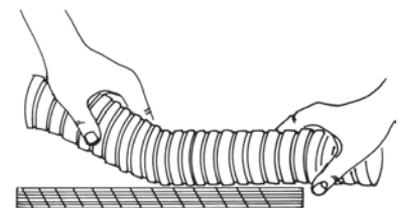
## Installation

Flexible tubing's function is to prevent excessive stress on exhaust system components by absorbing vibration and thermal expansion that would otherwise cause system components to shake loose and break.

To provide adequate flexibility, flex tubing should be installed in a half extended state. To reach half extension, place the middle of the tubing over the edge of a work bench, push down on both halves and bend as much as possible.



Then place the entire piece of tubing on the work bench and push the end down until straightened. The tubing is now at half extension.



Note: Do not use flexible tubing to form an exhaust pipe bend. Use elbows instead.

## Donaldson & Industry Acronyms

ATD	After Treatment Device
Bp	Backpressure
CARB	California Air Resources Board
CCM	Catalytic Converter Muffler (or DOC)
CCV	Crankcase Ventilation or Closed Crankcase Vent
CDPF	Catalyzed Diesel Particulate Filter
CFM	Cubic Feet per Minute
CFS	Crankcase Filtration System
CO	Carbon Monoxide
dBA	Decibel, A scale (noise level)
DMF	Diesel Multi-stage Particulate Filter
DOC	Diesel Oxidation Catalyst
DPF	Diesel Particulate Filter
EAT	Exhaust After Treatment
EDM	Emissions Device Monitor
EGR	Exhaust Gas Recirculation
EIEO	End In / End Out (muffler style)
EISO	End In / Side Out (muffler style)
EPA	Environmental Protection Agency
EPA Tier 4/IV	Off-road emissions standards
EPA07	U.S. EPA 2007 on-road regulation
EPA10	U.S. EPA 2010 on-road regulation
ERC	Emissions Resource Center
Euro Stage XX	European Emissions Reduction Regulations
FTP	Federal Test Procedure
HC	Hydrocarbon (unburned fuel)
HP	Horse Power
HTEF	High Temperature Exhaust Filter
ICC	Independent Catalytic Converter
ID	Inside Diameter
IOM	Installation Operation Manual
ISO	International Organization for Standardization
ISO/TS	ISO Technical Specification
LNF	Low NO <sub>2</sub> Filter (muffler)
LXF	Low NO <sub>x</sub> Filter (muffler)
LSD	Low Sulfur Diesel (fuel)
LTF	Low Temperature Filter (muffler)
NO <sub>x</sub>	Nitrogen Oxides
OCV	Open Crankcase Ventilation
OD	Outside Diameter
PM	Particulate Matter
SC	Silicone Carbide
SCR	Selective Catalyst Reduction
SEF	Semi-active Electric Filter (muffler)
SIEO	Side In / End Out (muffler style)
SISO	Side In / Side Out (muffler style)
SRF	Standard Recirculation Filter
SS	Stainless Steel
ULSD	Ultra-Low Sulfur Diesel (fuel)
VOC	Volatile Organic Compound
VOF	Volatile Organic Fraction

## Engine Brake & Exhaust Silencer



### Designed to specifically address engine brake noise

- Addresses engine brake noise, silencing engine brake “bark”
- Reduces exhaust noise 66% versus a standard muffler

### Silences engine brake “bark”

- Reduces driver fatigue
- Improves trucking industry image

### All stainless steel construction available\*

- Won’t rust out like conventional mufflers

### Direct replacement

- Easy installation, can be applied on existing trucks

### No increase in back pressure

- Silences without engine power loss
- Maintains fuel economy

### \*Models available in both stainless steel and aluminized steel



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# Flat Band SealClamp™ Installation Instructions

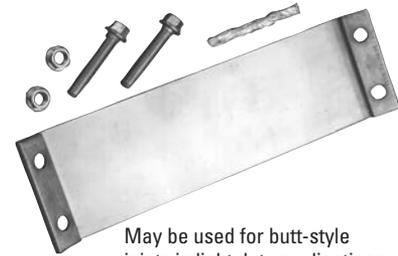


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### Step 1

Position 1/3 to 1/2 way onto the larger diameter tube or to completely cover slots.



May be used for butt-style joints in light duty applications



### Step 2

Assemble bolts between clamp bolts and tubes.



### Step 3

For all models, tighten by alternating the wrench between fasteners several times to uniformly take up the slack, beginning with the large diameter side of the connection. Tighten the nuts for stainless clamps as illustrated. Tighten alternately until the gasket is fully compressed and the mating bars' surfaces are fully touching. The grade 8 bolts and nuts are rated to 100 ft. lbs. of torque. For best results use an impact wrench.

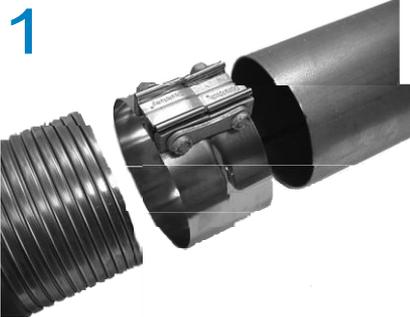
### Important Application Notes

- Use either 9/16 inch (14mm) hex wrench
- Grease the clamps and the joint area before installing
- Do not use for exhaust system mounting support
- Do not use for exhaust manifold or turbocharger connections
- Do not reuse the clamps
- Do not use as a butt joint clamp—use for overlap connections only



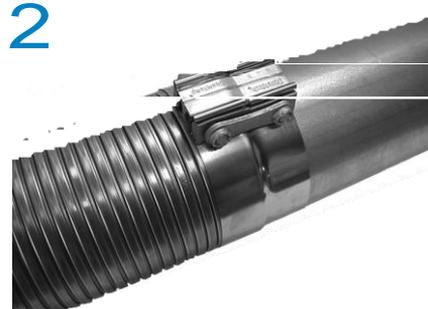


Stepped Preformed SealClamp is Individually packaged with installation instructions



### Unique design with fully assembled hardware!

1. Position the SealClamp over the smallest tube. Larger end of the clamp must be on the overlapping tube or flex.
2. Locate the step of the clamp to the overlapping tube at the joint.
3. Using the v-groove as a visual guide, alternately tighten bolts until the groove is approximately half closed (~50 ft. lbs). Do not exceed 70 ft. lbs. torque as clamp damage may occur.

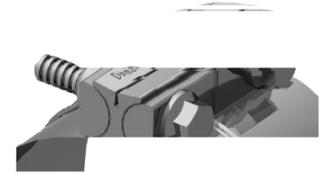


### Diseño único para un ensamble completo!

1. Colocar el SealClamp sobre el tubo más pequeño. El diámetro mayor del SealClamp debe estar sobre el tubo rígido o flexible a sobrepasar.
2. Ubicar el escalón de la abrazadera en la unión del tubo sobrepuesto.
3. Usando la ranura como guía visual, apriete alternadamente los pernos hasta que la ranura esté aproximadamente a medio cerrar. No exceda 47,5 N(m) (35 lbs-pie) de par de apriete por que puede producir daños en la abrazadera.



Before / Antes / Avant



After / Después / Après

### Conception unique avec pièces entièrement assemblées!

1. Placer le collier sur le tuyau de diamètre inférieur. La portion la plus grande du collier doit se trouver sur le tuyau qui chevauche.
2. Positionner la partie étagée du collier sur la portion chevauchante du tuyau en l'alignant sur le joint.
3. En utilisant la rainure comme guide visuel, serrer alternativement les boulons, jusqu'à ce que la rainure soit à moitié fermée. Ne pas dépasser une force de torsion de 35 pied-livre, cela risquerait d'endommager le serre-joint.

## Attenuation

In an exhaust system, attenuation refers to the reduction in sound level measured between an engine without a muffler and the same engine with a muffler.

## Backpressure

Backpressure is the force necessary to flow exhaust gas through the system. Backpressure reduces horsepower and fuel economy - for turbocharged diesel engines - about 0.5% decrease in horsepower and fuel economy per inch Hg backpressure. Typically measured in inches of mercury (Hg) or inches of water (H<sub>2</sub>O) - 1.0" Hg - 13.6" H<sub>2</sub>O

## CFM

Cubic feet per minute of airflow.

## dBA

The sound level measured in decibels using a sound level meter weighted for the "A" scale frequency response. It has over 82% correlation with loudness as determined by the typical human ear (dB without the "A" scale weighting overall has only 70% correlation to loudness).

## Decibel (dB)

A unit used to express the relative difference in acoustic power. Whenever dB is used a reference level is implied. The reference value of 0.0002 dynes/cm<sup>2</sup> = 0dB.

## DOC Muffler

Diesel Oxidation Catalyst (DOC) Muffler. This muffler design contains a catalyst inside that reduces emissions while reducing exhaust noise. Also referred to as a catalytic converter muffler (CCM).

## DPF Muffler

Diesel Particulate Filter (DPF) Muffler. This muffler design contains a particulate filter that requires Ultra Low Sulfur Diesel fuel. The filter eliminates a greater amount of particulate matter compared to a DOC Muffler, but has a higher activation temperature (260°C). Like a DOC, it also reduces emissions while reducing exhaust noise.

## Dynamometer Test

A test that allows an engine to be run to full horsepower and rated RPM while remaining stationary.

## Exhaust Noise Level

Sound level of the exhaust system, typically measured in dBA.

## N/A

Naturally aspirated

## Resonator

A device inserted in the exhaust system ahead of the muffler that provides additional exhaust noise silencing without adding significant backpressure.

## Sound Level Meter

A sound level measuring device that includes a microphone, an amplifier, an output meter and sound frequency networks for measuring sound levels in decibels,

## Total Vehicle Noise

The sum of exhaust noise level measurement plus fan, intake, mechanical and tire noise. Noise levels add logarithmically (equal noise levels combined add 3 dB; example 75 dB + 75 dB = 78 dB).

