There Is Something In the Air

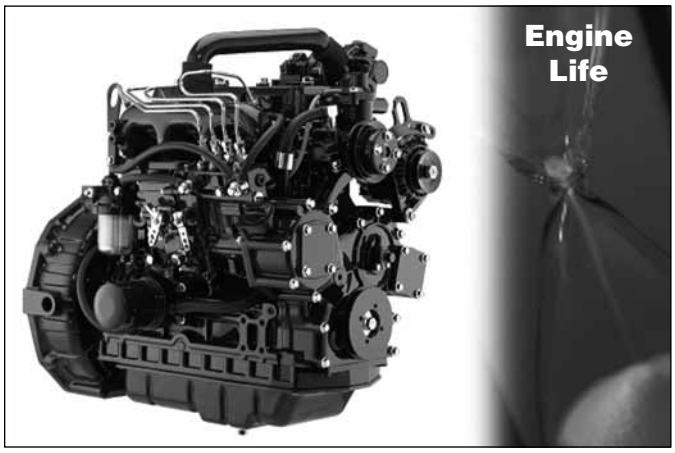
Air is not only vital for any life form on earth but also important for today's state of the art diesel engines. An average Heavy Duty Diesel truck engine requires between 3,650 to 5,600 gallons (13,000 to 20,000 liters) of air to burn just one liter of fuel. However, this air is polluted with all kinds of contaminants, such as fumes, dust, smog and other particles. Like temperature and humidity, these particles are not always visible to the eye, but they are harmful to the engine. They diminish the purity of the air and can lead to severe damage of all engine components. Under normal highway conditions, the air consumed by a 16 liter engine contains almost 20 kilograms of dirt/contaminants per 62,500 miles (100,000 kilometers).

Don't Compromise On Air Filtration

There is no room for compromise. The air intake is an open loop system, and the air filter only has one opportunity to filter the contaminant out of the intake air. Air filters are essential for heavy duty diesel engines, and the air that these engines 'breathe' needs to be as clean as possible. Poor air quality will significantly impact the performance of a diesel engine. Plugged air filters reduce engine performance, create higher fuel consumption, increase exhaust fumes and are harmful to the environment. Fleetguard® air filters are engineered to deliver optimized air quality and provide the best overall performance and service life. To properly perform its function of reducing wear and extending engine life, the air filter must filter 100% of the pre-combustion air and remove as much contaminant of any and every particle size as it can to a very high final efficiency. Sooner or later, the choice of the right filter for the right application can make a substantial difference in wear rate, cost and performance of your diesel engine.

From Pre-Cleaning to Direct Flow™

With a range of over 1,500 different air filtration products from clamps to air housings to "state-of-the-art" air filters, Fleetguard Heavy Duty Air Filtration, covers all the needs for your sophisticated air intake systems. Fleetguard Visibowl™ Pre-Cleaners and highly efficient Fleetguard pre-cleaner ™ self cleaning Pre-cleaners are strongly recommended for construction, mining, farming, forestry and other segments where operating conditions are severe. For best preventive maintenance practice and to automatically monitor the performance of your air filter, use Fleetguard Restriction indicators. Fleetguard products are engineered to provide the best overall performance and service life. They are the ideal solution in terms of better engine protection, extended service intervals and lower maintenance cost. Our media technology is designed to meet technical specifications including fiber size, shape, pore size, paper thickness and mechanical strength. Fleetguard LIPS (Lenticular Integral Pleat Spacing) ensures that pleats are evenly spaced and that the air spreads equally throughout the surface to maximize filter capacity and life. Special resins impregnated in the media provide maximum performance. Hot melt bonding ensures proper alignment and protection of pleats throughout filter life.



Air Cleaner Housings

Fleetguard® air housings, air cleaners and intake components meet the needs of over 200 Original Equipment Manufacturers (OEM). Fleetguard leads the way in air filtration technology through state-of-the-art design and manufacturing capabilities worldwide. We have the experience and technical expertise to design air filtration systems that exceed application requirements and maximize system potential.

Fleetguard manufacturing facilities around the world produce air filtration systems and are QS 9000, ISO 9001 and/or TS16949 certified. All performance data displayed in this section is based on ISO 5011/SAE J726 standards.

Fleetguard products are used in a wide variety of markets, including:

- **On-Highway - Heavy and Medium Duty Trucks**
- **Construction and Mining**
- **Agriculture**
- **Marine**
- **Industrial**

Determine the Requirements

- Establish the air flow required
  - Refer to engine data sheet or contact engine manufacturer
  - Calculate from the available engine data using the formula below
- Establish the maximum allowable initial restriction
  - Refer to engine data sheet or contact engine manufacturer
  - If no information is available, use the 152 mm H_20, 1.5 kPa, or 6 in H_20 rule of thumb as a guide for On-Highway applications and 254 mm H_2O, 2.5 kPa, or 10 in H_2O for Off-Highway/Industrial applications

Determine the Class of Air Cleaner: If in doubt always over-specify

- In what type of application/ environment will it operate?
  - Light dust concentration environment (single stage air cleaner)
    On highway, Marine, Light dust environments
  - Medium dust concentration environment (2 stage air cleaner)
    On/off highway, industrial with moderate dust
  - Heavy dust concentration environment (2 stage air cleaner with safety element)
    Off road, industrial equipment with heavy dust in the air

Select an Appropriate Air Cleaner

- Examine the flow versus restriction curves to determine the restriction at your given flow rate
- Check the dimensional data to ensure it will fit the customer's application
- Verify that the capacity meets the performance requirements
- Inlet and outlet size and positioning

Determine the Accessories Needed

- Mounting Bracket(s)
- Weather Hood
- Restriction Indicator
- Fleetguard Pre-Cleaner
- Rubber Elbows, Hump Hoses, Hose Clamps, etc.

Air Flow Calculation Formula

Metric: Air flow in **m^3/min =** $$\frac{\text{swept volume}^1\text{ (liters) x speed}^2\text{ x VE}^3\text{ x PF}^4}{\text{1000 x CF}}$$

[1] engine displacement in liters; [2] maximum engine RPM; [3] Volumetric Efficiency; [4] Pulsation factor

Imperial: Air flow in **CFM =** $$\frac{\text{swept volume}^5\text{ (CID) x speed}^2\text{ x VE}^3\text{ x PF}^4}{\text{1728 x CF}}$$

[5] engine displacement in **cubic inches**; [2] maximum engine RPM; [3] Volumetric Efficiency; [4] Pulsation factor

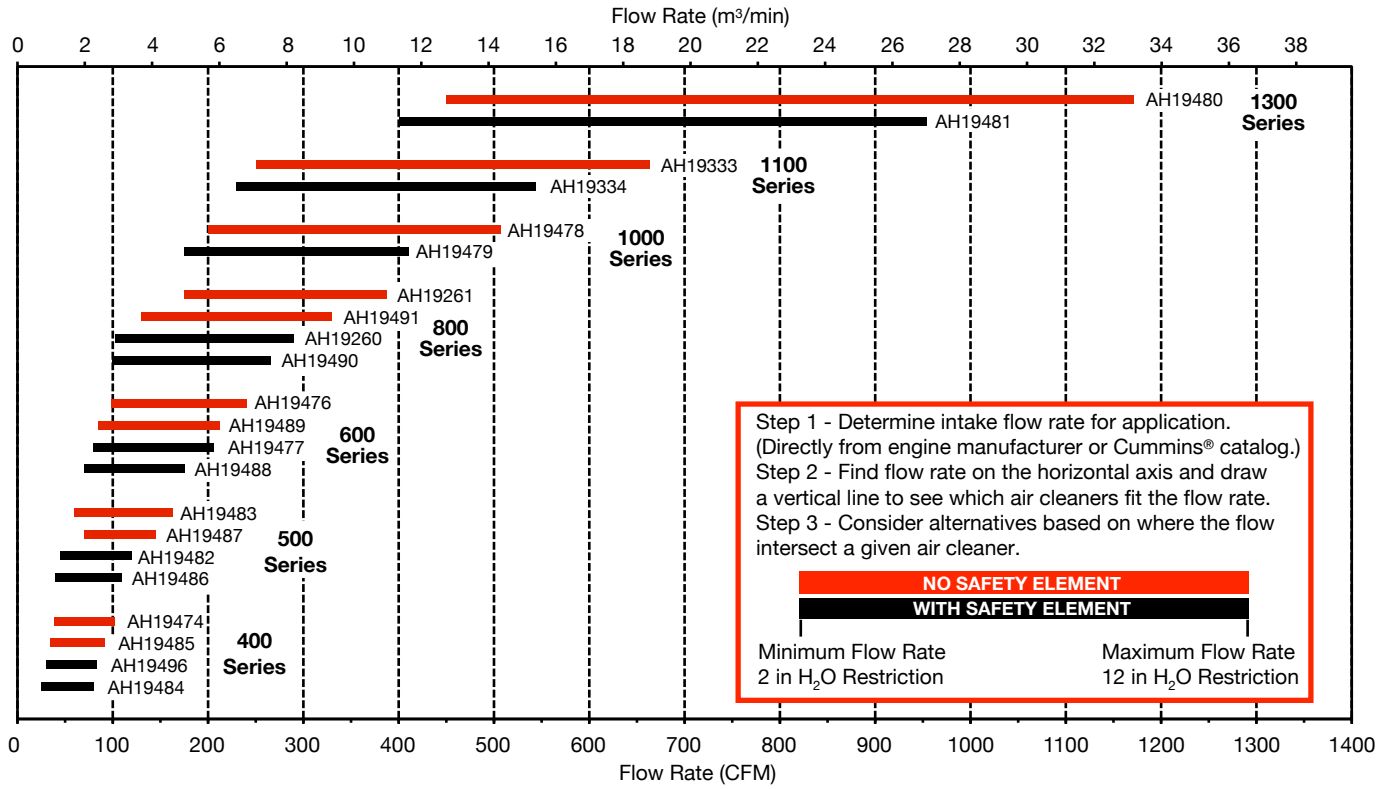
Volumetric Efficiency (VE)
- VE = can be greater than >2 for very new engine designs
- VE = 1.3 to 1.8 for 4 stroke engine with turbocharger
- VE = 0.85 for 4 stroke engine that is naturally aspirated
- VE = 1.4 for 2 stroke (cycle) engine with Roots-Compressor (blower)
- VE = 1.9 for 2 stroke (cycle) engine with Turbocharger

Cycle Factor (CF)
- CF = 2 for a four stroke (cycle) engine
- CF = 1 for a 2 stroke (cycle) engine

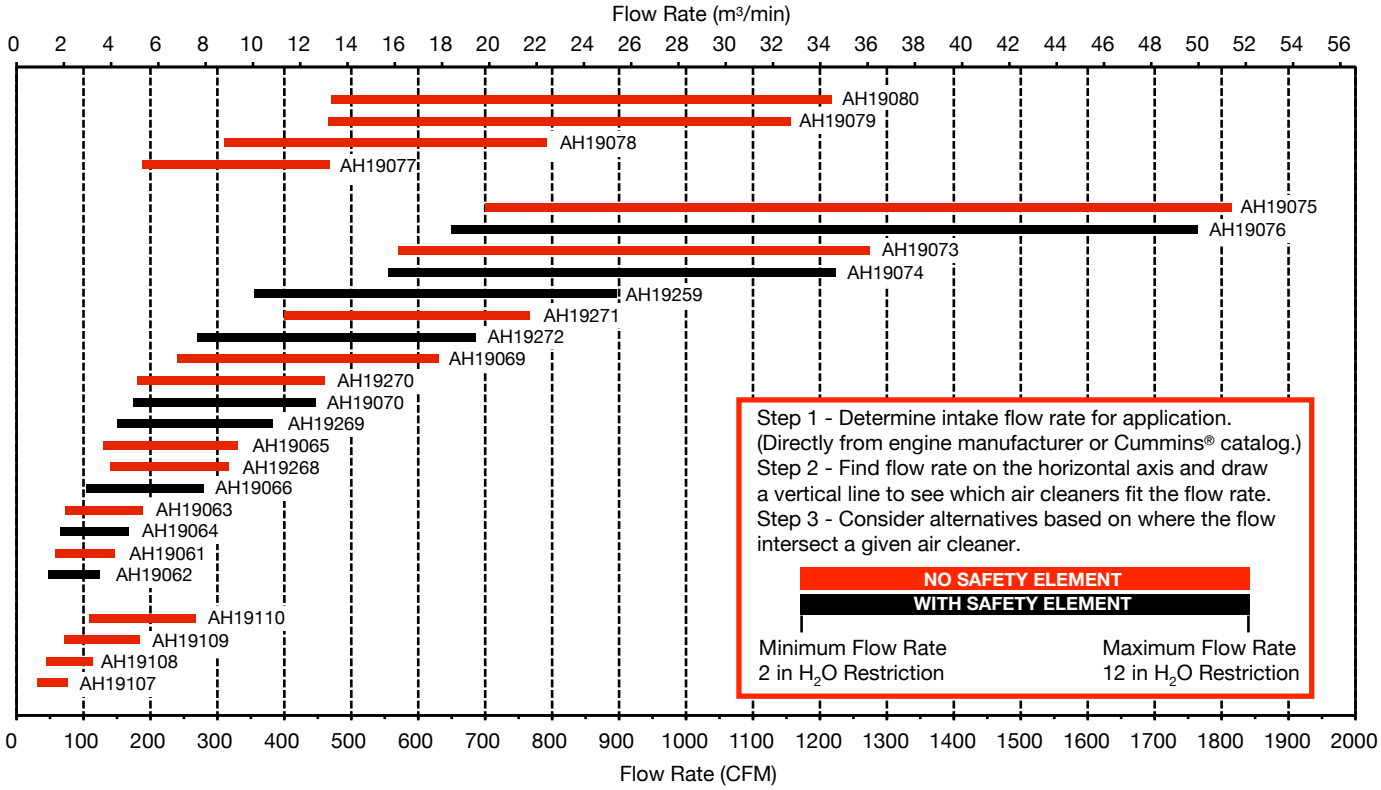
Pulsation Factor (PF) - only applies to engines that are ***both naturally aspirated and having 3 cylinders or less***
- PF = 2-2.1 if only 1 cylinder
- PF = 1.4-1 for two cylinders
- PF = 1.33 for three cylinders

Air Cleaner Selection Charts

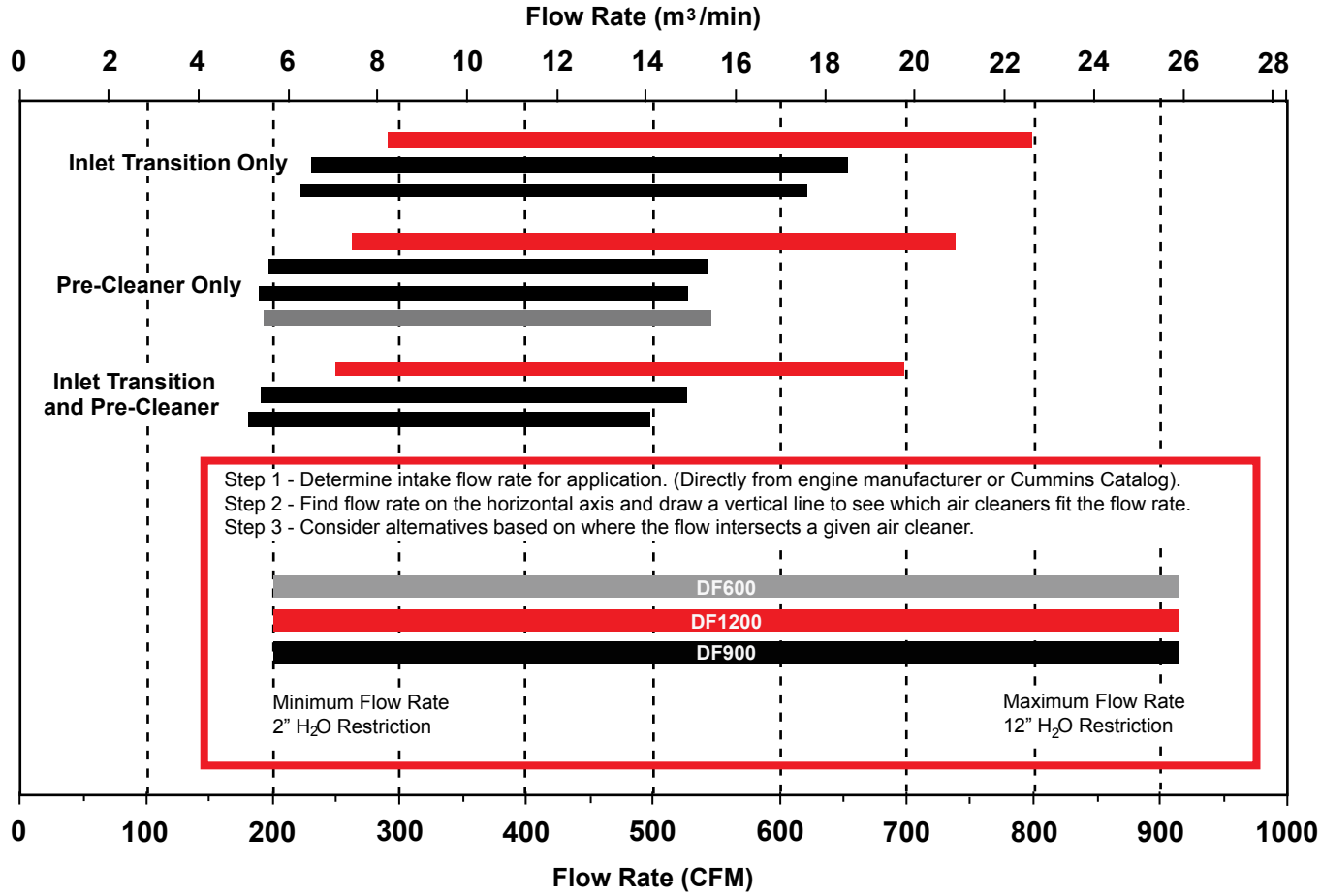
OptiAir™ Air Cleaner Selection Chart



Metal Air Cleaner Selection Chart



Direct Flow™ Flow Air Cleaner Selection Chart



This section describes Air Filtration Application Guidelines as they relate to Engine Manufacturer Requirements, Environmental Considerations, and Durability.

Engine Manufacturer Requirements

System Restriction

Every engine manufacturer has their own recommendation for the maximum allowable initial (clean) restriction for the air intake system, which includes upstream and downstream ducting and grills. If the system's initial restriction requirements are unknown, use 3.74 kPa (15 in H_2O) for off- highway applications and 2.49 kPa (10 in H_2O) for on-highway applications.

This application is where ducting specifications are important. Pressure loss through the combination of upstream and downstream ducting is generally 0.75-1.25 kPa (3-5 in H_2O). However, poor ducting designs can more than double that effect. Proper duct design and care taken to minimize initial restriction will improve the air cleaner's capacity and **increase service life**.

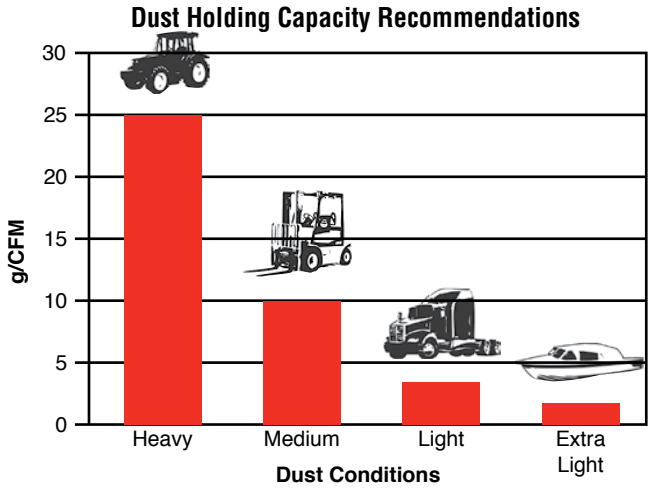
The following are key items for minimizing pressure drop:

- Ensure that air intake openings are as large as possible. Utilize ideal openings or grills (where possible) to straighten the flow path at air intake openings.
- Minimize the number of turns and transitions and avoid sharp angles and rough surfaces.
- Keep the duct diameter as large as possible throughout the system and reduce down as close to the engine/turbo intake as possible.
- When combining two flows, use gradual “Y” angles. A gradual “Y” angle is preferred, as “T” style connections cause pressure loss due to turbulence.

Ducting Designs

One way to describe dust holding capacity is by taking a ratio of the grams of dust processed by the air cleaner per engine airflow (g/CFM). The following dust holding capacities are recommended for the given dust environments:

Dust Holding Capacity



Dust Environments and Typical Applications

Heavy = Construction, mining, convoys on dirt roads, agricultural equipment

Medium = Asphalt equipment, forklifts

Light = On-highway vehicles in developed countries, lawn & turf equipment

Extra Light = Marine use, residential stationary equipment

For light environments the dust holding capacity can range from 1.5-3 g/CFM.

Heavy and medium dust environments require a two-stage air cleaner such as an integral pre-cleaner with a tangential inlet, or a spinner fin. Dump trucks and on-road trucks spending more than 20% of their time off-road or in developing countries should anticipate medium or heavy dust conditions. Heavy-duty applications should always utilize an air cleaner with a secondary element. The use of a secondary element is also recommended for medium-duty applications.

Air Filtration Application Guidelines

Environmental Considerations

The purpose of the air intake system is to provide clean, cool, quiet, and dry air for the engine. Keep the following environmental conditions in mind when positioning the air cleaner and intake ducting:

- **Protect the intake air from water ingestion by utilizing weather hoods or other protection.**
- **Position the air intake to minimize dust ingression.** Do not draw air from the wheel well or under carriage areas. The air intake should be positioned as high as possible and toward the front of the vehicle for on-highway vehicles. (Small variations in the air intake position can greatly improve service life.)
- **Air intake ducting should draw air from near-ambient locations.** Increased air intake temperatures have a significant effect on engine power.
- **Continuous Operating Temperature Range (COTR) for the plastic air cleaners shown in this catalog is -40 °F (-40 °C) to 180 °F (82 °C).** Heat shielding and air baffles are acceptable options for reducing skin temperatures. If higher temperature materials are required, contact your Fleetguard sales representative to inquire about custom designs (minimum quantities may apply).

Durability

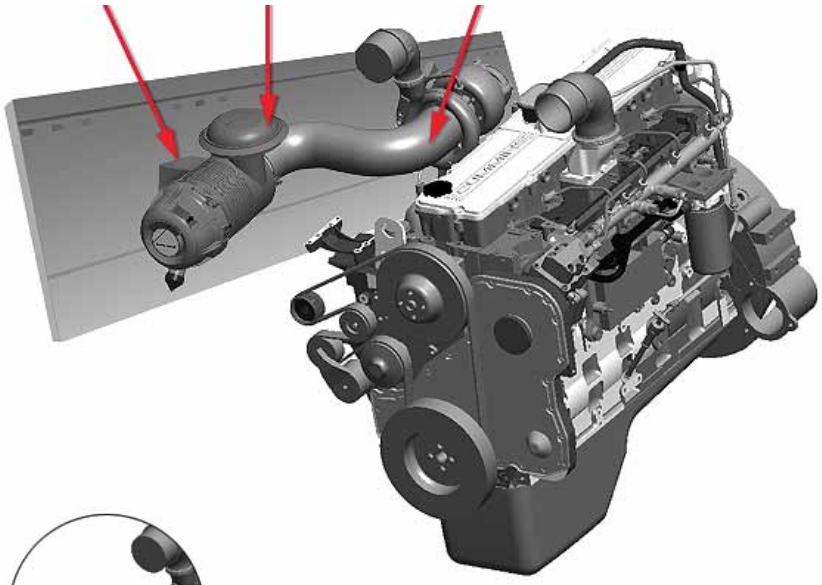
Air cleaners should be chassis mounted to minimize vibration. Engine mounting is only recommended with proper validation by a vehicle/equipment designer. Avoid the mounting of air cleaners or other components to 3-cylinder engines, as the vibration level is excessive due to the natural unbalanced condition of the engine. If vibration is a concern, consider iso-mounting or bracket designs to reduce acceleration levels and move the air cleaner resonance points away from the engine or vehicle resonance frequencies. Consider both the engine and vehicle resonance points. Engine resonance frequencies can be easily calculated. Vehicle resonance points are not easy to calculate. However, many on-highway vehicles have their first resonance point at or around 20 Hz. For further assistance in dealing with vibration issues, contact your Fleetguard representative to inquire about custom designs or materials (minimum quantities may apply).

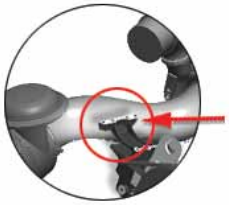
When air cleaners are chassis mounted, pay close attention to the clean side ducting design. Because of the relative movement between the air cleaner and the engine, the ducting will be exposed to additional forces and the hose design may need to compensate for significant length changes between connections during operation. Flexible hose connections are essential.

Minimize vibration with a chassis mount.

Protect the inlet from harmful elements with a weather hood.

Ensure that the design accounts for full relative motion between the air cleaner and the engine. Flexible connections are mandatory.





Avoid mounting in areas where ducting is exposed to components that could cause abrasive wear.

Miscellaneous Guidelines

- Torque Range: The torque range for plastic inlet/outlet tubes = 25-40 in-lbs (2.8-4.5 N·m). Do not over-torque connections.
- Hose Connections: Use appropriate hose connections. SAE HD Worm Gear F-style or T-bolt are recommended.
- Connection Points: Minimize the connection points. Leakage is a greater risk with multiple connections.
- Hose Materials: Utilize the appropriate high temperature material at the turbo.
- Intake Routing: Use caution when routing intake system ducting by avoiding damage from abrasion and heat sources.
- Excessive Weight: Avoid excessive unsupported weight on clamped joints (< 3 lb (1.4 kg) recommended).
- Restriction Indicators: Utilize restriction indicators in the system to monitor restriction and maximize performance and service life.

Notes