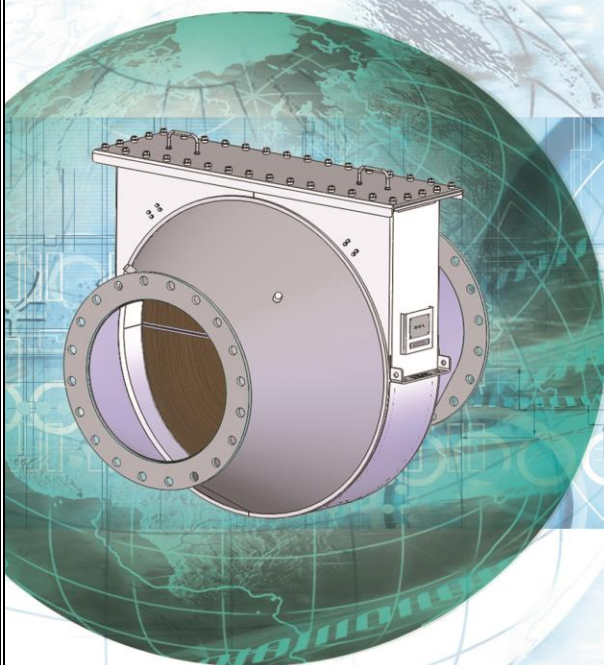


# QUICK-LID<sup>®</sup> CATALYTIC CONVERTER INSTALLATION, OPERATION AND MAINTENANCE



## QUICK-LID<sup>®</sup>

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## 1.0 GENERAL

**Important Note: Before any work, consult your company health and safety officer for details of safe working practices. Safety requirements include but are not limited to: proper engine shut down; personal protection (gloves, coveralls, safety glasses etc.); and safe handling temperature of converter.**

The QUICK-LID® catalytic converter is designed for emission control of industrial internal-combustion engines used in the following applications:

- Power generation and co-generation
- Gas compression
- Chillers
- Irrigation and pumping stations
- Air compressors
- CNG refuelling

This manual contains instructions on installation, maintenance and operation of the converter\*, as well as operating limits and restrictions.

For lean-burn spark-ignited or compression ignited engines the converter promotes the oxidation reactions of carbon monoxide (CO), hydrocarbons (C<sub>x</sub>H<sub>y</sub>) and partially oxidized hydrocarbons (C<sub>x</sub>H<sub>y</sub>O) into carbon dioxide (CO<sub>2</sub>) and water (H<sub>2</sub>O). For these reactions to take place the catalyst element must have a coating designed for oxidation reactions.

For rich-burn or stoichiometric spark-ignited engines, the converter promotes the three-way reactions of oxides of nitrogen (NO<sub>x</sub>), carbon monoxide (CO), and hydrocarbons (C<sub>x</sub>H<sub>y</sub>) into nitrogen (N<sub>2</sub>), carbon dioxide (CO<sub>2</sub>) and water (H<sub>2</sub>O). For these reactions to take place the catalyst element must have a coating designed for three-way reactions, and it is necessary for the engine to operate with a closed loop air-fuel ratio control system.

The converter is normally used for allowing a site to comply with air quality requirements. The design conversion efficiency and/or design post-converter emissions are provided in the Quotation. The conversion of any of substance across the converter shall be the difference of the inlet quality of the substance minus the quantity of the substance divided by the inlet quantity of the substance.

In some cases the converter is combined with a muffler or silencer to also provide sound attenuation.

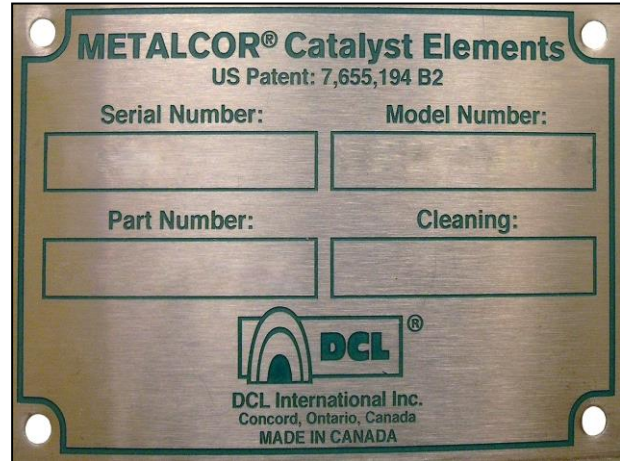
\*The term “converter ” (unless otherwise specified) will be used in this manual to include both QUICK-LID® catalytic converters and QUICK-LID® catalytic silencers installed with either oxidation or three-way catalysts.

## 2.0 NAMEPLATE INFORMATION

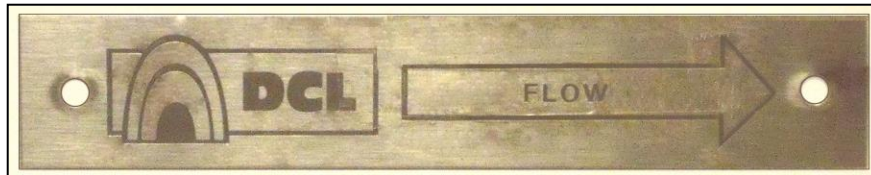
Refer to the nameplate for the part, model and serial numbers. Nameplates are located on both the housing and the catalyst element. Record this information for reference. Affixed to the converter will also be a warning label and a flow direction arrow as depicted below.



Housing Nameplate



Element Nameplate



Flow Direction Arrow

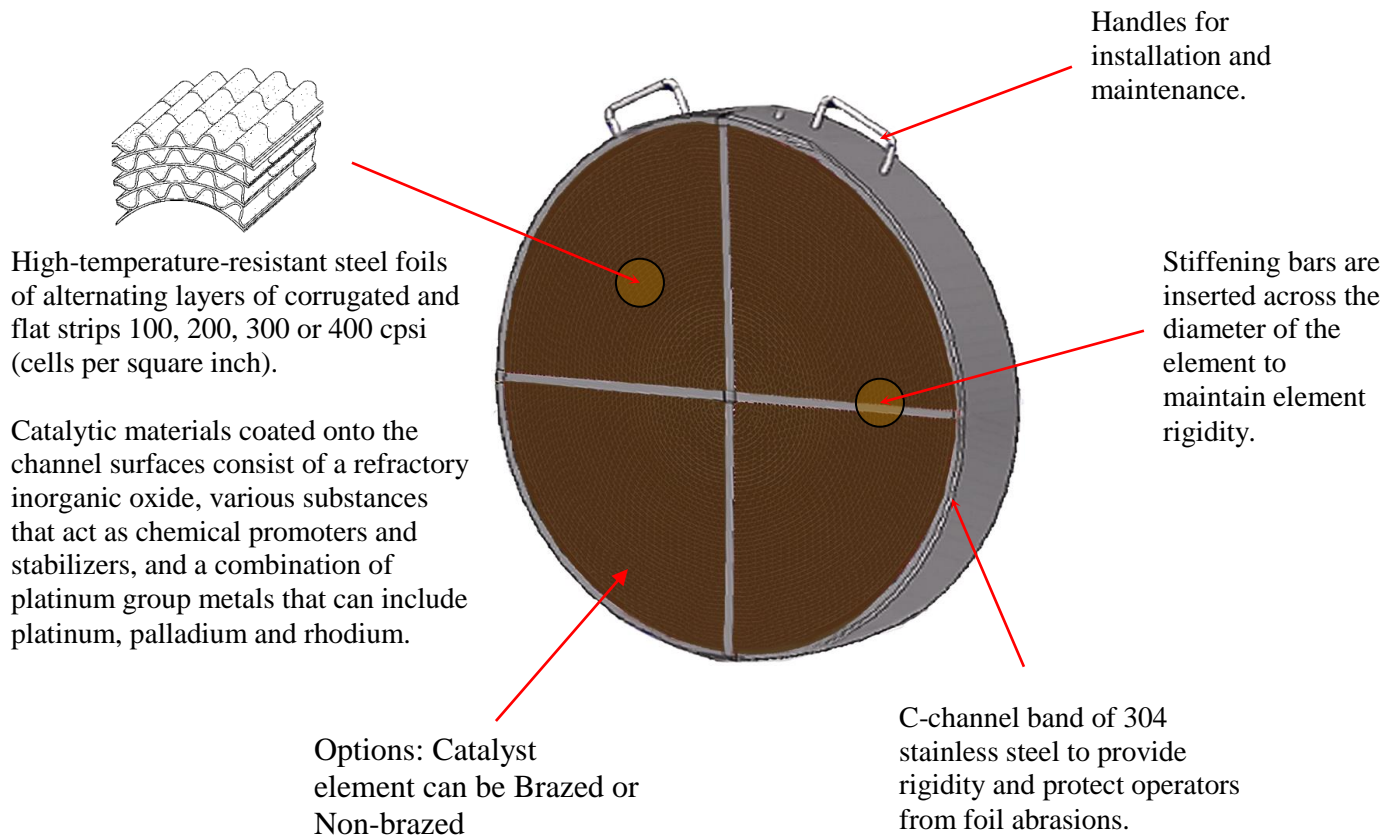


Warning Label



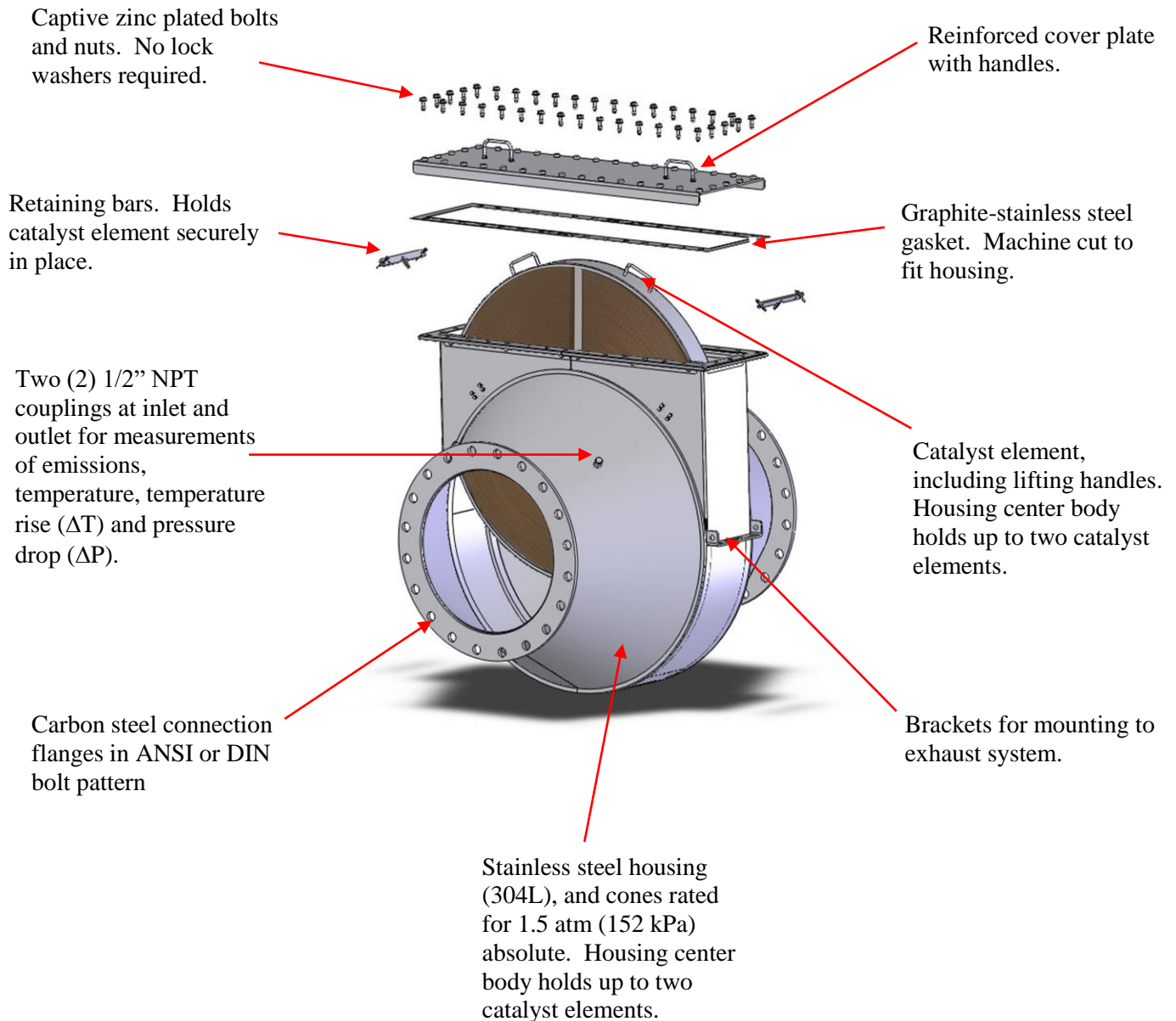
## 3.0 PRODUCT DESCRIPTION

### 3.1 Catalyst Element Specifications



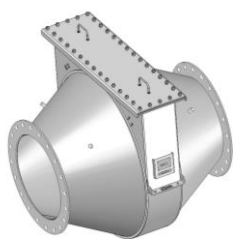
## 3.2 Converter Housing Specifications

The following section contains general specifications for the QUICK-LID<sup>®</sup> catalytic converter housing. For any special customer specifications refer to the sales drawing.

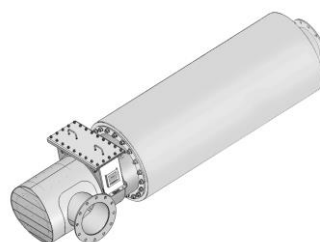


### 3.3 Housing Configurations

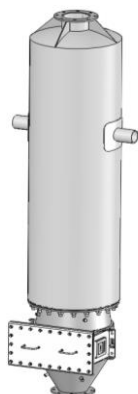
The QUICK-LID® converter comes in several configurations. The converter housing is primarily 304L stainless steel. In some cases the converter center body is integrated with a silencer. Where silencer components are integrated with the converter, the silencer jacket and silencer internal baffle components are mild steel unless specified otherwise by the customer. Where applicable, the sales drawing and/or quotation will indicate the sound attenuation or grade for the silencer.



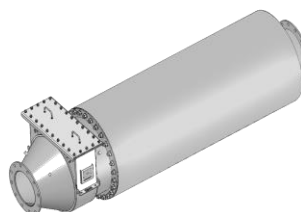
**QUICK-LID® Q6 Catalytic Converter.**  
Holds up to two catalyst elements.



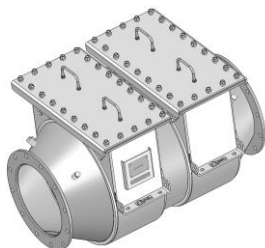
**QUICK-LID® QM6 Catalytic Silencer.**  
Holds up to two catalyst elements.  
(Custom Inlet)



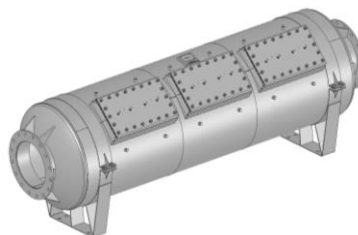
**QUICK-LID® QM6 Vertical Catalytic Converter.** Holds up to two catalyst elements.



**QUICK-LID® QM6 Catalytic Silencer.**  
Holds up to two catalyst elements.



**QUICK-LID® Q6 Catalytic Converter.** Holds up to four catalyst elements.



**QUICK-LID® Q6 Lateral Catalytic Silencer.**  
Holds up to six catalyst elements.

### **3.4 Paint and Coating Specifications**

Catalytic converter housings are almost entirely stainless steel and therefore are supplied without paint or coating.

Catalytic silencer housings are supplied with high heat black paint. Under normal high temperature operation, peeling and other imperfections may occur. Higher grades of paint and protective coatings are available upon request.

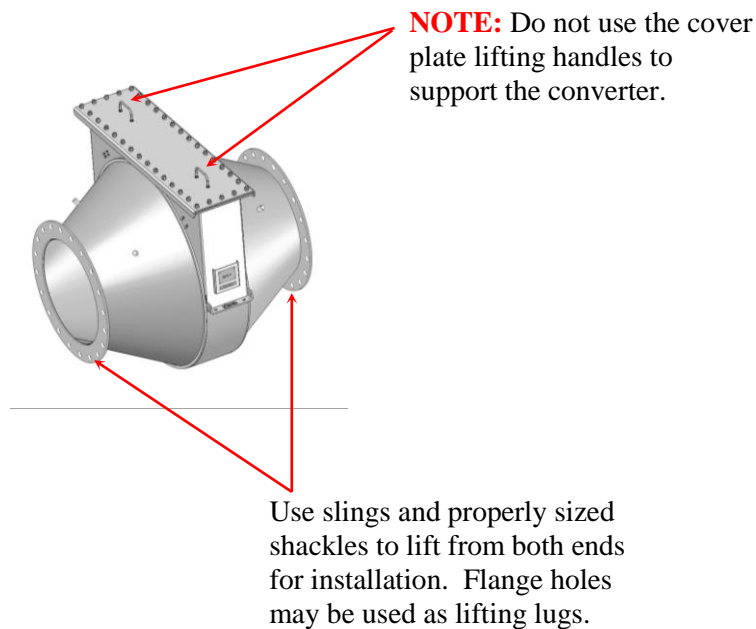


## 4.0 INSTALLATION

### 4.1 General Mounting Guidelines

- The converter should be mounted by overhead supports or base supports as shown in Sections 4.3 and 4.4.
- Mount the converter according to the flow direction sticker on the housing.
- Always isolate the converter from engine vibration (ie., use expansion joint between the engine and the beginning of the exhaust piping).
- Ensure the converter does not support the weight of the exhaust pipe or any other exhaust system components.
- Avoid long piping runs before the converter that will thermally expand into the housing.
- Ensure that the converter location is easily accessed for inspection and removal of the catalyst element(s). Where necessary, install non-slip walking grids and/or safety railings for accessing the catalyst element.
- The converter should be located close to the exhaust manifold or turbocharger outlet as the higher exhaust gas temperatures will increase the destruction efficiency of pollutants.
- Where the exhaust temperature exceeds the design temperature for the converter, short lengths of un-insulated pipe upstream of the converter are acceptable for outdoor applications.

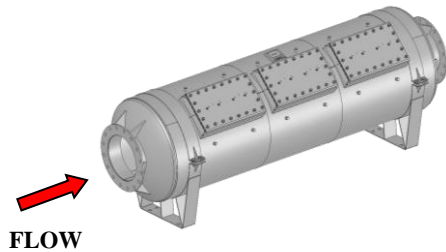
### 4.2 Lifting and Handling of Housing



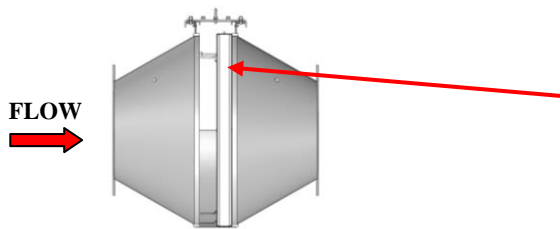
## 4.3 Mounting Orientation

### Horizontal Flow Orientation

For best mechanical durability of the catalyst element it is recommended the housing be positioned so that the exhaust flow direction is parallel with the ground. It is important to install the catalytic converter so that the housing cover is facing away from the ground and the catalyst element is held in place mostly by gravity.



**NOTE:** If installing only one catalyst element for the lateral design it is recommended to follow vertical installation guidelines Refer to Appendix A.

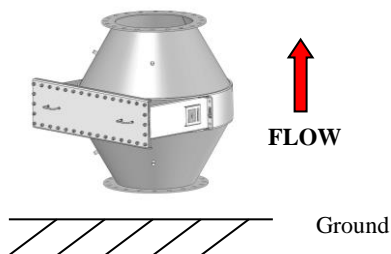


**NOTE:** If installing only one catalyst element, it is recommended the slot furthest from the inlet be used first. See Appendix A.

### Vertical Flow Orientation

Positioning the housing so that the exhaust flow direction is perpendicular to ground level is acceptable only for engines running at speeds 1000 rpm or higher.

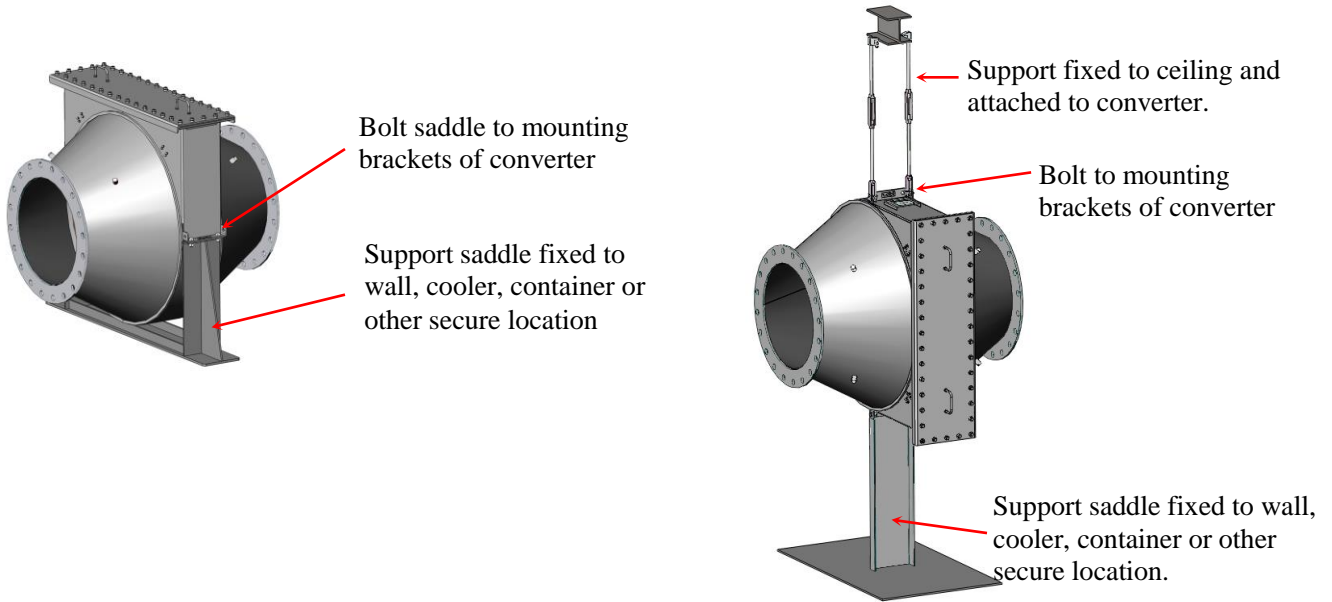
**Important note:** Mounting a catalytic silencer in the vertical orientation may involve structural components such as trunnions, wind load and seismic zone standards, and the need to support a stack. Design details for vertically mounted catalytic silencers must be discussed with DCL at the proposal stage and incorporated into the sales drawing.



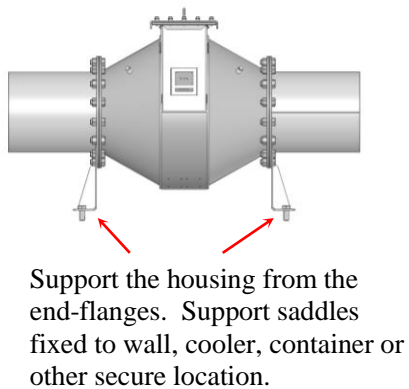
**NOTE:** Refer to Appendix A for catalyst installation instructions.

## 4.4 Mounting Examples

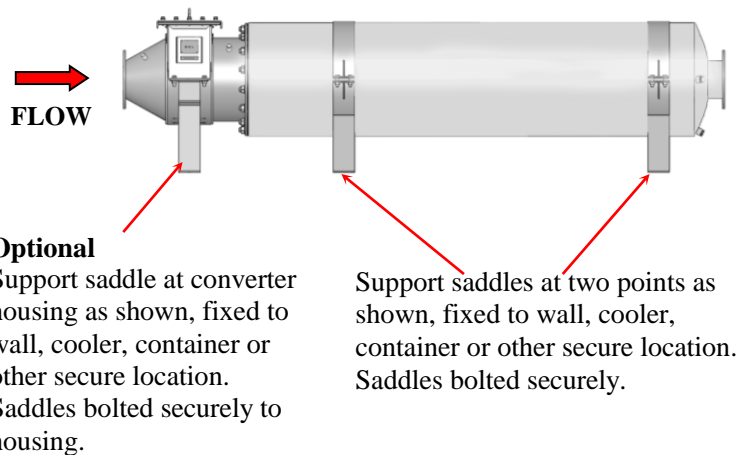
### Horizontal Flow – Catalytic Converter Q6



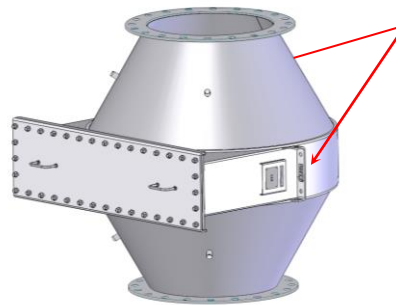
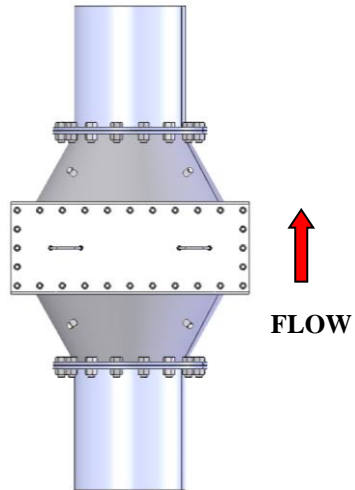
### Horizontal Flow – Catalytic Converter Q6



### Horizontal Flow – Catalytic Silencer QM6



## Vertical Flow – Catalytic Converter Q6



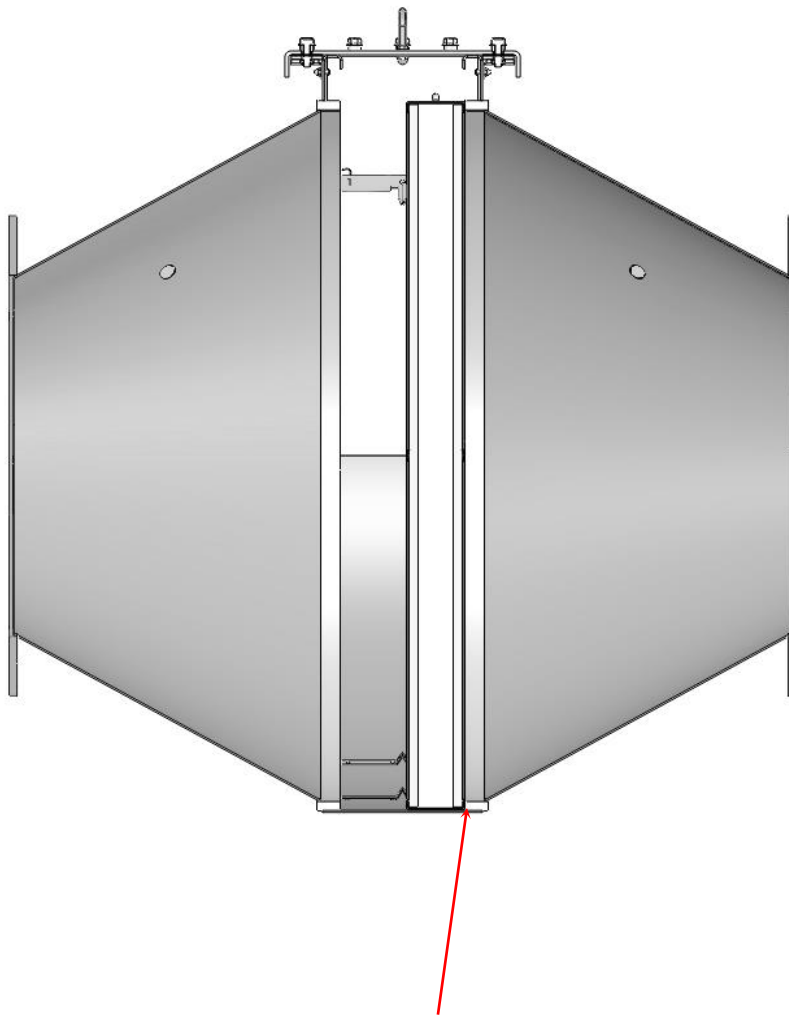
Bolt to mounting brackets on both sides of the converter and support at two points fixed to wall, cooler, container or other secure location

## 4.5 Inspection for Exhaust Gas Blow-By

Inspection for exhaust gas blow-by is recommended after a backfire or explosion or if a leak is suspected. Inspection is done by using gap feelers in the following manner.

Remove cover plate and check accessible areas of the catalyst element. Using a 0.125" (3.2 mm) gap feeler, check to make sure it does not fit between the catalyst element and the housing at any point around the catalyst element. There should be no localized gap of 0.125" (3.2 mm) or greater at any point around the catalyst element.

Using a 0.06" (1.5 mm) gap feeler, check to make sure it does not fit between the catalyst element and the housing and slide for the entire accessible area of the catalyst element. The gap around the catalyst element should not be greater than 0.06" (1.5 mm) for any extended area.



Maximum localized gap anywhere  $\leq 0.125''$  (3.2 mm)]  
Maximum gap  $< 0.06''$  (1.5 mm) for up to 300 degrees

## 4.6 Safety, Storage and Handling of Elements

Handling the DCL metal element does not pose any particular health or safety hazard related to catalyst composition or formulation (see Appendix C for MSDS sheets). If elements are stacked together for shipping, use a layer of cardboard, plywood or other suitable material between each element to prevent them from rubbing against each other and causing damage.

The metal foils are sharp and abrasion of the hands or other body parts may occur if the elements are handled without gloves or other protective clothing. The elements should be packed in bubble wrap or other suitable packing material. The thin metal foils on the element are prone to damage if handled improperly. The element foils can be easily crushed if struck with a hard object, resulting in plugging of the channels.

To store DCL elements, pack the element in a plastic or bubble wrap and store at normal room temperature in a dry area away from direct sunlight. If stored under these conditions DCL elements have an indefinite shelf life. It is recommended that parts stored in excess of two years be tested for activity before use. DCL should be contacted if activity testing is required.

After prolonged storage some dust may accumulate at the bottom of the element. This dust will contain high levels of alumina and platinum group metals. This dust does not pose any health or safety hazard but should be disposed of properly.

## 4.7 Insulation Installation



The sampling ports must not be covered with insulation, as any leaks could lead to heat damaged and potential for insulation fire. If insulation is required, the height of the sampling port must be extended above the insulation. The insulation must have proper opening for the sampling port.



## 5.0 OPERATION

### 5.1 Operating Requirements for Three-Way (NSCR) Catalysts

The operating requirements below are necessary to achieve the emission targets indicated in the quote. Failure to meet these operating requirements may result in lower than expected emission destruction efficiencies.

Exhaust Flowrate	✓ As indicated in quote.
Exhaust Temperature	<ul style="list-style-type: none"> <li>✓ Minimum 752 °F (400 °C) at inlet to converter.</li> <li>✓ Maximum 1250 °F (677 °C) at inlet to converter.</li> <li>✓ Maximum 1350 °F (732 °C) at outlet of converter.</li> </ul>
Engine Power	✓ As indicated in quote.
Engine Speed	✓ As indicated in quote.
Lube Oil Specification	<ul style="list-style-type: none"> <li>✓ Sulfated ash &lt;0.6 wt%.</li> <li>✓ Zinc &lt; 900 ppm.</li> <li>✓ Phosphorus &lt; 400 ppm.</li> </ul>
Lube Oil Consumption Rate	✓ Manufacturer's normal lube oil consumption rate or 0.5 g/bhp-hr (0.67 g/kW-h), whichever is lower.
Crank case ventilation	✓ Crank case ventilation should be routed either back to the air intake or downstream of the converter.
Fuel Quality	<ul style="list-style-type: none"> <li>✓ Pipeline quality natural gas or commercial grade LPG or gasoline is preferred by not required.</li> <li>✓ Unprocessed wellhead gas is acceptable if all other specifications are maintained and measures are taken to ensure the engine can run on the fuel without misfires.</li> <li>✓ Biogas, landfill gas and digester gas are acceptable if all other specifications are maintained.</li> <li>✓ For gaseous fuels the energy content should be &gt; 750 BTU/ft<sup>3</sup> LHV.</li> <li>✓ Total Sulfur (all sulfur compounds) &lt; 30 mg/Nm<sup>3</sup> and &lt; 20 ppm.</li> <li>✓ Chlorinated compounds &lt; 10 ppm.</li> <li>✓ Siloxane compounds &lt; 40 ppb (Scrubbing of the fuel is normally required to achieve this level for landfill gas).</li> </ul>
Exhaust gas oxygen (EGO) sensor set-point	<ul style="list-style-type: none"> <li>✓ For air-fuel ratio controllers that operate using a pre-converter EGO sensor and setpoint voltage, the optimum setpoint is typically between 700 and 800 mV. The optimum voltage setpoint may vary according to the engine load. The signal from the EGO sensor is somewhat biased by CO, H<sub>2</sub> and HC levels, exhaust gas temperature and age of the sensor.</li> <li>✓ For air-fuel ratio controllers that use a dithering strategy, follow the operating instructions provided by the manufacturer.</li> </ul>

Oxygen	<ul style="list-style-type: none"> <li>✓ 0.2-0.5% at inlet to converter.</li> </ul>
Air-Fuel Ratio Controller	<ul style="list-style-type: none"> <li>✓ After installation of the converter, use a portable analyzer to measure pre and post converter NO<sub>x</sub>, CO, O<sub>2</sub> emissions and determine the correct setpoints for operation. Note the setpoints may change depending on engine load, EGO sensor age and other operating conditions, so it is recommended that emissions are checked periodically with a portable analyser to see if adjustments to the setpoints are necessary.</li> <li>✓ Engine and air-fuel controller must operate at a steady condition, with air-fuel ratio swings not exceeding +/- 0.005 lambda.</li> <li>✓ The EGO sensor at inlet to the converter should not deviate by more than 50 mV from its setpoint during steady operation.</li> <li>✓ All operation and maintenance procedures for the air-fuel ratio controller must be followed, including scheduled replacement of thermocouples and EGO sensors.</li> </ul>
Ash Deposits	<ul style="list-style-type: none"> <li>✓ Ash deposits should not exceed 50 g per liter of catalyst element (1400 g/ft<sup>3</sup>).</li> <li>✓ High levels of ash on the catalyst element will result in higher pressure restrictions and reduce conversion efficiency.</li> <li>✓ It is recommended that an authorized cleaning facility is contacted if cleaning of the catalyst element is necessary.</li> <li>✓ Cleaning procedures are available from DCL upon request.</li> </ul>
Exhaust System	<ul style="list-style-type: none"> <li>✓ Ensure the exhaust system is free of leaks, particularly before the converter.</li> </ul>
Ignition System	<ul style="list-style-type: none"> <li>✓ Replace spark plugs at scheduled intervals. Never allow a spark plug to fail before replacing it.</li> <li>✓ Check spark gap, wiring harness and secondary leads as well as coils and magnetos.</li> <li>✓ Proper grounding of the ignition system is essential to proper combustion.</li> <li>✓ Timing must be adjusted to the manufacturer's recommended setting for the given site fuel and engine conditions.</li> <li>✓ Digital ignition systems are recommended for combustion stability, but are not required.</li> <li>✓ The ignition coils should not be painted. Painting of the coils has been known to cause incomplete combustion.</li> </ul>
Fuel System	<ul style="list-style-type: none"> <li>✓ Ensure the fuel system is properly maintained and functioning according to manufacturer's specifications.</li> <li>✓ Ensure a stable fuel supply, proper fuel pressures and balanced regulators and carburetors.</li> <li>✓ Eliminate the risk of backfires, due to purging of the exhaust system with fuel, by equipping the fuel supply system with a safety shut off valve triggered by the ignition or annunciator panel.</li> </ul> <p>Start up sequence: air – ignition – fuel Shut down sequence: fuel – ignition – air</p>

Back-Pressure	<ul style="list-style-type: none"> <li>✓ High back-pressure may indicate excessive build-up of ash deposits.</li> <li>✓ When the catalyst bed is new, measure pressure before and after the converter during full load operation. The difference in before and after pressure is the baseline back-pressure for the converter.</li> <li>✓ Re-measure the converter back-pressure under the same operating conditions periodically.</li> <li>✓ Should the converter back-pressure increase by more than 2" wc (0.5 kPa) over the baseline back-pressure, the catalyst element should be removed for cleaning.</li> <li>✓ Should the converter back-pressure decrease from baseline back-pressure, the catalyst element should be removed and inspected for damage.</li> </ul>
High Temperature Shutdown	<ul style="list-style-type: none"> <li>✓ A functioning high temperature shut-down system is required to prevent the catalyst element from over-heating due to misfires.</li> <li>✓ The thermocouple located on an outlet port of the converter should be set to 150°F (83°C) above the normal outlet temperature of the converter but should never exceed 1,350°F (732°C).</li> </ul>
Catalyst Poisons	<ul style="list-style-type: none"> <li>✓ Catalyst poisons build up on the catalyst element over time, due to their presence in the fuel or lube oil. The presence of certain contaminants may also indicate excessive engine wear or a coolant breach.</li> <li>✓ If there is a suspected problem, the catalyst element may be returned to DCL, where a small amount of washcoat is removed and analyzed for contaminants and activity.</li> <li>✓ For acceptable performance, catalyst poisons as a fraction of washcoat shall not exceed the following: <ul style="list-style-type: none"> <li>○ Sulfur &lt; 1%</li> <li>○ Calcium &lt; 1%</li> <li>○ Phosphorus &lt; 1%</li> <li>○ Zinc &lt; 0.5%</li> <li>○ Iron &lt; 1%</li> <li>○ Sulfur, Calcium, Phosphorus, Zinc, Iron &lt; 2% (collectively)</li> <li>○ Lead, Mercury, Arsenic, Antimony, Copper, Tin, Nickel, Chromium &lt; 200 ppm (collectively)</li> </ul> </li> </ul>
Compliance Assurance Monitoring	<ul style="list-style-type: none"> <li>✓ It is recommended that the site operator establish a Compliance Assurance Monitoring (CAM) plan.</li> <li>✓ A CAM plan should be tailored to the site specific or company specific needs. An example is provided in Appendix B.</li> </ul>

Unless stated otherwise in the quote, the following are the assumed pre-catalyst emissions after calibration of the air-fuel ratio controller. Should pre-catalyst emissions fall outside the ranges below, lower than expected emission destruction efficiencies may result.

Species	g/bhp-h	ppmvd (15% O <sub>2</sub> )	mg/Nm <sup>3</sup> (5% O <sub>2</sub> )
Nox (as NO <sub>2</sub> )	8-14	530 – 940	3000 – 5200
CO	10-16	1100 – 1800	3700 – 6000
NMHC	<0.5	< 100 (C1)	< 190
NMNEHC	<0.3	< 60 (C1)	< 110
VOCs	<0.3	39 (C1)	< 110
CH <sub>2</sub> O	<0.2	29	< 75

The product warranty shall be voided if the following occurs:

- Engine misfire, backfire or exhaust system explosion.
- Excess unburned fuel entering the catalyst, such as when the engine operates beyond its lean limit or if an ignition failure occurs.
- Turbocharger failure.
- Exhaust temperature in excess of the maximum.
- Catalyst poisons in excess of the maximum.
- Fuel quality not meeting the specifications in this manual.
- Mechanical damage to the converter due to improper mounting.
- Mis-handling or improper storage of catalyst elements.
- Improper cleaning of the catalyst element.
- Failure to conduct normal maintenance.

## 5.2 Operating Requirements for Oxidation Catalysts

The operating requirements below are necessary to achieve the emission targets indicated in the quote. Failure to meet these operating requirements may result in lower than expected emission destruction efficiencies.

Exhaust Flowrate	✓ As indicated in quote.
Exhaust Temperature	<ul style="list-style-type: none"> <li>✓ No lower than 54 °F (30 °C) than the temperature indicated in quote.</li> <li>✓ At inlet and outlet of the converter the temperature must never exceed a maximum 1112 °F (600 °C).</li> </ul>
Engine Power	✓ As indicated in quote.
Engine Speed	✓ As indicated in quote.
Lube Oil Specification	<ul style="list-style-type: none"> <li>✓ Sulfated ash &lt;0.6 wt% (Spark ignited engines).</li> <li>✓ Sulfated ash &lt;1.0 wt% (Compression ignited engines).</li> <li>✓ Zinc &lt; 900 ppm.</li> <li>✓ Phosphorus &lt; 400 ppm.</li> </ul>
Lube Oil Consumption Rate	✓ Manufacturer's normal lube oil consumption rate or 0.5 g/bhp-hr (0.67 g/kW-h), whichever is lower.
Crank case ventilation	✓ Crank case ventilation should be routed either back to the air intake or downstream of the converter.
Fuel Quality for Gaseous Fuels	<ul style="list-style-type: none"> <li>✓ Pipeline quality natural gas or commercial grade LPG or gasoline is preferred by not required.</li> <li>✓ Unprocessed wellhead gas is acceptable if all other specifications are maintained and measures are taken to ensure the engine can run on the fuel without misfires.</li> <li>✓ Biogas, landfill gas and digester gas are acceptable if all other specifications are maintained.</li> <li>✓ Total Sulfur (all sulfur compounds) &lt; 30 mg/Nm<sup>3</sup> and &lt; 20 ppm.</li> <li>✓ Chlorinated compounds &lt; 10 ppm.</li> <li>✓ Siloxane compounds &lt; 40 ppb (Scrubbing of the fuel is normally required to achieve this level for landfill gas).</li> </ul>
Fuel Quality for Diesel, LFO, or Biodiesel Blends	<ul style="list-style-type: none"> <li>✓ Fuel must conform to ASTM D975, ASTM D6751, EN590 or EN14214 standards, plus the following additional standards:</li> <li>✓ Sulfur &lt; 15 ppm by mass.</li> <li>✓ Chlorinated compounds – must be Nil.</li> <li>✓ Siloxane compounds – must be Nil.</li> <li>✓ Phosphorus &lt; 1 ppm.</li> </ul>
Oxygen	✓ > 2% at inlet to converter.

Ash Deposits	<ul style="list-style-type: none"> <li>✓ Ash deposits should not exceed 50 g per liter of catalyst element (1400 g/ft<sup>3</sup>).</li> <li>✓ High levels of ash on the catalyst element will result in higher pressure restrictions and reduce conversion efficiency.</li> <li>✓ It is recommended that an authorized cleaning facility is contacted if cleaning of the catalyst element is necessary.</li> <li>✓ Cleaning procedures are available from DCL upon request.</li> </ul>
Exhaust System	<ul style="list-style-type: none"> <li>✓ Ensure the exhaust system is free of leaks, particularly before the converter.</li> </ul>
Ignition System (Spark Ignited Engines)	<ul style="list-style-type: none"> <li>✓ Replace spark plugs at scheduled intervals. Never allow a spark plug to fail before replacing it.</li> <li>✓ Check spark gap, wiring harness and secondary leads as well as coils and magnetos.</li> <li>✓ Proper grounding of the ignition system is essential to proper combustion.</li> <li>✓ Timing must be adjusted to the manufacturer's recommended setting for the given site fuel and engine conditions.</li> <li>✓ Digital ignition systems are recommended for combustion stability, but are not required.</li> <li>✓ The ignition coils should not be painted. Painting of the coils has been known to cause incomplete combustion.</li> </ul>
Fuel System (Spark Ignited Engines)	<ul style="list-style-type: none"> <li>✓ Ensure the fuel system is properly maintained and functioning according to manufacturer's specifications.</li> <li>✓ Ensure a stable fuel supply, proper fuel pressures and balanced regulators and carburetors.</li> <li>✓ Eliminate the risk of backfires, due to purging of the exhaust system with fuel, by equipping the fuel supply system with a safety shut off valve triggered by the ignition or annunciator panel.</li> </ul> <p style="text-align: center;">Start up sequence: air – ignition – fuel Shut down sequence: fuel – ignition – air</p>
Fuel System (Compression Ignited Engines)	<ul style="list-style-type: none"> <li>✓ Repair and replace fuel injectors at intervals required by the engine manufacturer's maintenance schedule.</li> <li>✓ Fix worn hydraulic injectors to stop lube oil leaks into the fuel.</li> </ul>
Back-Pressure	<ul style="list-style-type: none"> <li>✓ High back-pressure may indicate excessive build-up of ash deposits.</li> <li>✓ When the catalyst bed is new, measure pressure before and after the converter during full load operation. The difference in before and after pressure is the baseline back-pressure for the converter.</li> <li>✓ Re-measure the converter back-pressure under the same operating conditions periodically.</li> <li>✓ Should the converter back-pressure increase by more than 2" wc (0.5 kPa) over the baseline back-pressure, the catalyst element should be removed for cleaning.</li> <li>✓ Should the converter back-pressure decrease from baseline back-pressure, the catalyst element should be removed and inspected for damage.</li> </ul>
High Temperature Shutdown	<ul style="list-style-type: none"> <li>✓ For spark ignited engines a functioning high temperature shut-down system is required to prevent the catalyst element from over-heating due to misfires.</li> </ul>



	<ul style="list-style-type: none"> <li>✓ The thermocouple located on an outlet port of the converter should be set to 150°F (83°C) above the normal outlet temperature of the converter but should never exceed 1,112°F (600°C).</li> </ul>
Catalyst Poisons	<ul style="list-style-type: none"> <li>✓ Catalyst poisons build up on the catalyst element over time, due to their presence in the fuel or lube oil. The presence of certain contaminants may also indicate excessive engine wear or a coolant breach.</li> <li>✓ If there is a suspected problem, the catalyst element may be returned to DCL, where a small amount of washcoat is removed and analyzed for contaminants and activity.</li> <li>✓ For acceptable performance, catalyst poisons as a fraction of washcoat shall not exceed the following: <ul style="list-style-type: none"> <li>○ Sulfur &lt; 1%</li> <li>○ Calcium &lt; 1%</li> <li>○ Phosphorus &lt; 1%</li> <li>○ Zinc &lt; 0.5%</li> <li>○ Iron &lt; 1%</li> <li>○ Sulfur, Calcium, Phosphorus, Zinc, Iron &lt; 2% (collectively)</li> <li>○ Lead, Mercury, Arsenic, Antimony, Copper, Tin, Nickel, Chromium &lt; 200 ppm (collectively)</li> </ul> </li> </ul>
Compliance Assurance Monitoring	<ul style="list-style-type: none"> <li>✓ It is recommended that the site operator establish a Compliance Assurance Monitoring (CAM) plan.</li> <li>✓ A CAM plan should be tailored to the site specific or company specific needs. An example is provided in Appendix B.</li> </ul>

Where post-catalyst emissions statements are provided in the quote, temperature at the inlet to the converter is assumed to be as shown in the table below, unless explicitly stated otherwise in the quote.

<b>Fuel</b>	<b>Pollutant</b>	<b>Min. Temperature at Inlet</b>	<b>Limits to Exhaust Compositions</b>
Natural Gas	Non-methane hydrocarbons (NMHCs), including formaldehyde	797 °F (425 °C)	Ethane < 37.5 wt.% of NMHC
Natural Gas	Non-methane, non-ethane hydrocarbons (NMNEHC) – EPA Method 18	797 °F (425 °C)	Propane < 20 wt.% of NMNEHC
Natural Gas	Volatile Organic Compounds – SCAQMD Method 25	797 °F (425 °C)	Propane < 20 wt.% of NMNEHC
Natural Gas	Formaldehyde (CH <sub>2</sub> O)	572 °F (300 °C)	-
LPG	Total Hydrocarbons (THCs)	797 °F (425°C)	Propane < 30 wt.% of exhaust THCs
Diesel	Total Hydrocarbons (THCs)	572 °F (300 °C)	-
All fuels	Carbon Monoxide	752 °F (300 °C)	-

**The product warranty shall be voided if the following occurs:**

- **Engine misfire, backfire or exhaust system explosion.**
- **Excess unburned fuel entering the catalyst, such as when the engine operates beyond its lean limit or if an ignition failure occurs.**
- **Turbocharger failure.**
- **Exhaust temperature in excess of the maximum.**
- **Catalyst poisons in excess of the maximum.**
- **Fuel quality not meeting the specifications in this manual.**
- **Mechanical damage to the converter due to improper mounting.**
- **Mis-handling or improper storage of catalyst elements.**
- **Improper cleaning of the catalyst element.**
- **Failure to conduct normal maintenance.**

## 6.0 MAINTENANCE

DCL's recommended monitoring and maintenance schedule during operation is given below. Due to large variations in operating conditions, the schedule may change depending on the specifics of the application. In addition to this schedule, additional monitoring and reporting may be needed according to the requirements of your environment permit.

It is recommended that a maintenance log be maintained. Measurements and records of temperature difference ( $\Delta T$ ) and pressure difference ( $\Delta P$ ) should always be made under the same operating conditions (e.g., engine load, speed, ignition timing and exhaust oxygen concentration).

### Monitoring and Maintenance Schedule

Item No.	Description	>4000 hours operation per year	500-3999 hours operation per year	<500 hours operation per year	Directions
1	Check back-pressure ( $\Delta P$ )	<ul style="list-style-type: none"> <li>At time of installation</li> <li>Every 3 months</li> </ul>	<ul style="list-style-type: none"> <li>At time of installation</li> <li>Every 6 months</li> </ul>	<ul style="list-style-type: none"> <li>At time of installation</li> <li>Every year</li> </ul>	If the ( $\Delta P$ ) is more than 55 mm H <sub>2</sub> O (2" H <sub>2</sub> O) higher than the initial ( $\Delta P$ ), inspect catalyst for excessive ash build-up. See Section 7 (Troubleshooting).
2	Check temperature change ( $\Delta T$ )	<ul style="list-style-type: none"> <li>At time of installation</li> <li>Every 3 months</li> </ul>	<ul style="list-style-type: none"> <li>At time of installation</li> <li>Every 6 months</li> </ul>	<ul style="list-style-type: none"> <li>At time of installation</li> <li>Every year</li> </ul>	If the ( $\Delta T$ ) is more than 25°F (14°C) higher than the initial ( $\Delta T$ ), check the engine for misfiring, and /or inspect catalyst element for damage or fouling. See Section 7 (Troubleshooting).
3	Conduct emissions test	<ul style="list-style-type: none"> <li>As required by operating permit</li> </ul>	<ul style="list-style-type: none"> <li>As required by operating permit</li> </ul>	<ul style="list-style-type: none"> <li>As required by operating permit</li> </ul>	As required by operating permit.
4	Visual inspection of catalyst element	<ul style="list-style-type: none"> <li>Every 2 years</li> </ul>	<ul style="list-style-type: none"> <li>Every 3 years</li> </ul>	<ul style="list-style-type: none"> <li>Every 3 years</li> </ul>	See Section 7 (Troubleshooting).
5	Chemical cleaning of catalyst element	<ul style="list-style-type: none"> <li>Every 2 years</li> </ul>	<ul style="list-style-type: none"> <li>Every 3 years</li> </ul>	<ul style="list-style-type: none"> <li>N/A</li> </ul>	Contact DCL or authorized dealer for assistance.

**Note:** Items 1, 2 and 3 can be conducted by utilizing the ports on the inlet and outlet side of the converter.

## 7.0 TROUBLESHOOTING

### 7.1 General Troubleshooting

Inspecting the appearance of the catalyst can sometimes provide enough information to determine possible failure modes. The table below provides a guide for catalysts inspection.

#### Troubleshooting by Element Appearance

Element Appearance	Converter Operation	Possible Cause	Action
Tan or light brown to dark brown element. Little amount of gray/white ash.	<ul style="list-style-type: none"> <li>Normal back-pressure</li> <li>0-72 °F (0-40°C) temperature rise across converter</li> </ul>	<ul style="list-style-type: none"> <li>Normal operation</li> </ul>	<ul style="list-style-type: none"> <li>None</li> </ul>
Carbon fouling – soft black sooty deposits on element.	<ul style="list-style-type: none"> <li>High back-pressure</li> <li>Low conversion efficiencies</li> </ul>	<ul style="list-style-type: none"> <li>Clogged air filter</li> <li>Very low cylinder compression</li> <li>Weak ignition voltage</li> </ul>	<ul style="list-style-type: none"> <li>Check air filter</li> <li>Check carburetor and ignition system</li> <li>Check rings and valves</li> <li>Chemical wash of catalyst element</li> </ul>
Large amounts of powdery gray/white ash covering the element.	<ul style="list-style-type: none"> <li>High back-pressure</li> <li>Low conversion efficiencies</li> </ul>	<ul style="list-style-type: none"> <li>Ash originating from sulfated ash content and zinc and phosphorus compounds in the lube oil</li> </ul>	<ul style="list-style-type: none"> <li>Correct engine lube oil consumption rate to &lt; 0.5 g/bhp-hr (0.67 g/kW-h)</li> <li>Use lube oil with &lt;0.6% sulfated ash content; &lt;900 ppm zinc and &lt;400 ppm phosphorus</li> <li>Contact DCL for chemical wash of catalyst element</li> </ul>
Dark bronze to black in color.	<ul style="list-style-type: none"> <li>Low conversion efficiencies</li> </ul>	<ul style="list-style-type: none"> <li>Oil fouling. Too much oil entering combustion chamber; possible worn rings or cylinder walls</li> <li>Excessive clearance of valve stem guides</li> <li>Build-up of crank-case pressure</li> </ul>	<ul style="list-style-type: none"> <li>Correct engine</li> <li>Contact DCL for chemical wash catalyst element</li> </ul>
Pinholes, burnt element foil and/or white powdery appearance.	<ul style="list-style-type: none"> <li>Little or no conversion</li> </ul>	<ul style="list-style-type: none"> <li>Ignition misfire</li> </ul>	<ul style="list-style-type: none"> <li>Correct engine</li> <li>Contact DCL for replacement catalyst element</li> </ul>

## 7.2 Troubleshooting for Three-Way Catalysts

In order to achieve high conversion efficiency of NO<sub>x</sub>, CO and HCs simultaneously, it is necessary for the engine, air-fuel controller and converter to all function properly as a system. If any one of these components in the system malfunctions, the emissions may exceed the desired levels. In order to isolate the source of a problem to the engine, AFRC or converter, the following is recommended:

Step 1 Deactivate the AFRC and allow the engine to operate at open loop

Step 2 Manually adjust the air-fuel ratio of the engine to the point for optimum simultaneous conversion efficiencies of CO and NO<sub>x</sub> by means of trial and error, and with the use of a portable analyzer.

### Troubleshooting by Catalyst Performance

Case 1	High conversion efficiencies are achieved simultaneously for both NO <sub>x</sub> and CO (ie. >90%).	Refer to operating manual of AFRC for further troubleshooting assistance.
Case 2	High conversion efficiencies are achieved for CO or NO <sub>x</sub> , but not both simultaneous.	Refer to possible engine or converter related problems in tables on pages 24 and 26.
Case 3	High conversion efficiencies cannot be achieved at all for either CO or Nox.	Refer to possible engine or converter related problems in tables on pages 24 and 26.

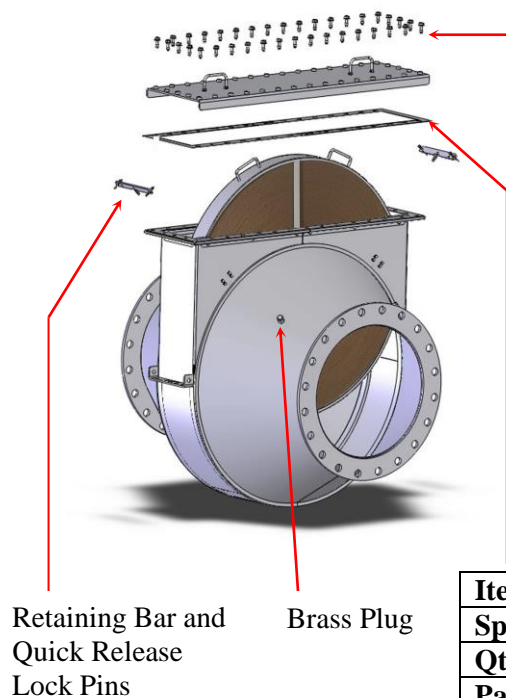
## Engine and Converter Related Problems

Problem	Possible Cause	Action
Little or no back-pressure and little or no conversion efficiency.	<ul style="list-style-type: none"> <li>Mechanical damage to element, possibly caused by excess vibration or engine backfires</li> </ul>	<ul style="list-style-type: none"> <li>Correct engine</li> <li>Contact DCL for replacement catalyst element</li> </ul>
High temperature alarm triggered and low conversion efficiency.	<ul style="list-style-type: none"> <li>Ignition and/or plugs failure</li> <li>Detonation</li> </ul>	<ul style="list-style-type: none"> <li>Check timing and fuel heating values</li> </ul>
High oxygen level (>0.5%) prior to converter and other parameters normal.	<ul style="list-style-type: none"> <li>Exhaust leak</li> </ul>	<ul style="list-style-type: none"> <li>Check all exhaust components</li> <li>Crankcase ventilation should be routed to the atmosphere or intake air</li> </ul>
Simultaneous high oxygen level ( $O_2 > 0.5\%$ ) and high CO level (> 7000 ppm) prior to converter. High exhaust temperature.	<ul style="list-style-type: none"> <li>Ignition misfire</li> </ul>	<ul style="list-style-type: none"> <li>Correct engine</li> </ul>
Simultaneous high oxygen level ( $O_2 > 0.5\%$ ) and high CO level (> 7000 ppm). Prior to converter. Normal exhaust temperature.	<ul style="list-style-type: none"> <li>Leaking exhaust valves.</li> </ul>	<ul style="list-style-type: none"> <li>Check exhaust valves</li> </ul>
Simultaneous high oxygen level ( $O_2 > 0.5\%$ ) and high CO level (> 7000 ppm). Prior to converter. Erratic swings in EGO sensor readings.	<ul style="list-style-type: none"> <li>Low compression ratio or load conditions</li> </ul>	<ul style="list-style-type: none"> <li>Correct engine</li> </ul>
High conversion efficiency for CO and low for $NO_x$ (or visa versa); engine operating correctly.	<ul style="list-style-type: none"> <li>Improper air fuel controller calibration or operation</li> </ul>	<ul style="list-style-type: none"> <li>Check instructions for air fuel controller.</li> </ul>
High conversion efficiency for CO and low for $NO_x$ (or visa versa) ; engine operating correctly.	<ul style="list-style-type: none"> <li>Damaged catalytic coating, i.e.lost oxygen storage capacity (possibly due to short term high temperature from ignition misfire)</li> </ul>	<ul style="list-style-type: none"> <li>Check engine ignition system.</li> <li>Replace catalyst element (High temperature damage can be assessed by chemical analysis of element)</li> </ul>
Low simultaneous conversion efficiencies of $NO_x$ and CO; AFRC and engine operating correctly.	<ul style="list-style-type: none"> <li>Exhaust by-passing catalyst element.</li> <li>Possible catalyst activity problem</li> </ul>	<ul style="list-style-type: none"> <li>Inspect catalyst element for gaps. Inspect and replace gasket material</li> <li>Add additional layer of gasket if necessary</li> <li>Contact DCL if problem persists</li> </ul>

**Note: Typical exhaust values for good three-way conversion are provided on the table in page 15.**



## 8.0 SPARE PARTS



<b>Item</b>	Captive Bolts*	
<b>Specification</b>	1/2"-13 UNC X 1.50L WHIZ – LOCK bolt	
<b>Part Number</b>	X0400-Q500-04	
<b>Quantities</b>	<b>Model</b>	<b>Qty</b>
	DC63 or DC73	22
	DC64 or DC74	24
	DC64.5 or DC74.5	24
	DC65 or DC75	26
	DC66 or DC76	26
	DC68 or DC78	26
	DC68.1 or DC78.1	34
	DC69.5 or DC69.5	34

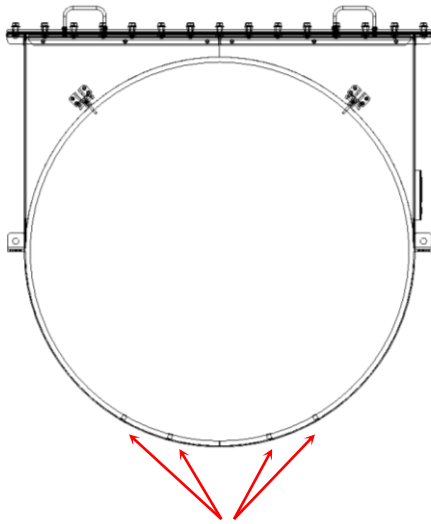
\* Non-captive bolts/nuts also available  
Bolt P/N X0400-Q500-03 Nut P/N X4008-NUTC-IS

<b>Item</b>	Cover Plate Gasket	
<b>Specification</b>	Machine cut graphite-stainless steel	
<b>Qty per cover plate</b>	2	
<b>Part Numbers</b>	<b>Model</b>	<b>P/N</b>
	DC63 or DC73	X1963-Q502-09
	DC64 or DC74	X1964-Q502-09
	DC64.5 or DC74.5	X1967-Q502-09
	DC65 or DC75	X1965-Q502-09
	DC66 or DC76	X1966-Q502-09
	DC68 or DC78	X1968-Q502-09
	DC68.1 or DC78.1	X19C4-Q502-09
	DC69.5 or DC79.5	X19C9-Q502-09

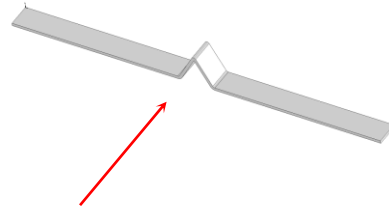
Item	P/N	Qty per cover plate
Retaining Bar	X0500-Q502-35	2
Quick Release Lock Pin	X0400-Q500-01	4
½" NPT Brass Plug	X0702-0028-02	4

**Note: For spare elements, or for part information from older QUICK-LID® models, contact a DCL representative.**

## Horizontal Mount QUICK-LID®

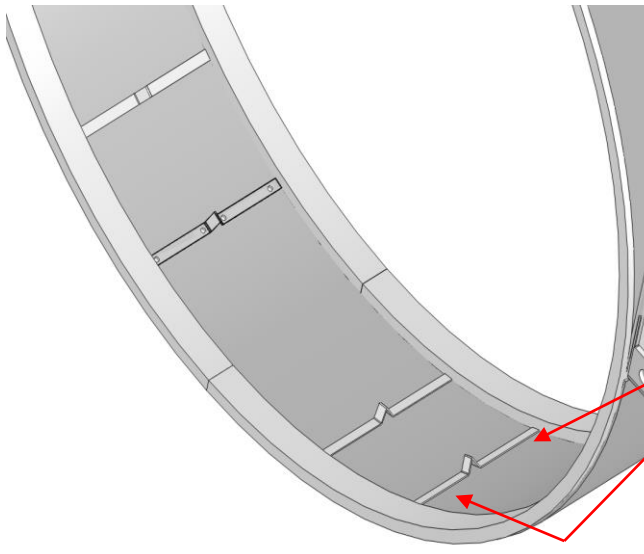


Spacer location



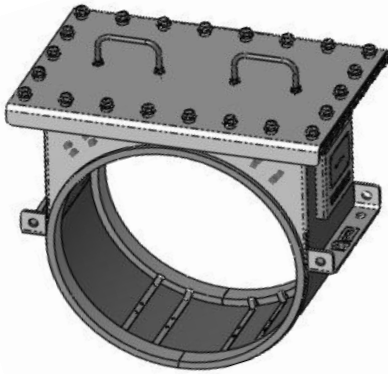
Item	Spacer
P/N	X0500-Q5XX-02
Qty per housing	4

**Note:** In the case of a high pressure event, such as engine backfire, the four spacers supporting the catalyst element(s) may break. This breakage will help to minimize damage to the catalyst element(s). The four brackets can be welded back in place by following the instructions below.

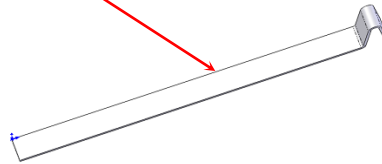


Use the GMAW (MIG) process with ER308L wire to apply two 1/4" dia spot welds on each side of the spacers

## Vertical Mount QUICK-LID®



Item	P/N	Qty per cover plate
Retaining Bar	X4600-A9C7-01	2
Quick Release Lock Pin	X0400-Q500-01	4
Spacer	X4600-A9C7-02	4



**Note:** When installing the catalyst element(s), the end of the spacer with the bend (holder spring) should always be on top of the catalyst as shown below. Its purpose is to provide a tight fit, and minimize damage to the catalyst element(s) in the case of a high pressure event such as an engine backfire.

