Technical Support Note

Title: Gasoline-Fueled Engine Emissions
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Overview:

Gasoline fueled equipment has never really been viewed as 'clean burning', although vehicles of recent manufacture and equipped with closed loop fuel metering systems and three-way catalytic converters are cleaner than most imagine. The typically achievable exhaust gas emission levels of the constituent gases in gasoline-fueled engine exhaust is still relatively unknown, however – to the detriment of both users of the equipment and those chartered with equipment maintenance and repair.

The purpose of this document is to provide some general guidelines regarding the expected gas concentrations in the exhaust of gasoline fueled vehicles – and other general information that may be helpful to keep this equipment in proper tune and operation.

Non-CAT Converter Equipped Vehicles:

This class of equipment is what historically was built prior to the common use of unleaded gasoline and catalytic converters. They commonly meter fuel either using a carburetor 'open loop' fuel injection (no Lambda Sensor) and are highly subject to tuning variables such as mixture control, ignition timing, and spark plug condition, etc.

In essence, the levels of emissions of this class of equipment is totally a function of how well the equipment is maintained and tuned.

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Open-Loop Emissions Levels:

	Idle (~750 RPM @ 20" Hg)		Medium Power (~2000 RPM @ 10" Hg)		High Power (>3000 RPM @ 5" Hg)	
Gas	**Typical Range:**	**Ideal Target**	**Typical Range:**	**Ideal Target**	**Typical Range:**	**Ideal Target**
CO:	1.00% to 2.00%	1.00%	1.50% to 3.00%	1.50%	2.00% to 4.00%	2.00%
HC:	100 to 300 ppm (Hexane)	100 ppm	150 to 350 ppm (Hexane)	150 ppm	150 to 400 ppm (Hexane)	150 ppm
CO2:	13.0% to 14.0%	14.0%	12.0% to 13.5%	13.5%	11.0% to 13.0%	13.0%
O2:	1.0% to 2.0%	1.0%	0.5% to 2.0%	0.5%	0.5% to 2.0%	0.5%
NOx:	500 to 1000 ppm	500 ppm	1500 to 2500 ppm	1500 ppm	2000 to 3000 ppm	2000 ppm

Open-Loop Emissions Levels:

	Idle (~750 RPM @ 20" Hg)		Medium Power (~2000 RPM @ 10" Hg)		High Power (>3000 RPM @ 5" Hg)	
Lambda:	0.950 to 1.050	1.000	0.950 to 1.050	0.980	0.900 to 1.000	0.950
AFR:	14.0 to 15.4	14.7	14.0 to 15.4	14.49	13.2to 14.7	14.0
CE:	92.00% to 95.00%	95.00%	92.00% to 96.00%	96.00%	92.00% to 95.00%	95.0%

CAT Converter Equipped Vehicles:

This class of equipment has computer controlled closed-loop fuel injection and a catalytic converter. This class of equipment has a lambda sensor in the exhaust stream, which is

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used for 'closed loop' mixture control – and a catalytic converter to reduce CO, HC and NOx emissions.

In essence, the levels of emissions of this class of equipment is less a function of tuning and more a function of maintenance – as the on-board computer maintains equipment tune by means of a variety of sensors, including a lambda sensor for mixture control. While there is less adjustment capability on this class of equipment, the control system sensors have to be verified and maintained in good operating condition in order to assure proper operation and CAT function. The CAT converters on this class of vehicles require very close mixture control, and poor CE can quickly degrade the CAT as well by causing over temperature conditions in the CAT.

Closed-Loop Emissions Levels (Post CAT):

	Idle (~750 RPM @ 20" Hg)		**Medium Power (~2000 RPM @ 10" Hg)**		**High Power (>3000 RPM @ 5" Hg)**	
Gas	**Typical Range:**	**Ideal Target**	**Typical Range:**	**Ideal Target**	**Typical Range:**	**Ideal Target**
CO:	0.00% to 0.25%	0.05%	0.00% to 0.25%	0.05%	0.00% to 0.50%	0.05%
HC:	0 to 40 ppm (Hexane)	0 ppm	10 to 50 ppm (Hexane)	10 ppm	20 to 100 ppm (Hexane)	20 ppm
CO2:	14.5% to 15.0%	15.0%	14.5% to 15.0%	15.0%	14.5% to 15.0%	15.0%
O2:	0.3% to 1.0%	0.3%	0.3% to 1.0%	0.3%	0.3% to 1.0%	0.3%
NOx:	25 to 100 ppm	25 ppm	35 to 150 ppm	35 ppm	50 to 250 ppm	50 ppm
Lambda:	0.980 to 1.020	1.000	0.980 to 1.020	1.000	0.980 to 1.020	1.000
AFR:	14.4 to 15.0	14.7	14.4 to 15.0	14.7	14.4 to 15.0	14.7
CE:	99.00% to 99.95%	99.95%	99.00% to 99.95%	99.95%	99.00% to 99.95%	99.95%

As can be seen from the above table, the emissions levels of this class of equipment are much lower due to the oxidation and reduction capabilities of the CAT, and the engine management system control. Engine out gases (pre-CAT) are higher than the ranges

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given for post CAT Converter CO, HC, and NO, but are generally lower and closer to the target values than the open-loop systems - and the gases are held to tight Lambda control with the closed-loop system to enable the CAT to function properly. The CAT reduces CO, HC, and NO engine-out gases by 80% to 90% - providing Lambda of the engine-out exhaust gas is controlled within 0.980 to 1.002 by the closed–loop system.

In general, engine-out gases are in the range of 95.00% CE maximum, while the CAT converter improves this by about a factor of 10 – resulting in 99.50% CE typically. It is important to realize that all of the technological improvements made to gasoline-powered vehicles engine control systems in the past 25 years have been to assure a higher combustion efficiency – including the great benefits of the catalytic converter. This higher CE results in substantially lower CO and HC emissions.

NOx emissions are reduced by a combination of Exhaust Gas Recirculation (EGR) to reduce pumping losses and rarefied compression and a chemically reducing section added to the catalytic converter (resulting in what is referred to as a 'three way catalyst' – due to the fact that it creates chemically reducing reactions for NO and chemically oxidizing reactions for CO and HC.

The three way catalytic converter requires very tight (0.980 to 1.020) lambda control of the gases coming into the converter – and this is readily accomplished by means of closed loop (lambda sensor controlled) fuel injection systems.

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