

Kettering University

2009 Clean Snowmobile Challenge

Kettering Yamaha Phazer GT



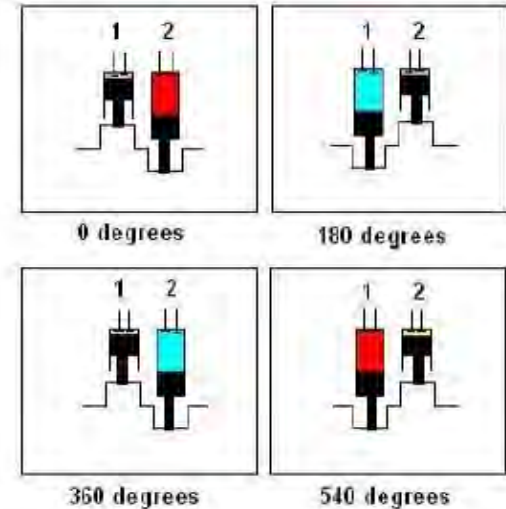
Project Goals

- Flex-fuel capability
- Exceed 2012 emissions standards
- Substantially decrease noise
- Increase driveline efficiency
- Maintain cost and performance

Engine Specifications

- 499 cc displacement
- 4 stroke
- 2 cylinder
- 12.4:1 compression ratio
- 5 valves per cylinder
- Naturally aspirated
- BigStuff3 ECU

Yamaha 499cc 2-cylinder 4-stroke SI Engine Cycle



Vehicle Modifications

- Fuel System
 - Fuel lines
 - Twin Fuel Pumps
 - Flex Fuel Sensor
 - Fuel Filter
 - Fuel Regulator

Vehicle Modifications Cont.



- Electronics
 - BigStuff 3 ECU
 - Racepak UDX interface
 - GPS interface



- Exhaust
 - Catalyst
 - Secondary muffler
 - New exit location

Vehicle Modifications Cont.



- Body

- Side Panels
- Side Skirts
- Exhaust cover

- Track/Suspension

- Idler Wheels
- Slides
- Shocks

Flex Fuel Adaptation

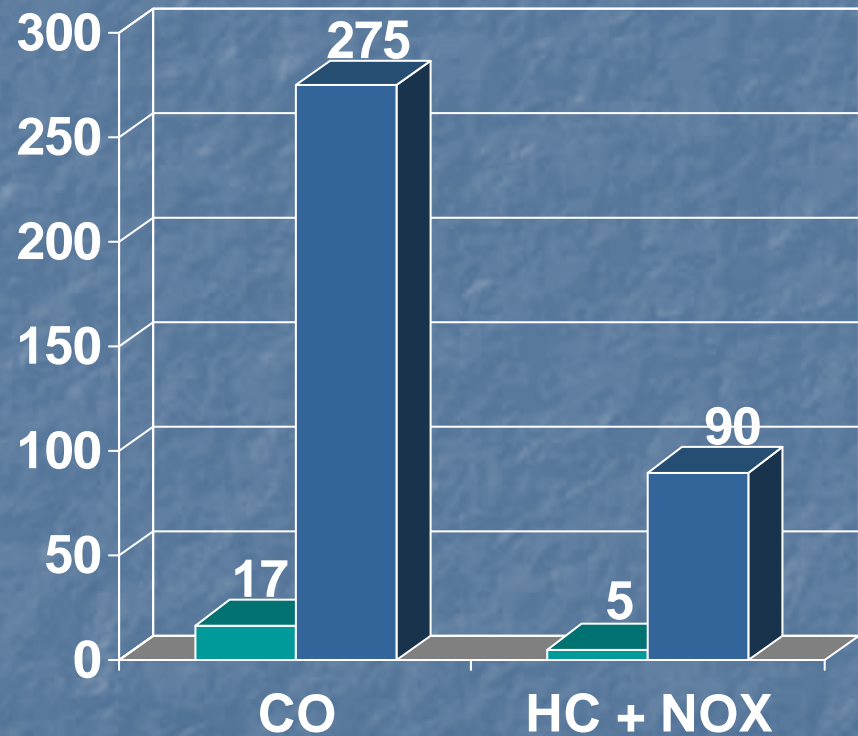
- Program BigStuff3 ECU
- GM flex fuel sensor
- O₂ Sensor



Emissions Reduction

Emmissions in g/kW-hr

- E-85 Example
- Significant improvement over 2012 standards
 - 94% reduction in carbon monoxide
 - 94% reduction in hydrocarbons and nitrous oxides



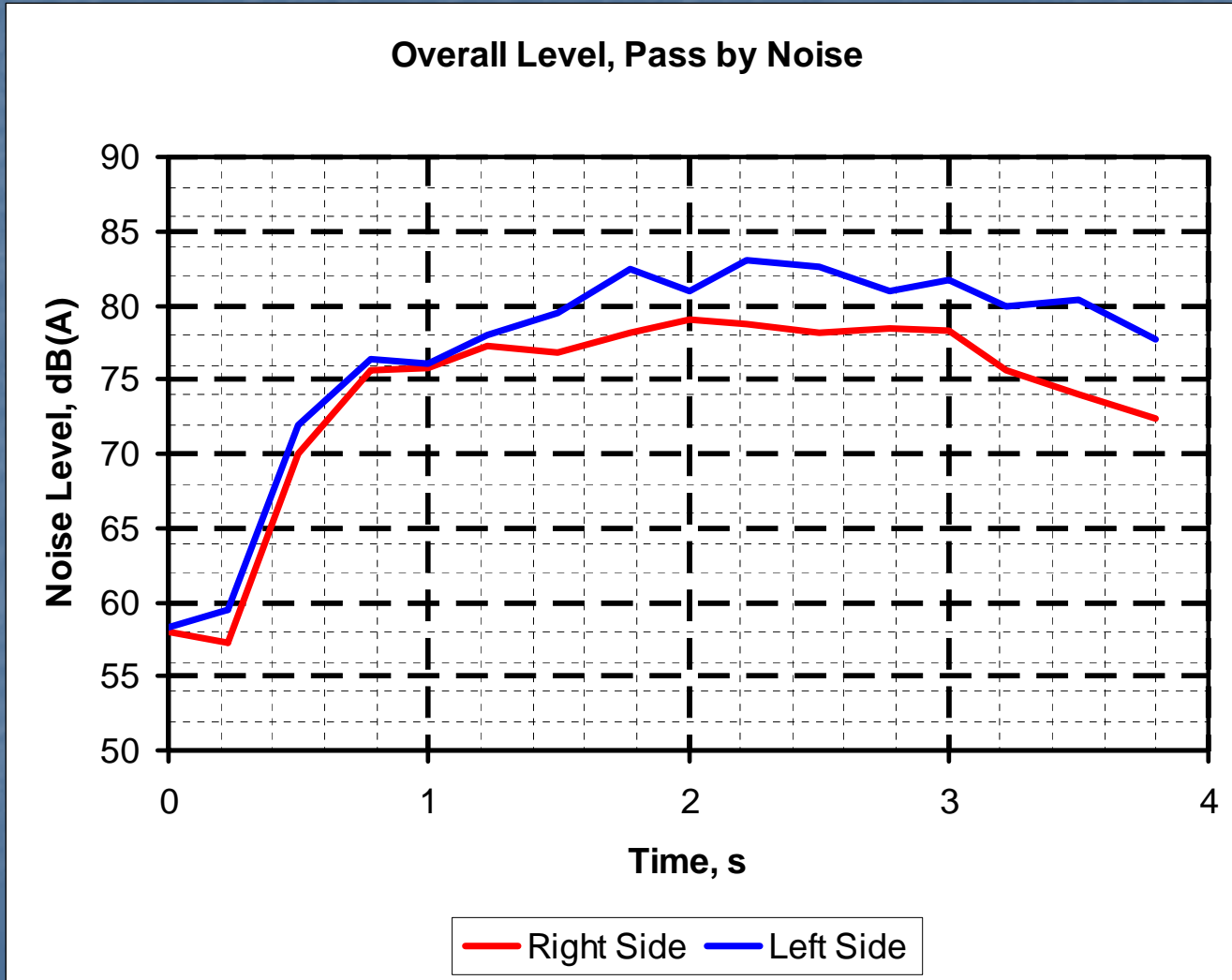
■ 2009 Snowmobile
■ 2012 Standard

Noise Reduction

- Largest problem areas
 - Tunnel
 - Side panels
 - Primary clutch



Noise Reduction Cont.



Noise Reduction Cont.

■ Reduction Measures

- Tunnel coating
- Side skirts
- New side panels
- Sound deadening in engine compartment
- Aluminum "Boat Tail"



Driveline Efficiency

- Drag testing
 - Track idler wheels
 - 10 mph and 15 mph tests



Drag, lb _f (N)				
	10 mph (16 kph)		15 mph (24 kph)	
	With Idlers	Without Idlers	With Idlers	Without Idlers
Average Drag Force	77 (343)	97 (432)	80 (354)	113 (501)
Delta	20 (89)		33 (147)	
% Reduction	20.6%		29.2%	

Cost and Performance

■ Cost

- 2008 North American average MSRP—\$9,324
- Base snowmobile MSRP—\$7,799
- Modified snowmobile MSRP—\$11,135

■ Performance

- Power
- Weight
- Handling



Accomplished Goals

- Extensive modifications
- Desirable product
 - Decreased emissions
 - Decreased noise
 - Increased efficiency
 - Reasonable cost
 - Good performance

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