

North Dakota State University's Clean Snowmobile Challenge 2012

Design Presentation

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Outline:

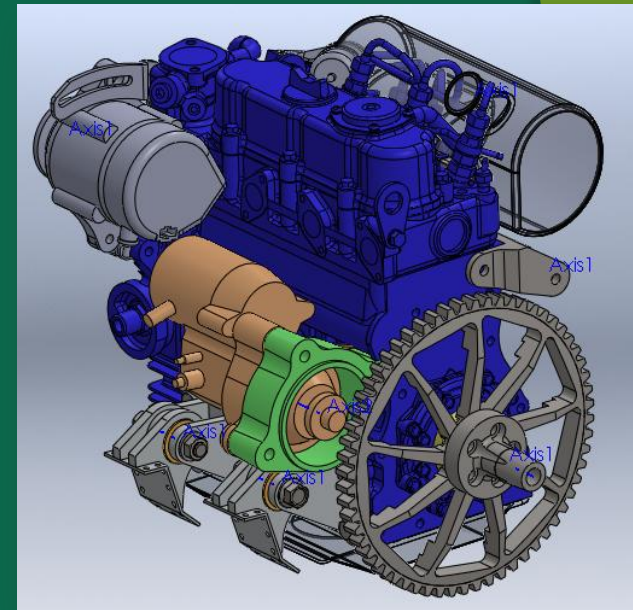
- Design Constraints
- Consumer Appeal
- Dealer & Outfitter Perspective
- Environmental Impact
- Test Results
- Conclusions

Design Constraints

- ⦿ Engine Considerations and Improvements
- ⦿ Handling/Comfort Performance
- ⦿ Noise reduction
- ⦿ Chemical Emissions

Engine Considerations

- Efficiency considerations
 - Turbo Diesel-Cycle vs. Turbo Otto-Cycle
- Noise Emissions
 - Low RPM operation (4100 RPM)
 - Tolerable low frequencies
- Small Turbo-Diesel Engine
 - Kubota D902 3-cylinder SuperMini
 - Garrett GT1241 Turbocharger



Engine Improvements

- ◎ Garrett GT1241 Turbo – 20psig (max)
 - Increased thermal efficiency
 - Diesel: 39.3% Energy conversion efficiency (current)
 - Increased torque
- ◎ Increased Injection-Pump Output
- ◎ Fuel usage @ max Power → 0.123 kg/min
 - Translates to 28.5 mpg (trail riding)



Garrett GT1241

Handling & Comfort Performance

- Polaris IQ Chassis
 - Unequal length wishbone front suspension
 - RydeFX Coilover dampers
 - Front anti-roll bar
- Rear IQ Comfort Suspension 136"
 - RydeFX Dampers



Polaris Comfort 136" Suspension w/ Big-Wheel Kit

Noise Reduction

- ◎ Exhaust exit location
 - Under tunnel, utilizes natural attenuation of snow
- ◎ Sound absorbing foam and Quiet-ride damping material under cowl
- ◎ Tunnel noise abatement
 - Lizard-skin noise attenuating spray
 - Reduces noise where applied by up to 13dB



Lizard-Skin Application

Consumer Appeal

Why buy this snowmobile?

- ⦿ Excellent fuel economy
 - Approx. 28.5 MPG
- ⦿ Extended Maintenance Intervals
 - Oil/Filter change est. at 4,000 miles vs. 1,500 on stock Polaris FST.
- ⦿ Extremely Quiet Operation
 - Tests show under 76 dB before hood installation (J192 test)
- ⦿ Flexible Fuel Choice
 - Diesel/BioDiesel/Blends

Consumer Appeal cont'd

Why buy this snowmobile?

- ⦿ Reduce irritating emissions
- ⦿ Active particulate reduction vs. Passive reduction
- ⦿ Partial diesel particulate filter chosen
 - Emitec substrate w/ Aristo coating
 - Safe
 - Maintenance free
- ⦿ Small performance loss

Dealer & Outfitter Perspective

- ◎ Inexpensive rental or utility model
 - Initial purchase price \$11,726.90 (\$527.90 over original sled)
 - Recoup difference with fuel cost in only 5,500 miles
- ◎ Comfortable
 - Low noise operation
 - Factory seat with improved trail-riding ergonomics
 - Taller seat position with shorter handlebar height
- ◎ Simple operation
 - Perfect for novice riders
 - Reduced risk

Environmental Impact

Particulate Matter Reduction

- Active particulate reduction vs. Passive Oxidation
- Passive Partial diesel particulate filter and Diesel Oxidation Catalyst (PM Metalit)
 - Emitec substrate w/ Aristo coating
 - Safe (continuous regeneration)
 - Maintenance free
 - Oxidizes $\text{CO} \rightarrow \text{CO}_2$
 - Oxidizes $\text{HC} \rightarrow \text{H}_2\text{O} + \text{CO}_2$
- Negligible performance loss



Emitec PM METALIT
Partial Flow DPF
(D=4.65" x L=6.5")

Environmental Impact Cont'd

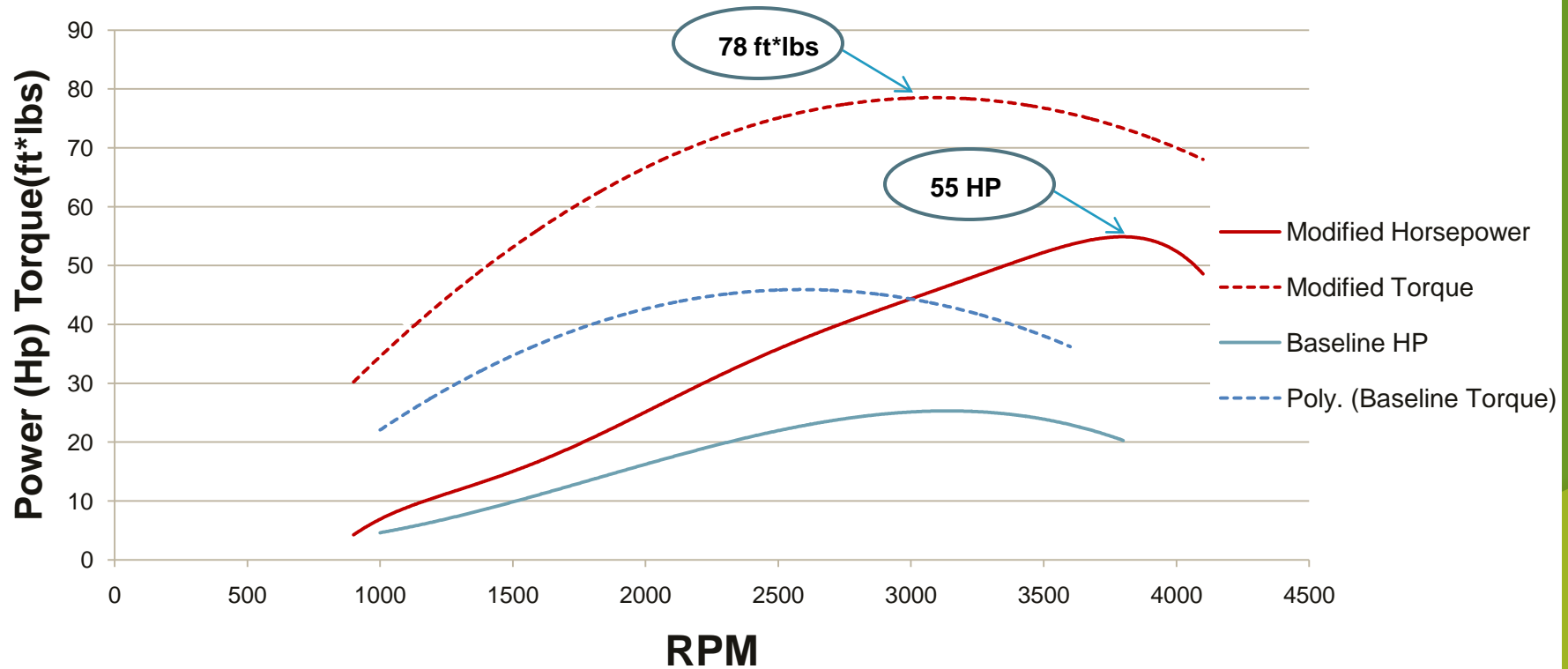
- Preliminary Test Results
 - Mode 4 Operation Data (Uncalibrated):

Emissions Testing Kubota D-902 (Cumulative Average Mode 2 Operation) (NOVA Exhaust Gas Analyzer)				
	HC (PPM)	Nox (PPM)	Nox (g/hp*hr)	Tier 4 Nox (g/hp*hr)
With Increased Air/Fuel Charge	N/A	265.6	1.33	0.3
With DOC & DPF	1.33	51	0.255	

- Exceeds Tier 4 NOx Regulations by 17%
- Virtually zero unburned Hydrocarbons

Test Results

Horsepower and Torque Before and After Modification



Conclusion

- ⦿ Reliable
- ⦿ Efficient
- ⦿ Cost effective
- ⦿ User Appeal
- ⦿ New market opportunities

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Questions?

