

*Design and Testing of a
Four-Stroke Snowmobile with
Catalytic Exhaust Treatment*

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Background

- Yellowstone National Park
 - ☞ Snowmobilers are approximately 6% of annual visitors
 - ☞ Significant contributors to emissions production

Team Goal

*“Design and Produce a Snowmobile with
Noise and Emissions Levels Comparable
to the Typical, Wheeled Vehicle in
Yellowstone National Park”*

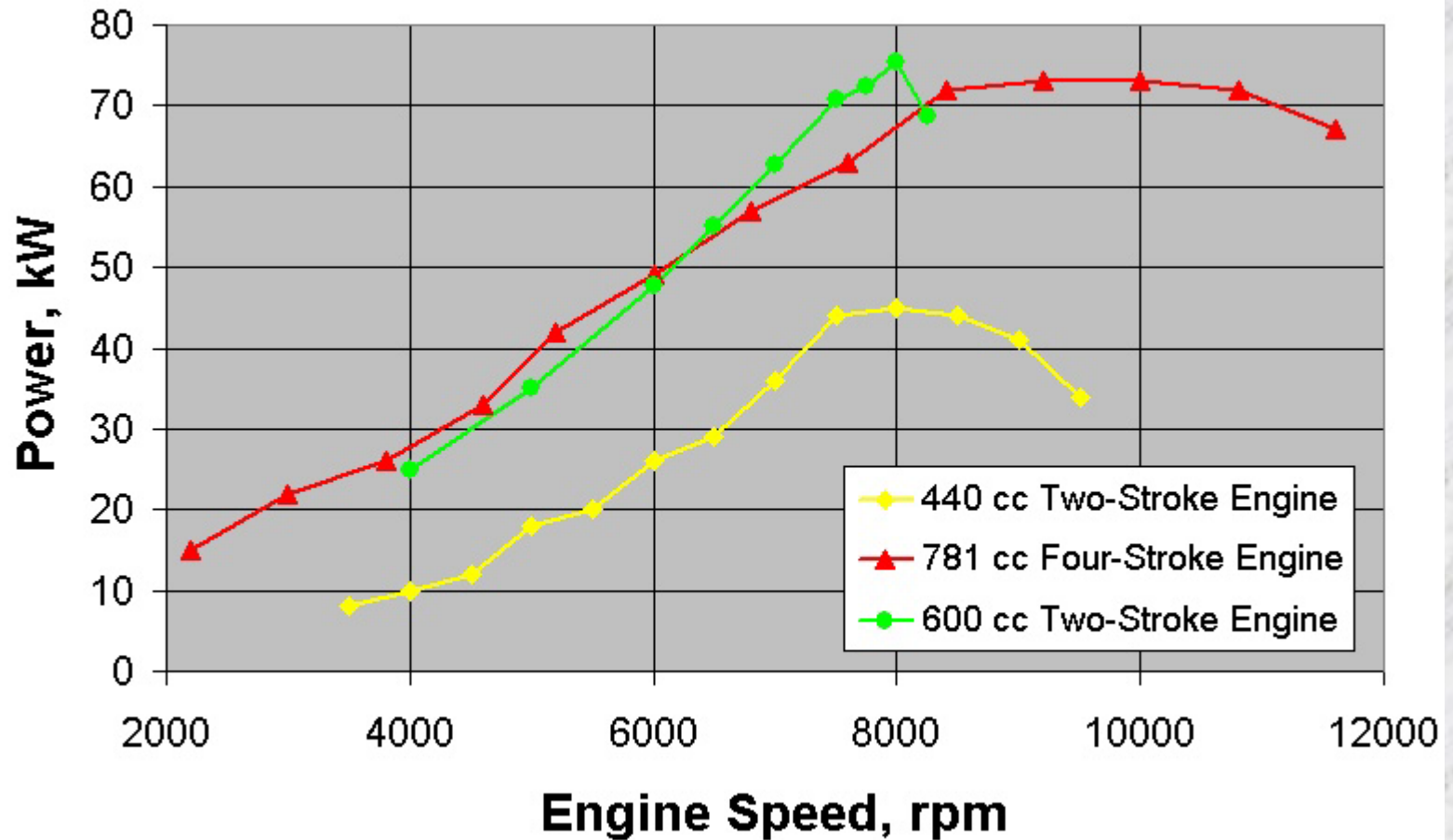
Strategy

To use a properly sized four-stroke engine with emissions controls to reduce emissions and noise levels while maintaining performance.

Engine Details

- Liquid-cooled, four-cylinder, four-stroke engine with emission controls
 - 781 cc V-4 configuration
 - Electronic fuel injection (EFI)
 - Catalytic exhaust treatment
 - Secondary air injection

Snowmobile Performance

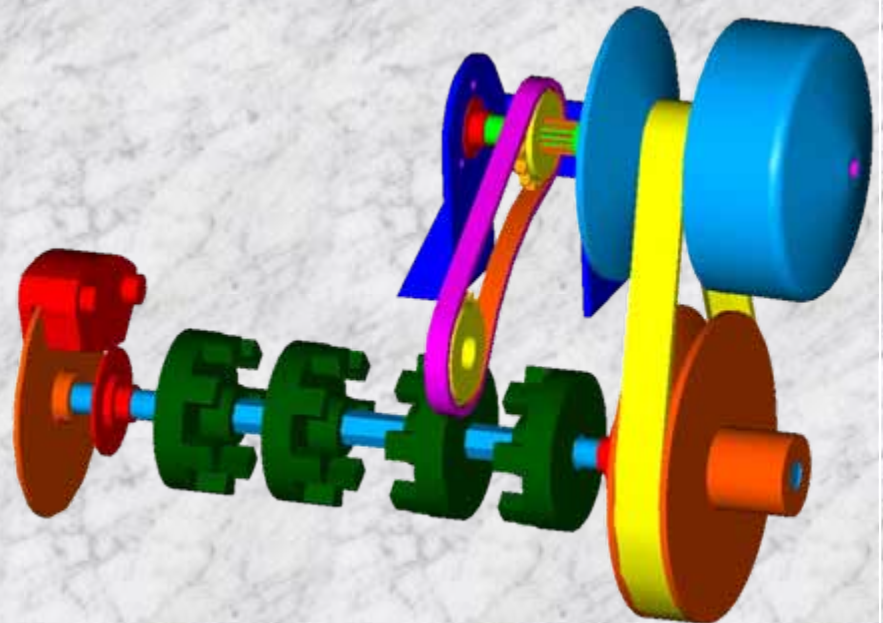


Snowmobile Handling

- Weight
 - ☞ Total weight = 650 lbs wet
 - (RF = 190 lbs, LF = 160 lbs, RR = 300 lbs)
 - ☞ OEM prototype four-stroke snowmobile - 610 lbs dry
- Travel extenders for telescopic strut suspension
- Wide, plastic skis for improved flotation and control
- M-10 rear suspension for improved ride quality

Additional Performance Enhancements

- Electronic fuel injection (EFI)
 - ↳ Altitude and temperature compensation
 - ↳ Increased fuel economy
- Innovative drive train

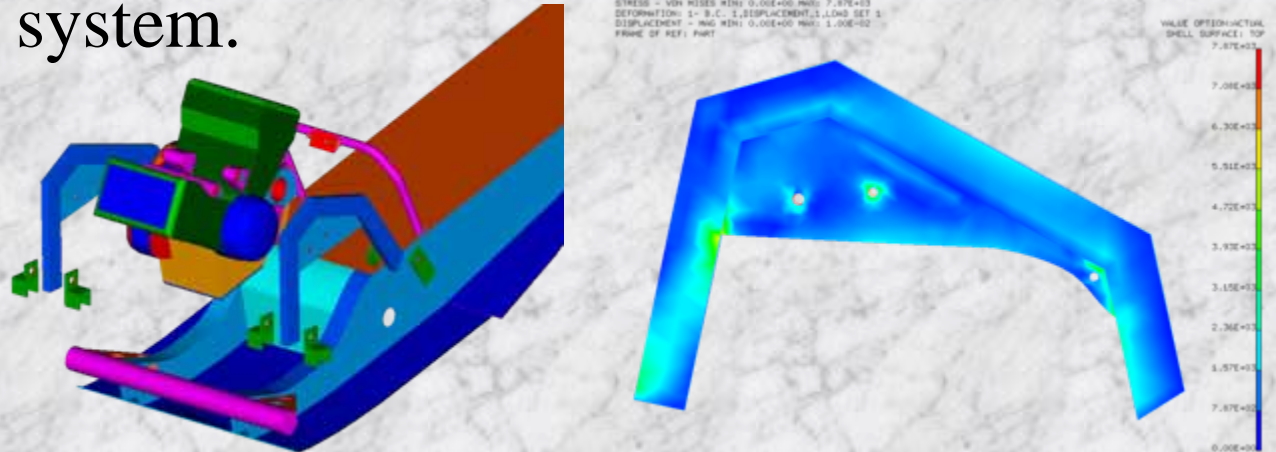


Cost Assessment

- 2001 550cc fan (MSRP) \$4500 - \$5000
- Final cost is expected to increase, compared to current, production models.
 - ↳ Technology Implementation Cost Assessment = \$959.26

Snowmobile Durability

- Production four-stroke engine chosen for reliability
 - ↳ Expected life of engine is similar to snowmobile, if not greater
- Finite element analysis used to design engine mounting system.



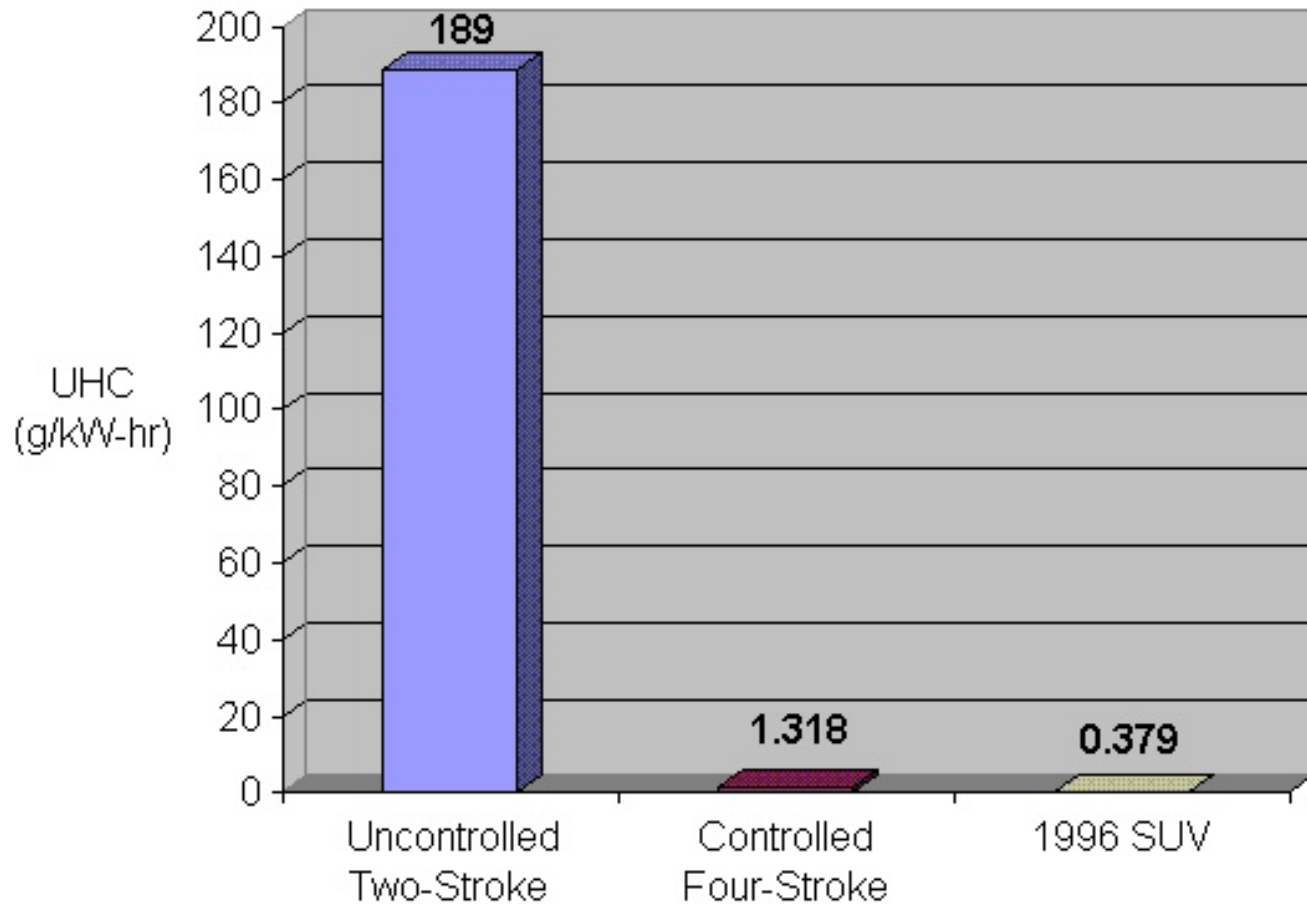
Snowmobile Maintenance

- Maintenance items
 - ☞ Oil/filter change - seasonal
 - ☞ Drive chain lubrication
 - ☞ Reduced spark plug replacements
- Net maintenance requirements are not increased

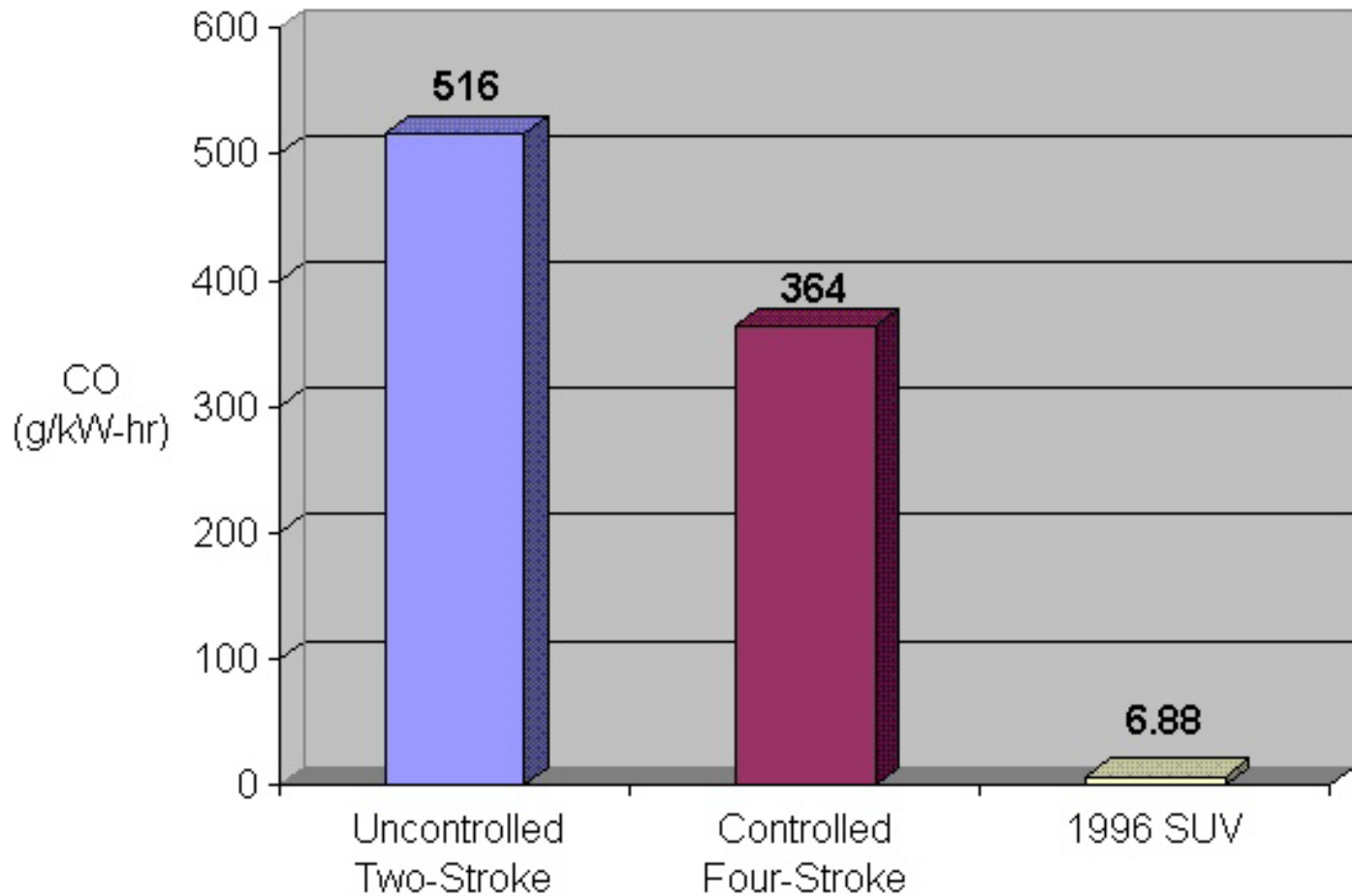
Consumer Acceptance

- Electric start
 - ↳ All levels of operators can safely operate the snowmobile
- Front suspension
- Rear suspension
- Engine
- Drive train

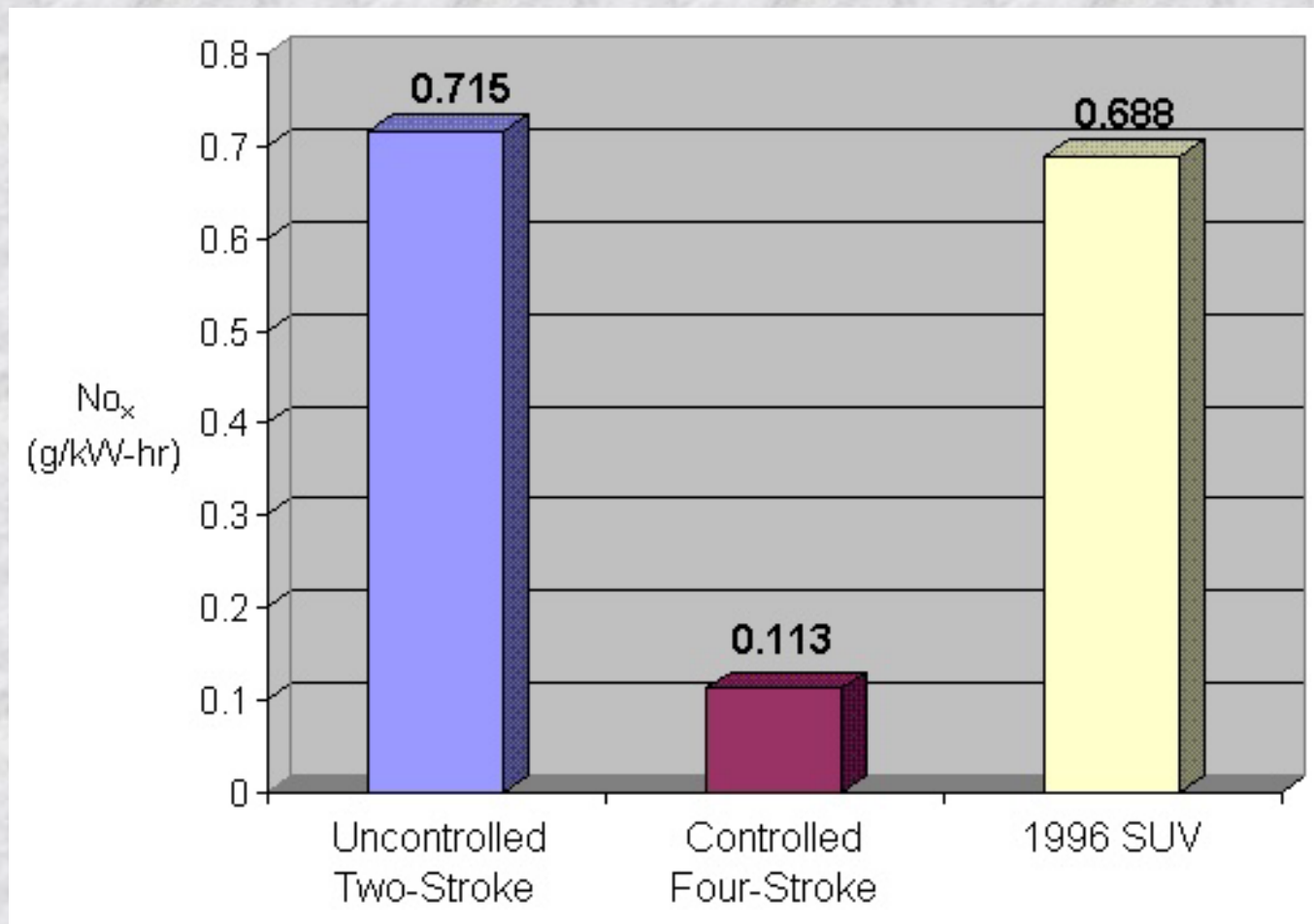
Emissions Reduction - UHC



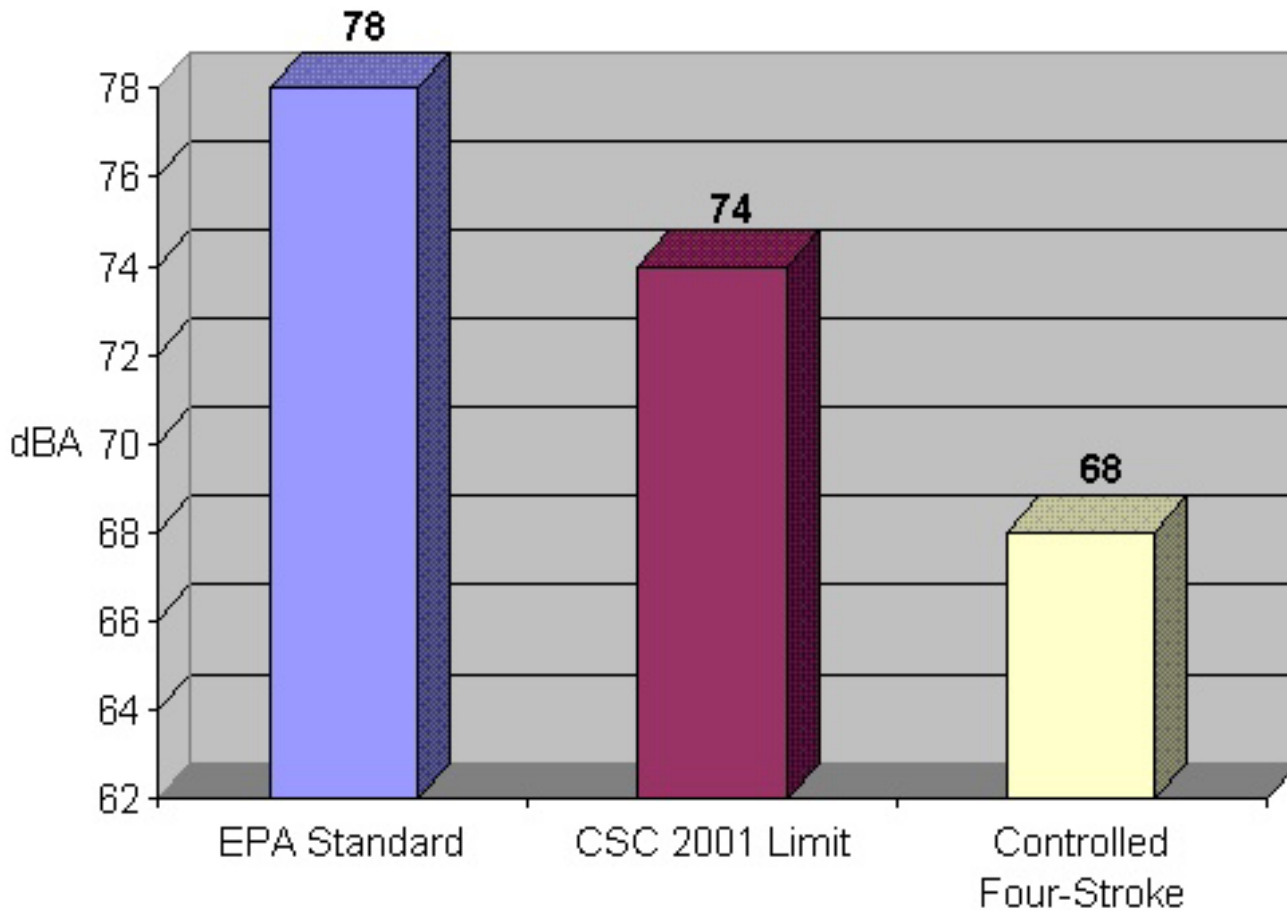
Emissions Reduction - CO



Emissions Reduction - NO_x



Noise Reduction



Environmentally Friendly Aspects

- Yellowstone Emissions Estimates - 1998 Data

☞ Calculated total yearly emissions deposition in YNP

	Uncontrolled Two-Stroke	Controlled Four-Stroke	1996 SUV
UHC, kg	641,000	4,500	14,200
CO, kg	1,750,000	1,200,000	258,000
NO _x , kg	2,426	383	25,816

Conclusions

- The four-stroke engine with emission controls provided significant reductions in emissions levels.
- The four-stroke snowmobile is fun to drive, quiet, and less aromatic than two-stroke snowmobiles.
- The four-stroke snowmobile alternative will be more appealing to the snowmobiling community than other options (snow coach) for Yellowstone winter use.