III. SUMMARY OF SPARK-IGNITED IC ENGINE CONTROLS

The combustion of hydrocarbon fuels in IC engines results in emissions of the following criteria pollutants: NOx, CO, VOC, particulate matter, and sulfur oxides (SOx). The pollutant of primary concern from stationary IC engines in this determination is NOx. Emissions of NOx are far greater than any other pollutant for engines burning hydrocarbon fuel.

There are probably more different types of controls available to reduce NOx from IC engines than for any other type of NOx source. These controls can be grouped into the following general categories: combustion modifications, fuel switching, post-combustion controls, and replacement of the engine with a new, low emissions engine or an electric motor.

Combustion modifications include ignition timing retard, optimization of the internal engine design, turbocharging or supercharging with aftercooling, exhaust gas recirculation, and leaning of the air/fuel ratio. In the case of leaning the air/fuel ratio, this is generally done in combination with other techniques, which allow extremely lean ratios. Fuel switching includes the substitution of methanol for natural gas. Post combustion controls include nonselective catalytic reduction and selective catalytic reduction. Low emission engines or “clean-burn” may use several combustion modifications to reduce emissions, and may also use fuel switching.

Table III-1 summarizes the applicability and effectiveness of the NOx control methods for stationary engines. Although control technologies are shown for NOx control, both CO and VOC emissions must meet their respective requirements. A more detailed description of controls for stationary IC engines can be found in Appendix B.

Table III-1
Summary of Primary NOx Controls For Stationary Spark-Ignited IC Engines

Control Technology	NOx Reduction Effectiveness
Combustion Modifications	
Ignition Timing Retard	15-30%
Prestratified Charge	80+%[1]
Lean Air/Fuel Ratio	80+%[2]
Turbocharging or Supercharging	
With Aftercooling	3-35%
Exhaust Gas Recirculation	30%
Fuel Switching	
Methanol	30%[3]
Post-Combustion Controls	
Nonselective Catalytic Reduction	90+%[1]
Selective Catalytic Reduction	80+%[4]
Replacement with Low Emissions Engine Or Electric Motor	60-100%[5]

1. Applies to rich-burn spark-ignited (SI) engines.
2. When the air/fuel mixture is leaned and combined with other NOx reduction techniques (i.e., "clean burn" modifications, ignition system improvement, prechamber design).
3. Applies to natural gas engines.
4. Applies to SI lean-burn engines.
5. For replacement with an electric motor, emissions are reduced 100 percent at the IC engine location, although emissions at power plants may increase.