

**Draft Estimates of Cost Effectiveness of Non-Selective Catalytic Reduction for Rich-burn IC Engines
(from March 21, 2006, email)**

Below is **draft** information from Jaime Pagan of OAQPS on emissions reductions and cost effectiveness of retrofitting rich-burn IC engines with non-selective catalytic reduction (NSCR). Jaime indicated this information could be shared with the state, though it is subject to revision. These engines are used in a wide variety of applications including oil fields, natural gas compressor stations, agricultural applications (e.g. irrigation systems), back-up power, and others.

Emission reductions from internal-combustion (IC) engines are possible through a variety of control strategies. Four-stroke rich burn IC engines (4SRB) are spark-ignited engines that typically burn natural gas and are operated at air-to-fuel-ratios that allow the use of aftertreatment devices known as non-selective catalytic reduction (NSCR), which are the typical 3-way catalysts that are used in automotive applications. The use of NSCR alone helps achieve reductions in the order of over 90% NOx and 90% CO and about 50% HC.

The costs of retrofitting 4SRB engines with NSCR will vary depending on the size of the engine. We've estimated the cost effectiveness associated with retrofitting these engines by size. For instance, for a 400 hp 4SRB engine the cost effectiveness is \$105/ton to reduce NOx. On the other hand, for a 75 hp engine, the cost effectiveness would be \$265/ton. The average NOx cost effectiveness that we estimated is approximately \$180/ton. As the table below shows, these cost effectiveness numbers look even more attractive when you consider the CO and HC reductions that are possible. Note that we don't think that NSCR are feasible for engines below 25 hp.

This table shows 4SRB control costs and reductions on a per engine basis (numbers are draft and subject to revision):

Engine Size Range (HP)	Average Engine Size (HP)	Annual NOX Emissions (Tons/year)	Annual CO Emissions (Tons/year)	Annual THC Emissions (Tons/year)	NSCR Annual Cost (\$/year)	NSCR Cost Per Ton of NOX Reduced (\$/Ton)
Natural Gas Fired						
< 50	25	1.20	1.00	0.116	723	671
50 ? 100	75	3.59	3.00	0.347	856	265
100 ? 175	135	6.36	4.94	0.625	1,015	177
175 ? 300	238	11.2	7.33	1.10	1,288	128
300 ? 500	400	18.3	9.18	2.16	1,717	105
500 ? 600	550	25.6	13.2	2.55	2,115	92
600 ? 750	675	30.4	16.2	3.13	2,446	89
750 ? 1200	975	43.0	27.0	5.06	3,241	84
1200 ? 2000	1,600	69.9	45.3	9.71	4,897	78
> 2000	2,000	77.0	64.6	12.3	5,957	86
Average						177