Iowa Title V Operating Permit
Control Efficiency Table

Control Device or Practice	Control Efficiency (%)						
	TSP	PM_{10}	SOx	NOx	VOC	CO	Pb
Wet Scrubber - high efficiency	note 1		note 2				
Wet Scrubber - med efficiency	note 1		note 2				
Wet Scrubber - low efficiency	note 1		note 2				
Gravity Collector	3[a]	--	--	--	--	--	2[a]
Centrifugal Collector (cyclone)-high efficiency*	95[c]	80[a]	--	--	--	--	65[a]
Centrifugal Collector (cyclone)-med efficiency*	75[c]	50[a]	--	--	--	--	40[a]
Centrifugal Collector (cyclone)-low efficiency*	35[c]	10[a]	--	--	--	--	8[a]
Electrostatic Precipitator-high efficiency **	95[a]	95[a]	--	--	--	--	75[a]
Electrostatic Precipitator-medium efficiency **	80[a]	80[a]	--	--	--	--	65[a]
Electrostatic Precipitator-low efficiency **	70[a]	70[a]	--	--	--	--	55[a]
Fabric Filter	99[a]	95[c]	--	--	--	--	80[a]
Catalytic Afterburner	--	--	--	--	95[c]	--	--
Direct Flame Afterburner	--	--	--	--	95[c]	--	--
Flaring	--	--	--	--	90[a]	--	--
Low NOx Burners	--	--	--	note 3	--	--	--
Staged Combustion	--	--	--	40[a]	--	--	--
Flue Gas Recirculation	--	--	--	50[a]	--	--	--
Reduced Combustion Air Preheat	--	--	--	note 4	--	--	--
Steam or Water Injection	--	--	--	65[a]	--	--	--
Low Excess Air Firing	--	--	--	30[a]	--	--	--
Fuel with low Nitrogen Content	--	--	--	50[a]	--	--	--
Sulfuric Acid Plant-Single Contact Process	--	--	50[a]	--	--	--	--
Sulfuric Acid Plant-Double Contact Process	--	--	95[a]	--	--	--	--
Vapor Recovery System (Condensers)	--	--	--	--	note 5	--	--
Activated Carbon Adsorption	--	--	note 6				--
Gas Absorption Column-packed	90[a]	90[a]	note 2				--
Gas Absorption Column-tray type	25[a]	25[a]	note 2				--
Spray Tower	20[a]	20[a]	note 2				--
Venturi Scrubber	90[a]	90[a]	note 2				--

Control Efficiency Table (continued)

(continued)

Control Device or Practice	Control Efficiency (%)						
	TSP	PM_{10}	SOx	NOx	VOC	CO	Pb
Impingement Plate Scrubber	note 7		--	--	--	--	--
Mat or Panel Filter	90 [c]	90 [c]	--	--	--	--	--
Dust Suppression by Water Spray	40 [a]	40 [a]	--	--	--	--	--
Dust Suppression by Chemical or Wetting Agents	40 [a]	40 [a]	--	--	--	--	--
Catalytic Reduction	--	--	--	note 8	--	--	--
Wet Lime Slurry Scrubbing	--	--	85 [c]	--	--	--	--
Multiple Cyclone w/o Fly Ash Reinjection	80 [a]	80 [a]	--	--	--	--	65 [a]
Multiple Cyclone with Fly Ash Reinjection	50 [a]	50 [a]	--	--	--	--	40 [a]
Water Curtain	50 [c]	10 [a]	--	--	--	--	--

[a] – Control efficiency was taken from a literature review and developmental work by the Minnesota Pollution Control Agency
[b] – Control efficiency was taken from AP-42
[c] – Control efficiency was developed from the combination of a literature review and developmental work by the Minnesota Pollution Control Agency, AP-42, and staff judgment

***** Low, medium, and high efficiency cyclones will be defined based on pressure drop. The ranges of pressure drops are as follows:

Low-efficiency cyclones	2-4 inches water
Medium-efficiency cyclones	4-7 inches water
High-efficiency cyclones	7-10 inches water

****** Low, medium, and high efficiency electrostatic precipitators (ESP) will be defined based on the specific collection area (SCA). The SCA is the total collector plate area divided by the gas volume flow rate. It is usually expressed in terms of square feet per 1000 acfm of gas flow. For example, the SCA of an ESP with a gas flow rate of 250,000 acfm and collection plate area of 100,000 square feet is:

$$100{,}000 \text{ ft}^2 / 250{,}000 \text{ acfm} \times 0.001 = 400 \text{ ft}^2/\text{thousand acfm}$$

The ranges of SCA for low, medium, and high efficiency ESPs are as follows:

Low-efficiency ESP	< 400
Medium-efficiency ESP	400 - 700
High-efficiency ESP	> 700

Typical control efficiencies were not assigned to all control devices because some efficiencies strongly depend on source specific parameters. In these instances the table will refer to one of the notes listed below for additional information.

Note 1. Particulate control equipment represented by these classifications should be included in the other, more specific categories (i.e., venturi scrubbers or packed bed absorption columns).

Note 2. The achievable gaseous pollutant control efficiencies for these types of control equipment will depend on the pollutant solubility, the solvent used, the vapor- liquid contact time, and the contact area. These devices are normally designed to achieve a promulgated control efficiency rather than the maximum achievable reduction. Control efficiencies for these devices should be evaluated on a case-by- case basis.

Note 3.Low NOx burners (LNB) have been developed by many boiler and burner manufacturers for both new and retrofit applications. Low NOx burners limit NOx formation by controlling both the stoichiometric and temperature profiles of the combustion process. This control is achieved with design features that regulate the aerodynamic distribution and mixing of the fuel and air, yielding one or more of the following conditions:

1. Reduced O_2 in the primary combustion zone, which limits fuel NOx formation;
2. Reduced flame temperature, which limits thermal NOx formation; and
3. Reduced residence time at peak temperature, which limits thermal NOx formation.

The amount of NOx reduction achievable is dependent upon the combustion system and burner design, actual operating practices, and fuel characteristics. The amount of reduction should be based on the manufacturer's demonstration.

Note 4. The amount of NOx reduction achievable from reducing preheating of combustion air will vary according to the temperatures before and after the modification. Therefore, efficiencies for this process should be evaluated on a case-by-case basis.

Note 5. Control efficiencies for a particular condenser will vary for different VOC compounds and depends on both the partial pressure of the pollutant and the operating parameters of the condenser. Efficiencies should be evaluated on a case- by-case basis.

Note 6. Since the overall control efficiency will depend on source specific parameters such as the physical characteristics of the absorbent bed and gaseous stream, the temperature, and the choice of regeneration technique, efficiencies should be evaluated on a case-by-case basis.

Note 7. Depending on the application control efficiencies may range from 25-99%.
Efficiencies should be evaluated on a case-by-case basis.

Note 8. Generic classification; recommend specific technologies be addressed on an individual basis. Two widely used NOx control technologies include Selective Catalytic Reduction (SCR) and Selective Noncatalytic Reduction (SNCR). SCR can obtain reductions of 60-90%. Urea based SNCR can achieve reductions of 30-80% and ammonia based 55-85%.