Source Category: Industrial, Commercial, and Institutional (ICI) Boilers

INTRODUCTION

The purpose of this document is to provide a forum for public review and comment on the evaluation of candidate control measures that may be considered by the States in the Midwest Regional Planning Organization (MRPO) to develop strategies for ozone, PM2.5, and regional haze State Implementation Plans (SIPs). Additional emission reductions beyond those due to mandatory controls required by the Clean Air Act may be necessary to meet SIP requirements and to demonstrate attainment. This document provides background information on the mandatory control programs and on possible additional control measures.

The candidate control measures identified in this document represent an initial set of possible measures. The MRPO States have not yet determined which measures will be necessary to meet the requirements of the Clean Air Act. As such, the inclusion of a particular measure here should not be interpreted as a commitment or decision by any State to adopt that measure. Other measures will be examined in the near future. Subsequent versions of this document will likely be prepared for evaluation of additional potential control measures.

The evaluation of candidate control measures is presented in a series of "Interim White Papers." Each paper includes a title, summary table, description of the source category, brief regulatory history, discussion of candidate control measures, expected emission reductions, cost effectiveness and basis, timing for implementation, rule development issues, other issues, and a list of supporting references. Tables 1a and 1b summarize this information for the Industrial, Commercial, and Institutional (ICI) boiler source category.

SOURCE CATEGORY DESCRIPTION

Highlighted below are several factors - fuel types, boiler designs, capacity utilizations and pollution control systems – that result in variability in emission rates and control options. See References 8 and 9 for information on the U.S. ICI boiler population. According to Reference 8, there are 10,700 industrial boilers and 283,000 mmBtu/hr of capacity in the 5-state MRPO region, and 20,089 commercial boilers and 212,000 mmBtu/hr of capacity. To provide more complete characterization of ICI boilers in the Midwest, a database (MRPO_ICI_Boilers_101805.xls) was compiled from USEPA's National Emissions Inventory, state inventories and permit files, and other information. The ICI boiler database contains 8,609 point sources in the 5-state region. Coal-fired boilers in the database make up over 70% of the total boiler SO2 emissions and 30% of the total boiler NOx emissions.

ICI boilers combust fuel to produce heat and process steam for applications the chemical, metals, paper, petroleum, food production and other industries. Industrial boilers are generally smaller than boilers in the electric power industry, and typically have a heat input in the 10-250 mmBtu/hr range; however, industrial boilers can be as large as 1,000 mmBtu/hr or as small as 0.5 mmBtu/hour. Commercial and institutional boilers are normally used to produce steam and heat water for space heating in office buildings, hotels, apartment buildings, hospitals, universities, and similar facilities. Most commercial and institutional boilers are quite small, with 80 percent of the population smaller than 15 mmBtu/hour. However, there are several larger coal-fired commercial and institutional boilers in the MRPO region.

TABLE 1a – SO2 CONTROL MEASURE SUMMARY FOR ICI BOILERS

Control Measure Summary	**SO2 Emissions (tons/year) in 5-state MRPO Region**	
2002 Existing measures : NSPS; PSD/NSR; State RACT Rules	2002 Base:	362,347
2009 On-the-Books measures: Enforcement settlements and Alcoa announced scrubbers	Reduction: 2009 OTB:	-66,826 295,521
Candidate measure ID ICI1: OTB measures plus 40% SO2 Reduction to All Medium and Large ICI Boilers *Emission Reductions*: overall reduction of 29% from the 2009 on-the-books estimate, based on 40% reduction in SO2 emissions from ICI boilers > 100 mmBtu/hr *Control Cost*: $633 to $1,075 per ton *Timing of Implementation*: Assumes full reductions achieved in 2009 *Implementation Area*: 5-State MRPO region	2009 OTB: 2009 Reduction: 2009 Remaining:	295,521 -86,425 209,096
Candidate measure ID ICI2: OTB Measures plus Likely Controls to ICI Boilers subject to the proposed BART requirements *Emission Reductions*: overall reduction of 40% from the 2009 on-the-books estimate, based on 90% reduction in SO2 emissions from ICI boilers subject to BART requirements *Control Cost*: $1,622 to 5,219 per ton *Timing of Implementation*: Assumes full reductions achieved in 2013 *Implementation Area*: 5-State MRPO region	2009 OTB 2013 Reduction: 2013 Remaining:	295,521 -117,721 177,800
Candidate measure ID ICI3: OTB Measures plus 90% SO2 Reduction (similar to BART) to All Medium and Large ICI Boilers *Emission Reductions*: overall reduction of 66% from the 2009 on-the books estimate, based on 90% reduction in SO2 emissions from ICI boilers > 100 mmBtu/hr *Control Cost*: $1,622 to 5,219 per ton *Timing of Implementation*: Assumes full reductions achieved in 2009 *Implementation Area*: 5-State MRPO region	2009 OTB 2009 Reduction: 2009 Remaining:	295,521 -194,456 101,065

TABLE 1b – NOx CONTROL MEASURE SUMMARY FOR ICI BOILERS

Control Measure Summary	**NOx Emissions (tons/year) in 5-state MRPO Region**	
2002 Existing measures : NSPS; PSD/NSR; State RACT Rules	2002 Base:	218,547
2009 On-the-Books measures: NOx SIP Call for large boilers, enforcement settlements	Reduction: 2009 OTB:	-5,264 213,283
Candidate measure ID ICI1: OTB Measures plus 60% Reduction (similar to NOx SIP Call) to all Medium and Large ICI Boilers *Emission Reductions*: overall reduction of 19% from 2009 on-the-books estimates, based on 60% reduction for all ICI boilers > 100 mmBtu/hr *Control Cost*: $280 to 1,399 per ton *Timing of Implementation*: Assumes full reductions achieved in 2009 *Implementation Area*: 5-State MRPO region	2009 OTB:2009 Reduction: 2009 Remaining:	213,283 -39,714 173,569
Candidate measure ID ICI2: OTB Measures plus Likely Controls to ICI Boilers subject to the proposed BART requirements *Emission Reductions*: overall reduction of 8% from 2009 on-the-books estimates, based on 80% reduction for ICI boilers subject to BART requirements *Control Cost*: $536 to 4,493 per ton *Timing of Implementation*: Assumes full reductions achieved in 2013 *Implementation Area*: 5-State MRPO region	2009 OTB:2013 Reduction: 2013 Remaining:	213,283 -17,007 196,276
Candidate measure ID ICI3: OTB Measures plus 80% Reduction (similar to BART) to all Medium and Large ICI Boilers *Emission Reductions*: overall reduction of 31% from 2009 on-the-books estimates, based on 80% reduction for ICI boilers > 100 mmBtu/hr *Control Cost*: $536 to 4,493 per ton *Timing of Implementation*: Assumes full reductions achieved in 2009 *Implementation Area*: 5-State MRPO region	2009 OTB:2009 Reduction: 2009 Remaining:	213,283 -66,330 146,953

The process that a particular unit serves strongly influences the boiler fuel choice. For example, the iron and steel industry generates blast furnace gas or coke oven gas which is used in boilers, resulting in sulfur emissions. Pulp and paper processing can use biomass as a fuel, resulting in high PM emissions. The use of a wide variety of fuels is an important characteristic of the ICI boiler category. While many boilers are capable of co-firing liquid or gaseous with solid fuels, boilers are usually designed to combust specific fuels. Changes to the fuel type may reduce the capacity or efficiency of the boiler.

Boiler design also plays a role in the uncontrolled emission rate. Most ICI boilers are of three basic designs: watertube, fire tube, or cast iron. The fuel firing configuration is a second major identifier of boiler design for solid fuels. Stoker boilers are the oldest technology. Pulverized coal boilers succeeded stokers as a more efficient method of burning coal. Circulating fluidized bed (CFB) boilers are the most recent type of boiler for solid fuel combustion and are becoming more commonplace. CFB boilers are capable of burning a variety of fuels, and are more efficient and less polluting than stoker or pulverized coal boilers. Combined heat and power (CHP) or cogeneration technologies are also used to produce electricity and steam or hot water from a single unit.

Some ICI boilers are used only in the colder months for space heating, while others have high capacity utilization year-round. Some ICI boilers already employ some level of control technology to meet existing regulatory requirements. In addition, some facilities have switched coal supply regions in order to utilize lower sulfur content coal to meet regulatory requirements.

Table 2a summarizes the 2002 inventory by boiler size range. The ICI boiler database contains some information on heat input (i.e., mmBtu/hour), but is not complete. Consequently, it was necessary to use actual emissions as a surrogate. Table 2a shows that a small number of large units account for a high percentage of the SO2 emissions. For NOx, it is important to note that area sources account for as much of the total NOx as do large units.

Table 2b summarizes the ICI boiler database by fuel type. The table shows the number of units capable of burning each fuel type, along with the NOx and SO2 emissions in the 5-state region for each fuel type. Coal-fired units account for a high percentage of the SO2 emissions from ICI boilers, while coal-fired and natural gas-fired units account for most of the NOx emissions from ICI boilers.

ICI boilers are a significant part of the base year 2002 SO2 and NOx inventory in the MRPO region, accounting for about 12 percent of the total SO2 and 7 percent of the total NOx. ICI boilers are projected to account for an even greater contribution after implementation of several national/regional regulatory requirements (i.e., Acid Rain program, multiple Federal motor vehicle and off-road engine standards, the regional NOx SIP Call, and the Clean Air Interstate Rule). According to Reference 2, after implementation of CAIR for the EGU sector and other existing measures, ICI boilers will account for 22 percent of SO2 and 18 percent of NOx emissions nationwide.

REGULATORY HISTORY

On-the-Books Regulation

ICI boilers are currently governed by multiple state and federal regulations under the Titles I, III, and IV of the Clean Air Act. Each of these regulatory programs is discussed in the following paragraphs.

TABLE 2a
COMPARISON OF NOx AND SO2 EMISSIONS BY SIZE RANGE

State	Boiler Category	NOx		SO2	
		Number of Units	**Category Emissions (tpy)**	**Number of Units**	**Category Emissions (tpy)**
IL	Point > 100 tpy	39	18,968	42	45,636
	Point 10-100 tpy	170	4,864	42	1,732
	Point <10 tpy	2,606	3,619	2,731	300
	Area Source	Unknown	21,286	Unknown	2,973
		2,815	**48,737**	**2,815**	**50,641**
IN	Point > 100 tpy	49	29,495	66	96,087
	Point 10-100 tpy	176	5,340	64	2,720
	Point <10 tpy	1,181	2,091	1,276	329
	Area Source	Unknown	18,974	Unknown	56,597
		1,406	**55,900**	**1,406**	**155,733**
MI	Point > 100 tpy	33	11,353	51	23,103
	Point 10-100 tpy	164	5,123	33	1,504
	Point <10 tpy	962	1,349	1,075	98
	Area Source	Unknown	18,337	Unknown	0
		1,159	**36,162**	**1,159**	**24,705**
OH	Point > 100 tpy	51	15,687	83	65,683
	Point 10-100 tpy	212	7,625	82	3,474
	Point <10 tpy	517	1,181	615	225
	Area Source	Unknown	16,812	Unknown	0
		780	**41,305**	**780**	**69,382**
WI	Point > 100 tpy	40	18,712	51	57,853
	Point 10-100 tpy	149	4,838	43	1,402
	Point <10 tpy	2,260	2,694	2,355	160
	Area Source	Unknown	10,199	Unknown	2,471
		2,449	**36,443**	**2,449**	**61,886**
MRPO	Point > 100 tpy	212	94,216	293	288,362
	Point 10-100 tpy	871	27,790	264	10,831
	Point <10 tpy	7,526	10,933	8,052	1,113
	Area Source	Unknown	85,608	Unknown	62,041
		8,609	**218,547**	**8,609**	**362,347**

TABLE 2b
COMPARISON OF NOx AND SO2 EMISSIONS BY FUEL TYPE

FUEL TYPE	Number Of Units	NOx (tpy)			SO2 (tpy)		
		Point	Area	Total	Point	Area	Total
Coal	403	67,711	14,195	81,905	261,929	51,308	313,237
Residual Oil	218	3,122	1,364	4,486	9,794	347	10,141
Distillate Oil	731	5,345	8,846	14,191	7,973	10,089	18,062
Kerosene	0	0	62	62	0	125	125
Natural Gas	6,599	34,861	59,389	94,250	329	170	499
Process Gas	247	16,701	0	16,701	17,561	0	17,561
LPG	129	26	1,746	1,771	2	1	3
Liquid&SolidWaste/Wood	282	5,174	7	5,180	2,717	1	2,718
	8,609	**132,939**	**85,608**	**218,547**	**300,306**	**62,041**	**362,347**

Title I regulates criteria pollutants by requiring local governments to adopt State Implementation Plans (SIPs) that set forth their strategy for achieving reductions in the particular criteria pollutant(s) for which they are out of attainment. The SIP requirements includes Reasonably Available Control Technology (RACT) requirements, but more stringent requirements may be imposed depending on both the locale's degree of nonattainment with ambient air standards and the local political will for imposing tough air pollution standards. Some 1-hour ozone nonattainment areas, such as those surrounding Lake Michigan, received waivers from the required installation of NOx RACT based on the assessment of relative local ozone improvement versus potential detrimental air quality impact. Attachment 1 summarizes the current NOx and SO2 regulations for ICI boilers in the five MRPO states.

EPA finalized the NOx SIP in 1998. The final version of the rule called for NOx emission reductions in twenty-two states (including Ohio, Indiana, Illinois, and the southern half of Michigan, but not Wisconsin) that contributed to 1-hour ozone nonattainment in other states. The rule required affected states to amend their SIPs and limit NOx emissions. EPA set an ozone season NOx budget for each affected state, essentially a cap on emissions from May 1 to September 30 in the state. The first control period was scheduled for the 2004 ozone season. States adopted NOx emissions trading programs and assigned 5-month ozone season NOx allowances for large ICI boilers (generally greater than 250 mmBtu/hour) in the NOx SIP call region.

Title I also imposes New Source Performance Standards (NSPS) on certain specified categories of new and modified large stationary sources. In 1986, EPA codified the NSPS for industrial boilers (40 CFR part 60, subparts Db and Dc) and revised portions of them in 1998 to reflect improvements in control methods for the reduction of NOx emissions. Subpart Db applies to fossil fuel-fired ICI units greater than 100 mmBtu per hour that were constructed or modified after June 19, 1984. Subpart Dc applies to fossil fuel-fired ICI units from 10 to 100 mmBtu per hour that were constructed or modified after June 9, 1989.

In addition, Title I subjects new and modified large stationary sources that increase their emissions to permitting requirements that impose control technologies of varying levels of stringency (known as New Source Review, or NSR). NSR prescribes control technologies for new plants and for plant modifications that result in a significant increase in emissions, subjecting them to Best Available Control Technology

(BACT) in attainment areas and to the Lowest Achievable Emission Rate (LAER) in nonattainment areas. The control strategies that constitute BACT and LAER evolve over time and are reviewed on a case-by-case basis in state permitting proceedings. For new sources in nonattainment areas, any NOx waiver in effect also applied to NOx offsets and the LAER (vs. BACT) technology requirement.

On September 13, 2004, EPA published a final rule under Title III of the CAA to substantially reduce emissions of toxic air pollutants from ICI boilers. These Maximum Achievable Control Technology (MACT) standards apply to ICI boilers located at major sources of hazardous air pollutants (HAPs). There are many options for complying with the MACT standards, ranging from continued use of existing control systems to fuel switching to install of a fabric filter and wet scrubber technologies. Thus, while designed to reduce HAP emissions, the control technologies used to reduce the level of HAP emitted from affected sources are also expected to reduce emissions of PM, and to a lesser extent, SO2 emissions.

Title IV of the CAA addresses acid rain by focusing primarily on power plant emissions of SO2. Title IV includes an Opt-in Program that allows sources not required to participate in the Acid Rain Program the opportunity to enter the program on a voluntary basis and receive their own acid rain allowances. The Opt-in Program offers sources such as ICI boilers a financial incentive to voluntarily reduce its SO2 emissions. By reducing emissions below its allowance allocation, an opt-in source will have unused allowances, which it can sell in the SO2 allowance market.

This long-history of regulation of ICI boilers by various CAA programs has resulted in a variety of unit level emission limits resulting from SIP, NSPS, NSR, or MACT requirements. Overlaid on these unit-level requirements are system-wide allowances of the NOx SIP call and the Acid Rain SO2 opt-in program. The specific emission limits and control requirements for a given ICI boiler vary and depend on boiler age, size, and geographic location.

On-the-Way Regulations or Other Emission Reductions

On May 12, 2005, EPA published the Clean Air Interstate Rule (CAIR) to reduce emissions of SO2 and NOx in 29 eastern states, including Illinois, Indiana, Michigan, Ohio, and Wisconsin. The final rule requires states to significantly reduce and cap emission of SO2 and NOx from the power sector. CAIR does not call for emission reductions from non-EGU sources such as ICI boilers.

On June 15, 2005, EPA issued final amendments to its July 1999 regional haze rule. These amendments require emissions controls known as best available retrofit technology or BART for industrial facilities emitting air pollutants that reduce visibility. The BART requirements of the regional haze rule apply to facilities built between 1962 and 1977 that have the potential to emit more than 250 tons a year of visibility-impairing pollutants. Those facilities fall into 26 categories, including industrial boilers. Some of these facilities previously have not been subject to pollution control requirements for these pollutants. Under the final BART guidelines, states are required to conduct source-by-source BART determinations to identify which facilities must install controls and the type of controls to be used.

There have been several recent consent orders issued by the Department of Justice that affect ICI boilers in the MRPO region. Under the EPA's national Petroleum Refinery Initiative, the agency has entered into 17 settlements with U.S. companies that refine nearly 77 percent of the nation's petroleum. These settlements cover 85 refineries in 25 states and on full implementation will result in annual emissions reductions on approximately 80,000 tons of nitrogen oxides and approximately 235,000 tons of sulfur dioxide. In addition, recent settlements with Archer Daniels Midland and Cargill will require emission reductions from ICI boilers at multiple facilities in the MRPO region.

Alcoa announced on July 22, 2005 that is will install wet Flue Gas Desulfurization systems at its Warrick Power Plant in Newburgh, Indiana. This facility includes four large units – Units 1-3 are considered ICI boilers while 4 which is an EGU covered unit under the CAIR rules. The design for the scrubbers is for a 98 percent reduction in SO2, but this is not a federally enforceable condition that must be met.

CANDIDATE CONTROL MEASURES

Air pollution reduction and control technologies for ICI boilers have advanced substantially over the past 25 years. In addition, advances in power generation technologies, renewable energy, and energy efficiency have the potential to further reduce emissions from power plants. The focus of this White Paper is on the first category mentioned above - emission control technologies. The timing and magnitude of reductions from the other three strategies – improved generation technologies, demand reduction/energy efficiency, and clean power – are not likely to achieve the large emissions reductions needed to achieve attainment in the next 3-6 years. However, these other three approaches should be considered as part of a longer-term solution.

Control techniques may be classified into three broad categories: fuel treatment/substitution, combustion modification, and post-combustion control. Fuel treatment primarily reduces SO2 and includes coal cleaning using physical, chemical, or biological processes. Fuel substitution involves burning a cleaner fuel or renewable fuel. Combustion modification includes any physical or operational change in the furnace or boiler and is applied primarily for NOx control purposes. Post-combustion control employs a device after the combustion of the fuel and is applied to control emissions of SO2 and NOx.

There are a wide variety of proven control technologies for reducing NOx and SO2 emissions from ICI boilers. Control technologies proven to be effective and widely used have been identified by EPA in References 3 and 4 and are summarized in Attachments 3 and 4. The type or types of SO2 and NOx control appropriate for any individual ICI boiler is dependent upon the type of boiler, type of fuel, capacity utilization, and the types and staging of other air pollution control devices. However, cost-effective emissions reduction technologies for SO2 and NOx are available and are effective in reducing emissions from the gas stream of ICI boilers.

Two specific candidate control measures are discussed below. The first candidate control measure applies reasonably available controls to medium and large ICI boilers. A second candidate control measure applies likely BART controls for those sources likely to require a BART engineering analysis. A third candidate control measure applies likely BART controls to all medium and large ICI boilers.

Measure ICI1 – Apply 60% NOx and 40% SO2 Reduction to All Medium and Large ICI Boilers. For the purposes of this White Paper, we are assuming that both large-sized (>250 mmBtu/hour) and medium-sized (100-250 mmBtu/hour) ICI boilers would be included under this measure. For NOx, we are assuming that a 60 percent reduction from uncontrolled levels is achievable and cost-effective, which is comparable to the levels used in developing the NOx SIP call budgets (note: no additional controls are applied for boilers already subject to the NOx SIP call). For SO2, we are assuming that a 40 percent reduction is achievable using dry sorbent injection-type systems, which could be considered a highly cost-effective means of controlling SO2 emissions.

Measure ICI2 – Apply Likely Controls to ICI Boilers Subject to BART Requirements. Under this approach, States would develop source-by-source control requirements for those ICI boilers subject to a BART engineering analysis. Under a separate task, MACTEC worked with the States to prepare a list of sources likely to be subject to the BART requirements. For the purposes of this White Paper, we are assuming that sources requiring BART controls could achieve an 80 percent reduction for NOx (based on

ultra-low NOx burner or SCR technology) and a 90 percent reduction for SO2 (based on a wet or dry FGD systems).

Measure ICI3 – Apply 80% NOx and 90% SO2 Reductions (similar to BART) to All Medium and Large ICI Boilers. For the purposes of this White Paper, we are assuming that both large-sized (>250 mmBtu/hour) and medium-sized (100-250 mmBtu/hour) ICI boilers would be included under this measure. For NOx, we are assuming that an 80 percent reduction from uncontrolled levels is achievable and cost-effective, which is comparable to the BART level of control (note: incremental reductions are applied for boilers already subject to the NOx SIP call). For SO2, we are assuming that a 90 percent reduction is achievable and cost-effective (based on a wet or dry FGD systems). (Note, further review of the feasibility of these reduction levels may be necessary for some medium-sized boilers.)

EMISSION REDUCTIONS

We estimated the emission reductions expected from adoption of the two control measures in the following manner:

1. Obtained 2002 actual emissions from the MRPO's 2002 inventory.
2. Identified medium- and large-sized boilers. Ideally, this identification would be based on boiler design capacity; however, boiler design capacity data were missing from most of the boilers in IN, IL, MI, and WI. Thus, for the purposes of this White Paper, we defined a "medium- or large-sized ICI boiler" as one that had actual emissions of 100 tons per year or greater of either SO2 or NOx in 2002.
3. Identified on-the-books (OTB) emission reductions from (a) boilers subject to the NOx SIP Call with their 5-month NOx allocations using information provided in Table III-2 of Reference 6, (b) recent enforcement settlements, and (c) Alcoa's announced plans to install scrubbers at their Warwick, Indiana facility.
4. Identified boilers potential subject to BART requirements using information provided by the States.
5. For NOx SIP call boilers, calculated the future year emissions for by prorating the 5-month NOx allocation to a full 12-month period (i.e., multiplying the 5-month allocation by 365/153); for enforcement settlements, used information from the consent decrees to estimate future emission reductions.
6. For *ICI1*, applied a 60 percent reduction to 2002 NOx emissions from medium and large boilers not already controlled by the NOx SIP call or enforcement settlements. For SO2 emissions, applied a 40 percent reduction to 2002 SO2 emissions for all medium- and large-sized boilers not already controlled by enforcement settlements.
7. For *ICI2*, applied an 80 percent reduction to 2002 NOx emissions and a 90 percent reduction to 2002 SO2 emissions for boilers identified as being potentially subject to BART, in addition to the OTB controls.
8. For ICI3, applied an 80 percent reduction to 2002 NOx emissions and a 90 percent reduction to 2002 SO2 emissions from medium and large boilers.

Tables 3a and 3b summarize the actual annual emissions for 2002, the projected emissions in 2009 based on the on-the-books control requirements, and the projected emissions for the three candidate control measures. Note that for *ICI2*, the BART requirements will not require emission reduction until 2013 at the earliest.

TABLE 3a
COMPARISON OF NOx ACTUAL, ON-THE-BOOKS, AND CANDIDATE CONTROL MEASURES

NOx Emissions (tons per year)										
			On-the-Books (NOx SIP Call, Enforcement Settlements)		Measure ICI1 OTB plus 60% Control (similar to NOx SIP Call) for all Medium and Large ICI Boilers		Measure ICI2 OTB plus Likely Controls for ICI Boilers Subject to BART Requirements		Measure ICI3 OTB plus 80% Control (similar to BART) for all Medium and Large ICI Boilers	
State	2002 Actual		Reduction from 2002	2009 Remaining	Reduction from 2002	2009 Remaining	Reduction from 2002	2013 Remaining	Reduction from 2002	2009 Remaining
IL	Point	27,451	301	27,150	6,920	20,531	518	26,933	13,884	13,567
	Area	21,286	0	21,286	0	21,286	0	21,286	0	21,286
IN	Point	36,926	3,248	33,678	15,070	21,856	11,605	25,321	23,454	13,472
	Area	18,974	0	18,974	0	18,974	0	18,974	0	18,974
MI	Point	17,825	339	17,486	6,150	11,675	1,256	16,569	8,875	8,950
	Area	18,337	0	18,337	0	18,337	0	18,337	0	18,337
OH	Point	24,493	1,376	23,117	5,611	18,882	2,462	22,031	10,411	14,082
	Area	16,812	0	16,812	0	16,812	0	16,812	0	16,812
WI	Point	26,244	0	26,244	11,228	15,016	6,430	19,814	14,970	11,274
	Area	10,199	0	10,199	0	10,199	0	10,199	0	10,199
MRPO	**Point**	**132,939**	**5,264**	**127,675**	**44,978**	**87,961**	**22,271**	**110,668**	**71,594**	**61,345**
	Area	**85,608**	**0**	**85,608**	**0**	**85,608**	**0**	**85,608**	**0**	**85,608**
	Total	**218,547**	**5,264**	**213,283**	**44,978**	**173,569**	**22,271**	**196,276**	**71,594**	**146,953**

Note: the 2009 emission estimates presented here are not growth-adjusted.

TABLE 3b
COMPARISON OF SO2 ACTUAL, ON-THE-BOOKS, AND CANDIDATE CONTROL MEASURES

SO2 Emissions (tons per year)										
			On-the-Books (Enforcement Settlements and Alcoa Scrubbers)		Measure ICI1 OTB plus 40% Control (similar to NOx SIP Call) for all Medium and Large ICI Boilers		Measure ICI2 OTB plus Likely Controls for ICI Boilers Subject to BART Requirements		Measure ICI3 OTB plus 90% Control (similar to BART) for all Medium and Large ICI Boilers	
State	**2002 Actual**		**Reduction from 2002**	**2009 Remaining**	**Reduction from 2002**	**2009 Remaining**	**Reduction from 2002**	**2013 Remaining**	**Reduction from 2002**	**2009 Remaining**
IL	Point	47,668	11,157	36,511	23,196	24,472	11,157	36,511	38,245	9,423
	Area	2,973	0	2,973	0	2,973	0	2,973	0	2,973
IN	Point	99,136	55,305	43,831	71,178	27,958	61,511	37,625	91,018	8,118
	Area	56,597	0	56,597	0	56,597	0	56,597	0	56,597
MI	Point	24,705	199	24,506	9,360	15,345	2,234	22,471	20,811	3,894
	Area	0	0	0	0	0	0	0	0	0
OH	Point	69,382	165	69,217	26,376	43,006	20,861	48,521	59,140	10,242
	Area	0	0	0	0	0	0	0	0	0
WI	Point	59,415	0	59,415	23,141	36,274	21,958	37,457	52,068	7,347
	Area	2,471	0	2,471	0	2,471	0	2,471	0	2,471
MRPO	**Point**	**300,306**	**66,826**	**233,480**	**153,251**	**147,055**	**117,721**	**182,585**	**261,282**	**39,024**
	Area	**62,041**	**0**	**62,041**	**0**	**62,041**	**0**	**62,041**	**0**	**62,041**
	Total	**362,347**	**66,826**	**295,521**	**153,251**	**209,096**	**117,721**	**244,626**	**261,282**	**101,065**

Note: the 2009 emission estimates presented here are not growth-adjusted.

Note that these estimated emission reductions are very uncertain for two reasons. First, information on boiler size (i.e., design capacity) was missing from the ICI boiler database for many boilers, so we may not have accurately identified sources falling into the medium (100-250 mmBtu/hr) and large (>250 mmBtu/hr) ICI boiler size ranges. Second, information regarding existing control devices/measures (i.e., low-sulfur coal, low-NOx burners, etc.) was missing from the ICI boiler database for most boilers, so we may be overestimating the emission reductions as some sources that are already be controlled.

COST EFECTIVENESS AND BASIS

EPA (References 3 and 4) recently evaluated the cost effectiveness of various NOx and SO2 controls for ICI boilers. Attachments 3 and 4 summarize the cost-effectiveness for various control options. We used the data from EPA's analysis to estimate the range of costs for the two candidate control measures. Costs for a specific unit will vary depending on the boiler size, fuel type, and capacity factor.

Control Measure	Pollutant	% Reduction	Cost Effectiveness ($/ton)
ICI1 –Apply 60% NOx and 40% SO2 Reduction to All Medium and Large ICI Boilers	NOx	60	280 to 1,399
	SO2	40	633 to 1,075
ICI2 – Apply Likely Controls to ICI Boilers Subject to BART Requirements	NOx	80	536 to 4,493
	SO2	90	1,622 to 5,219
ICI2 – Apply 80% NOx and 90% SO2 Reduction (similar to BART) to All Medium and Large ICI Boilers	NOx	80	536 to 4,493
	SO2	90	1,622 to 5,219

TIMING OF IMPLEMENTATION

Generally, sources are given a 2-4 year phase-in period to comply with new rules. Under the NOx SIP Call for Phase I sources, EPA provided a compliance date of about 3½ years from the SIP submittal date. Most MACT standards allow a 3-year compliance period. Under Phase II of the NOx SIP Call, EPA provided a 2-year period after the SIP submittal date for compliance. States generally provided a 2-year period for compliance with RACT rules. For the purposes of this White Paper, we have assumed that SIP rules would be adopted in early 2007 and that a 2-year period after SIP submittal is adequate for the installation of controls. Thus, emission reductions would occur in 2009 for Measure ICI1.

For the BART control measure, the proposed BART guidelines require states to establish enforceable limits and require compliance with the BART emission limitations no later than 5 years after EPA approves the regional haze SIP. Since the regional haze SIPs are due in 2008, emission reductions would not occur until 2013 with the 5-year compliance period.

RULE DEVELOPMENT ISSUES

There are many implementation issues that would need to be addressed. An emissions cap-and-trade program (such as the NOx SIP call or proposed CAIR program) is best implemented on a national or regional basis. The MRPO States would need to work with EPA in adding ICI boilers to a national trading program, other RPO's in adding ICI boilers to a multi-region trading program, or with each other in establishing a MRPO-region trading program. Alternatively, MRPO States could develop state-

specific RACT regulations for specific sources or categories of sources . The BART control scenario requires source-by-source control determinations implemented through the permitting process.

GEOGRAPHIC APPLICABILITY

The suggested control measure would apply throughout the MRPO region, not just in nonattainment areas.

SEASONAL APPLICABILITY

In addition to emission reductions during the ozone season to attain the ozone NAAQS, reductions are needed throughout the year to address the PM2.5 NAAQS and regional haze. Thus, the candidate control measures are intended to be applied on an annual basis. An alternative scenario could be developed to create separate ozone season and non-ozone season emission budgets if more stringent control is needed during the ozone season.

AFFECTED SCCs

The primary SCCs affected by this candidate control measure are:

1-02-xxx-xx External Combustion, Industrial Boilers
1-03-xxx-xx External Combustion, Commercial/Institutional Boilers

For modeling purposes, we have identified specific sources in the 2002 inventory for which we will develop control factors. These sources are those ICI boilers that emitted 100 tons or more of either SO2 or NOx in 2002 and were not subject to the NOx SIP Call. Source-specific control factors will also be developed for sources likely to be subject to BART requirements (ICI2) and for all medium and large boilers (ICI3).

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Attachment 1 – Summary of State NOx Regulations for ICI Boilers in the MPRO States

State	Effective Date	Source Type	Description (minimum size cutoff)	NOx Emission Limit (units of lb/mmbtu unless other identified)	Applicability	Average Time	Rule
IL	03/15/01	NEW Fossil Fuel Combustion	≥ 250 mmbtu/hr	Gas - 0.20	Statewide	Hourly	Part 217; Subpart B
				Liquid - 0.30			
				Dual - 0.30			
				Solid -0.7			
IL	03/15/01	Existing Fossil Fuel Combustion	≥ 250 mmbtu/hr	Gas & Liquid -0.3	Chicago/St Louis Metro Areas only	Hourly	Part 217; Subpart C
				Solid- 0.9			
IL	5/1/04	Non-EGU Boilers; Gas Turbines; Small EGU's	Listed Units ≥ 250 mmbtu/hr; EGU's < 25 MW	Trading Program	Statewide	Ozone season	Part 217; Subpart U
IN	5/13/96	Industrial, Commercial, Institutional Boilers	≥ 100 mmbtu/hr - coal	Wall-fired or spreader stoker - 0.5	Clark & Floyd Counties	rolling 30 day average	326 IAC 10-1
				Tangential-fired or overfeed stoker - 0.4			
			≥ 100 mmbtu/hr - Oil	Distillate - 0.2			
				Residual - 0.3			
			≥ 100 mmbtu/hr - Gas	Gas - 0.20			
IN	5/1/04	EGU's	>25 MW	Trading Program	Statewide	Ozone season	326 IAC 10-4
		Non-EGU Units	≥ 250 mmbtu/hr				
MI	5/17/00	Boilers, Process Heaters, EGU < 25 MW	≥ 250 mmbtu/hr -Coal	Spreader Stoker or Pulverized Coal - 0.4	Statewide	Ozone season	R 336.1801
			≥ 250 mmbtu/hr - Oil	Distillate - 0.3			
				Residual - 0.4			
			≥ 250 mmbtu/hr - Oil	Natural Gas - 0.20			
				Other than Nat. Gas - 0.25			

State	Effective Date	Source Type	Description (minimum size cutoff)	NOx Emission Limit (units of lb/mmbtu unless other identified)	Applicability	Average Time	Rule
MI	5/17/00	EGU's	>25 MW	Trading Program	Fine Grid Counties	Ozone season	R 336.1802
		Non-EGU Units	≥ 250 mmbtu/hr				
OH	02/15/72	Boilers	≥ 250 mmbtu/hr -Coal	0.9	Priority I Counties	Annual	3745-23-06
			≥ 250 mmbtu/hr - Oil	0.3			
			≥ 250 mmbtu/hr - Gas	0.2			
OH	5/25/04	Non-EGU Units	≥ 250 mmbtu/hr	Trading Program	Statewide	Ozone Season	3745-15
WI	2/1/01	NEW Boilers	≥ 250 mmbtu/hr - solid fuel	0.15	Six Counties: Kenosha, Milwaukee, Ozaukee, Racine, Washington, Waukesha	rolling 30 day average	NR 428 Subchapter I
			< 250 mmbtu/hr - solid fuel	0.20			
			≥ 25 mmbtu/hr - Residual Oil	0.15			
			≥ 25 mmbtu/hr - Distillate Oil	0.09			
			≥ 25 mmbtu/hr - Gas	0.05			
			≥ 50 mmbtu/hr - kraft recovery	0.10			
WI	12/31/02	Existing Non-Utility Boilers	≥ 100 mmbtu/hr - Coal	Cyclone-Fired - 0.45	Seven Counties	rolling 30 day average, Ozone Season	NR 428 Subchapter I
				Fluidized Bed - 0.20			
				Pulverized - 0.30			
			≥ 100 mmbtu/hr - Oil	Residual - 0.2			
				Distillate - 0.12			
			≥ 100 mmbtu/hr - Gas	0.10			

Attachment 2 – Summary of State SO2 Regulations for ICI Boilers in the MPRO States

State	Effective Date	Source Type	Description (minimum size cutoff)	SO2 Emission Limit (units of lb/mmbtu unless other identified)	Applicability	Average Time	Rule
IL	3/28/1983	New Fuel Combustion	> 250 mmbtu/hour	solid - 1.2	statewide	one hour	Part 214 Subpart B
				residual oil - 0.8			
				distillate oil - 0.3			
	6/26/1980		≤ 250 mmbtu/hour	solid - 1.8			
				residential oil - 1.0			
				distillate oil - 0.3			
IL	3/28/1983	Existing Fuel Combustion - Solid Fuel	All Units	1.8 or Case-by-Case Alternative up to 6.8	Chicago, St. Louis, and Peoria Areas	one hour	Part 214 Subpart C or Subpart F
	6/26/1980		> 250 mmbtu/hour	Case-by-Case Dispersion Based Limits	Statewide except above areas		Part 214 Subpart C or Subpart E
			≤ 250 mmbtu/hour	6.8 or Case-by-Case Dispersion Based Limits			
	5/20/1986		All units	6.8	Kankakee & McHenry Counties	one hour	Part 214 Subpart C
			no flue gas desulf. As of 12/1/1980 and ≥ 154 foot stack	5.5	Peoria Major Metro Area	one hour	Part 214 Subpart C
			Units with flue gas desulf. As of 12/1/1980	1.4	City of East Peoria	one hour	Part 214 Subpart C
			> 125 mmbtu/hour units with flue gas desulf. As of 12/1/1980	1.1	Hollis Township, Peoria County	one hour	Part 214 Subpart C

State	Effective Date	Source Type	Description (minimum size cutoff)	SO2 Emission Limit (units of lb/mmbtu unless other identified)	Applicability	Average Time	Rule
IL	3/28/1983	Existing Fuel Combustion - Liquid or Mixed Fuels	All Units	residual oil - 1.0 distillate oil - 0.3	Statewide	one hour	Part 214 Subpart D
IN	8/28/1990	Fuel Combustion Facilities with Potential Emissions ≥ 25 tpy or 10 lb/hr	Coal or Coal & Oil simultaneously	6.0	Statewide	rolling 30 day for ≥ 1,500 mmbtu/hr; otherwise calendar month	326 IAC 7-1
			Residual Oil alone or	1.6		calendar month	
			Distillate Oil	0.5		calendar month	
IN	8/8/1991	Facilities in Lake County	combustion and process sources	natural gas fuel combustion unless facility specific limit	Lake County		326 IAC 7-4
IN	8/28/1990	Facilities in Listed Counties	combustion and process sources	facility specific limits	Marion, Vigo, Wayne, LaPorte, Jefferson, Sullivan, Vermillion, Floyd, Warrick, Morgan, Gibson, Dearborn, and Porter Counties		326 IAC 7-4
MI	1/19/1980	Power Plants	≤ 500,000 lb steam/hour	1.5 wt. % sulfur	Statewide		R 336.1401
			> 500,000 lb steam/hour	1.0 wt. % sulfur			
MI	1/19/1980	Other Fuel Burning Sources	Coal	2.4	Statewide		R 336.1402
			Oil	1.7			
OH		Fuel Combustion and Process Sources	Emission Limits by Rule by County for Source Categories and/or Individual Sources				3745-18-07 thru 3745-18-94

State	Effective Date	Source Type	Description (minimum size cutoff)	SO2 Emission Limit (units of lb/mmbtu unless other identified)	Applicability	Average Time	Rule
WI	10/1/1986	Existing Fossil Fuel Combustion Units	≥ 250 mmbtu/hour - Solid Fuel	3.2	Statewide		NR 417.07
			≤ 250 mmbtu/hour - Solid Fuel	5.5			NR 417.07
			≥ 250 mmbtu/hour - Residual Fuel Oil	1.5			NR 417.07
			≤ 250 mmbtu/hour - Residual Fuel Oil	3.0			NR 417.07
WI	2/1/1985	New Fossil Fuel Combustion Units	Solid Fuel	3.2	Statewide		NR 417.07
			Residual Fuel Oil	1.5			

Attachment 3 – NOx Technology and Retrofit Costs for ICI Boilers

Fuel	Technology	NOx Reduction %	Capacity Factor %	1000 mmBtu/hr	250 mmBtu/hr	100 mmBtu/hr
Coal Sub-bituminous	LNB	51	14	1520	2304	3033
			50	426	645	849
			83	256	389	512
Coal Sub-bituminous	LNB + OFA	65	14	1727	2608	3428
			50	496	743	972
			83	306	454	593
Coal Bituminous	LNB + OFA	51	14	2197	3317	4358
			50	634	947	1239
			83	392	581	757
Coal	SCR	80	14	4481	5924	7262
			50	1359	1766	2141
			83	876	1123	1349
Coal	SNCR	40	14	2962	4015	4970
			50	1510	1814	2073
			83	1285	1473	1625
Gas	LNB + OFA	60	5	5260	7973	10521
			50	526	797	1052
			94	280	424	559
Gas	LNB + OFA + GR	80	5	6204	9415	12374
			50	656	981	1278
			94	368	543	700
Gas	SCR	80	5	14815	21095	26859
			50	1670	2330	2933
			94	986	1354	1689
Gas	SNCR	40	5	14165	20870	27105
			50	2452	3116	3735
			94	1842	2193	2521
Oil	LNB + OFA (0.5 lbs/mmBtu inlet NOx)	30	10	2630	3986	5260
			50	526	797	1052
			86	306	464	612
Oil	LNB + OFA + GR (0.5 lbs/mmBtu inlet NOx)	50	10	2505	3790	4973
			50	533	791	1028
			86	326	477	615
Oil	SCR (0.5 lbs/mmBtu inlet NOx)	80	5	10458	14443	18544
			50	1191	1595	2014
			86	760	997	1245
Oil	SNCR (0.5 lbs/mmBtu inlet NOx)	40	10	4271	5892	7399
			50	1749	2070	2367
			86	1485	1670	1840

LNB – Low-NOx Burner SNCR – Selective Non-Catalytic Reduction
OFA – Overfire Air SCR – Selective Catalytic Reduction
GR – Gas Recirculation (only for gas- and oil-fired boilers)

Source: U.S. EPA. *Methodology, Assumptions, and References Preliminary NOx Controls Cost Estimates for Industrial Boilers.* November 2003.

Attachment 4 – SO2 Technology and Retrofit Costs for ICI Boilers

Fuel	Technology	SO2 Reduction %	Capacity Factor %	1000 mmBtu/hr	250 mmBtu/hr	100 mmBtu/hr
Coal High Sulfur	IDSI	40	14	1703	2471	3543
			50	776	992	1292
			83	633	763	943
Coal Low Sulfur	IDSI	40	14	1986	2952	4283
			50	870	1131	1504
			83	697	849	1075
Coal	SDA	90	14	1500	2611	3920
			50	531	842	1209
			83	381	569	790
Coal High Sulfur	Wet FGD	90	14	1789	2708	3513
			50	563	820	1046
			83	373	528	664
Coal Low Sulfur	Wet FGD	90	14	2273	3460	4495
			50	704	1036	1326
			83	461	661	836
Oil	Wet FGD	90	10	5082	7801	10160
			50	1109	1654	2126
			86	693	1011	1285

IDSI – In-duct Dry Sorbent Injection (coal only)
SDA – Spray Dryer Absorber (coal only)
FGD – Flue Gas Desulfurization (coal and oil)

Source: U.S. EPA. *Methodology, Assumptions, and References Preliminary SO2 Controls Cost Estimates for Industrial Boilers*. November 2003.