How Costs Were Determined for CIBO Boiler MACT Impacts Study

URS Corporation (URS) worked with the Council of Industrial Boiler Owners (CIBO) and its members to develop a rough order of magnitude estimate of the initial capital cost of complying with the Industrial Boiler MACT. The cost estimates were compiled in a Microsoft Excel workbook; were based on published information or similar project costs; have been reviewed by member company representatives; and have been made available to the US EPA and others for review. The Boiler MACT estimated costs are in large part based on information in EPA's March 2011 survey and emissions databases.

Capital and operating costs estimates are not intended to represent a worst case analysis. Rather, they represent median costs for the various scenarios based on published reports, industry information on specific project costs, EPA reports or control device fact sheets, or actual BACT or BART analyses submitted to permitting agencies. A primary resource was the document "Evaluation of Air Pollution Control Costs for the Pulp and Paper Industry," prepared by National Economic Research Associates (NERA) in May 2003. All costs were discussed with a core team of CIBO members and reviewed by URS engineers familiar with boiler operations and controls prior to finalizing the study.

The Boiler MACT will require emissions controls for particulate matter, hydrogen chloride, mercury, carbon monoxide, and dioxin/furan. The control technologies that EPA has identified as necessary to comply with the Boiler MACT are a fabric filter for control of particulate matter, carbon injection for control of mercury and dioxin/furan, a scrubber for control of hydrogen chloride, and combustion improvements or an oxidation catalyst for control of carbon monoxide. Although in some cases, the emission limits will be very difficult to achieve over all operating conditions, our cost analysis assumes that for each boiler, we can apply emissions controls to achieve the Boiler MACT limits with a comfortable margin of compliance. In some cases, existing equipment configurations may prove impossible to upgrade, and boilers and process heaters may need to be replaced, which is a cost that is not reflected in our analysis. Note also that many facilities may choose fuel switching as a compliance option; however, as the cost of fuel switching is highly dependent on site specific factors (e.g., whether the boiler can burn the alternate fuel, what upgrades must be made to the fuel supply system) and the price of fuel will change over time due to factors like supply and demand, we did not attempt to quantify costs for fuel switching.

The EPA collected information during Phase 1 of the Boiler MACT information collection request (ICR) on thousands of boilers and process heaters at hundreds of facilities. A detailed spreadsheet was developed to estimate costs for Boiler MACT for individual boilers and process heaters, based on EPA's major source boiler inventory database table and the emissions data included in EPA's boiler MACT database. URS extracted information from EPA's major source boiler inventory database including boiler ID, size, fuel category, emissions, and current air pollution control equipment. Based on the information in EPA's database and the baseline emission factors developed by EPA by boiler type and control device, URS determined whether each unit would require additional air pollution controls to meet the Boiler MACT limits. Note that we did not perform any quality assurance on the information in EPA's database, but where

we had knowledge that a boiler had been mis-categorized (e.g., a biomass boiler was listed as a liquid boiler) we did make those changes in our spreadsheet.

One spreadsheet was developed that represents only the units to be regulated by the rule (excludes natural gas boilers and process heaters and boilers and process heaters less than 10 MMBtu/hr heat input and limited use units). A second spreadsheet was developed for Gas 1 units, to evaluate a scenario where EPA did not establish work practice standards for Gas 1 units. Based on the information in the EPA emissions database, we estimated costs of controls that would likely be necessary to comply with the Boiler MACT for (1) coal, biomass, liquid, and Gas 2 boilers 10 MMBtu/hr and greater, and then (2) Gas 1 boilers 10 MMBtu/hr and greater (note that for the final rule, EPA moved all gas-fired boilers to the Gas 1 subcategory unless they were burning any amount of coke oven gas or blast furnace gas). As some forest products boilers at major sources did not receive an ICR from EPA in 2008, we added information for those boilers to the detailed spreadsheet based on information from AF&PA/ncasi. There are likely other units that are not included in the study, as other trade groups have submitted comments indicating that EPA has likely underestimated the universe of affected units (e.g., ACC and API/NPRA).

Information from various sources was used to determine a base capital cost for a 250 MMBtu/hr boiler for each PM, CO, and HCl control technology option and then scaled using an 0.6 power function based on the size of each boiler in the inventory. For example, the capital cost of a wet scrubber on a 100 MMBtu/hr boiler is calculated as the base cost times $(100/250)^{0.6}$. For non-Gas 1 boilers, a fixed cost of $1 million was assumed for installation of a carbon adsorption system for Hg and/or dioxin control, as these systems do not vary much in cost by boiler size. For Gas 1 boilers, in order to be conservative, the control cost was scaled by size. Base cost assumptions are presented below.

Base Control Size, MMBtu	250
Fabric Filter	$7,000,000
Scrubber	$8,000,000
Scrubber/FF/ESP upgrade	$4,000,000
Carbon Injection for Hg/dioxin	$1,000,000
Combustion Improvements or Catalyst for CO	$3,000,000

Controls were evaluated separately, first for particulate matter, then for hydrogen chloride, then for mercury and dioxin/furan, and last for carbon monoxide. To estimate Boiler MACT controls and costs for each unit, if there was no emissions information available for a particular boiler, we use the baseline emission factors developed by EPA for their analysis. In their boiler inventory table, EPA put the boiler pollution controls

into categories. The categories are explained in greater detail in EPA's baseline emission factor memo, but basically are as follows: for PM control code, 1=FF, 2=EFB/ESP, 3=venturi scrubber, 4=wet scrubber, 5=multiclone, 6=none/mist eliminator/unknown. If a unit did not already have a FF or ESP and there was information that indicated the unit cannot meet the limit, we assumed a new FF. If the unit already had a FF or ESP and there was information that indicated the unit cannot meet the limit we assumed an upgrade to the existing control equipment. For HCl control code, 1=wet scrubber or spray dryer, 2=dry scrubber, 3=sorbent injection, 4=venturi scrubber, 5=none/dry PM only. To estimate control costs for HCl, if there was information that indicated the unit cannot meet the limit, we assumed either a scrubber upgrade or new scrubber depending on whether the unit currently had a scrubber. For Hg control code, 1=carbon injection, 2=FF plus sorbent injection or spray dryer, 3=FF only, 4=wet scrubber, 5=venturi scrubber, 6=none/multiclone/EFB/mist eliminator. For Hg and dioxin, if there was information that indicated the unit cannot meet the limit, we added carbon injection. For CO, if there was information that indicated the unit cannot meet the limit, then we assumed that capital would be necessary to either perform combustion/fuel feed improvements or other boiler improvement projects to reduce CO or install a CO catalyst.

Although EPA's estimates indicate that the total capital cost of the final rule will be $5 billion, CIBO has estimated that the total capital cost of the rule will be over $14 billion for industry. It is evident major capital investments in add-on control technology will be required for continued operation of solid and liquid fueled boilers and process heaters.

Our capital cost estimates differ from EPA's cost estimates as follows:

- EPA has used the outdated Control Cost Manual and we have based our cost estimates on more recent information, including actual vendor cost estimates, actual project costs, BACT and BART analyses, industry control cost studies, etc.
- We used a CO catalyst cost 4 times higher than EPA's. Ours is based on a recent quote from BASF and EPA's is based on the 1998 Control Cost Manual section on catalytic oxidizers for VOC control.
- EPA has estimated that a tune-up or burner replacement will be adequate for many units to achieve the CO limits. We do not agree with this assumption because some of the CO limits are fairly low and must be met over all operating conditions except startup and shutdown, so we have estimated higher costs to implement combustion controls, burner replacements, fuel feed system improvements, or CO catalyst.
- Our CO control capital costs are higher than EPA's, mostly because EPA assumed that tune-ups and replacement burners will be adequate for the vast majority of boilers to comply, and we disagree with that assumption.
- EPA has estimated that activated carbon injection will be required on only 120 existing units because installation of a fabric filter is expected to achieve the mercury emission limits, except in cases where a unit already has a fabric filter and does not meet the limits. We do not agree that fabric filters will be sufficient to reduce mercury emissions to the some of the ultra-low levels in this rule. There

is a flaw in the logic that fabric filters are expected to achieve mercury emission limits when there are many boilers in the database that are equipped with fabric filters and have measured mercury emissions higher than the applicable limit. EPA's estimated industry-wide capital cost for activated carbon injection presented in the ERG cost and emissions impacts memo is extremely low, at only $6.2 million (only $52,000 per unit average). This cost better represents 12 units than 120 units.

- EPA has estimated costs to install packed bed scrubbers for HCl control. Industrial boilers do not use packed bed scrubbers for acid gas control, as the limitations of these devices make them impractical for use on applications with high flow rates, high PM loading, and high inlet pollutant concentration. EPA's own fact sheet on these devices, located at http://www.epa.gov/ttn/catc/dir1/fpack.pdf, lists these limitations of these devices and indicates that they are only used in applications up to 75,000 scfm, which limits their use to small units only (EPA responded to this comment by applying multiple packed bed scrubbers to units with higher flow rates). Facilities will instead install wet scrubbers, dry scrubbers, or semi-dry scrubbers to control acid gas emissions from industrial boilers. EPA has estimated HCl control costs for equipment that industry is not likely to install.
- EPA has assumed that facilities will not incur costs to comply with the dioxin/furan standards because they will test for dioxin/furan and be below detection levels. This logic does not make sense, especially when there are boilers in the EPA emissions database with dioxin/furan emissions that are non-detect but actually measured emissions higher than the applicable limit and there are boilers where EPA's baseline emission factor for dioxin/furan is above the applicable limit. We have estimated carbon injection as the control measure for dioxin/furan emissions, assuming that it will be effective at these low levels.

The following capital costs for control additions/upgrades were estimated by URS/CIBO for coal, biomass, liquid, and gas 2 units having numerical emission limits under Boiler MACT:

PM Upgrade Cost	HCl Upgrade Cost	Hg/Dioxin Upgrade Cost	CO Upgrade Cost	**Total Capital Cost**
$5.2 Billion	$5.2 Billion	$1.4 Billion	$2.5 Billion	**$14.4 Billion**

EPA has estimated a control cost of only $5.1 Billion for the rule.

Our study results in the following number of boilers having a zero capital cost estimate (no capital required to add/upgrade emissions controls to comply with the rule):

MACT Fuel Category	**Number of Boilers with No Estimated Capital Cost for Controls**
Coal	2
Biomass	26
Liquid	1
Gas 2	2
Total	**31 (2% of total units with numerical limits)**

In other words, our study indicates that there are only 31 units (or 2%) that are projected to be able to meet the final rule emission limits simultaneously with no additional emissions controls.

Estimated control costs for Gas 1 boilers 10 MMBtu/hr and greater (if the work practice standards are not retained in the final rule and Gas 1 limits are implemented) are as follows:

PM Upgrade Cost	HCl Upgrade Cost	Hg/Dioxin Upgrade Cost	CO Upgrade Cost	**Total Cost**
$16.4 Billion	$19.4 Billion	$2.4 Billion	$4.3 Billion	**$42.5 Billion**