Utah Department of Environmental Quality

Wasatch Energy Systems
Waste Combustor Analysis

WASATCH
ENERGY SYSTEMS

Final Report

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1.0 EXECUTIVE SUMMARY

Wasatch Energy Systems (WES) operates a 420 TPD municipal waste combustor in Davis County, Utah. The WES facility will be under new emission regulations that will require a carbon monoxide (CO) emission limit of 100 ppm based on a four-hour block average. The Utah Department of Air Quality (UDAQ) contracted with HDR to study CO emissions and related issues at the WES facility. The scope of the study included four technical tasks:

1. Evaluate Good Combustion Practices at WES
2. Identify combustion improvement options
3. Estimate achievable CO emissions with existing equipment
4. Consider the relationship between CO emissions and Dioxin/Furan emissions at the WES facility.

An analysis of previous years of operation indicates that the Facility is currently capable of demonstrating CO compliance, on the future four-hour block average basis, approximately 90-95% of time. The current CO limit, determined on a 24-hour geometric mean basis, is complied with nearly 100% of the time.

Wasatch Energy Systems has completed several projects that have improved their ability to control emissions. These include control upgrades, control logic modifications, feed grate replacement, grate tile changes, refractory material changes, and combustion air modifications. The great majority of the four-hour block averages above 100 ppm were the result of slagging, removal of slagging, short-term fuel conditions, or pile rollovers on the grate. Consideration of options to reduce CO (Task 2) should focus on those areas.

In the strictest sense, meeting GCP means meeting the CO limit imposed on the facility. This strict interpretation is not necessarily consistent with the ultimate goal of controlling organic emissions. What is more important, and is discussed later, is the relationship between CO emissions and Dioxin/Furans and the ability of the plant to control organics below the emission limit. In a more practical sense, WES has strived to understand and improve the seven specific components of GCP as is defined in Section 3.0 – Technical Memorandum No. 1. Stack tests have demonstrated the ability of the system to meet limits for MWC organics under test conditions with normal CO levels.

Of the options identified in this report as providing emission improvements, auxiliary fuel firing and operator training were deemed to have the greatest potential to effectively lower the CO emissions to achieve 4 hour averages below 100 ppm. Auxiliary fuel firing comes at significant capital and operating expense. Because of the temporary nature of the CO emissions above 100 ppm (i.e., 2 to 3 hours above 100 ppm), the ability of the other combustion improvement options, described in Section 4.0 – Technical Memorandum No. 2, to reduce the frequency of 4 hour averages above 100 ppm is undefined.

CO emission levels of 40-50 ppm, during normal operation, are achievable. WES is typically achieving this level of CO control, with only occasional spikes that cause the units to go over the future applicable 100 ppm on a 4-hour block average limit of 40 CFR Part 60, Subpart BBBB. CO emissions during slagging conditions may have some room for improvement. However, it is not expected that all excursions, based on 4-hour average can be eliminated.

The test results, discussed in Section 5.0 – Technical Memorandum No. 4, for WES, SPSA and PERC indicate that there is no apparent correlation between CO concentration and dioxins/furans emissions for these three facilities. The more appropriate correlation, at least as indicated by WES test results and supported by the literature, is control of the particulate control device inlet temperature.

Because of this apparent lack of correlation between CO concentration and dioxin/furan emissions, HDR does not expect that raising the CO emission limit or changing the averaging period to a 24 hour block (or, alternatively, a 24 hour geometric) average basis would cause the units to emit dioxin/furans at levels exceeding the 60 ng/m^3 limit of 40 CFR Part 60, Subpart BBBB. In fact, EPA has already at least tacitly acknowledged that a higher CO concentration determined over a longer averaging period does not lead to higher dioxin/furan emissions. In the existing small unit rules, some incinerator designs (i.e., mass burn rotary waterwall and RDF stokers) have a higher CO concentration limit (250 ppm and 200 ppm, respectively), both on a 24-hour block average basis, but have the same dioxin/furan limit as the incinerator designs with the 100 ppm on a 4-hour block average basis limit.

2.0 INTRODUCTION AND BACKGROUND

Wasatch Energy Systems (WES) operates a 420 TPD municipal waste combustor in Davis County, Utah. This facility received a Notice of Violation (NOV) for not meeting its CO emission limits in 1999 and 2000 and separate NOV's for failing to meet dioxin/furan limits during stack tests. The facility has subsequently completed an air pollution control retrofit to control acid gases, mercury and dioxin/furans, which includes dry injection of hydrated lime and powdered activated carbon. WES has indicated that due to plant design and fuel characteristics they cannot meet the CO limit of 40 CFR Part 60, Subpart BBBB.

The Utah Department of Air Quality (UDAQ) has developed a settlement agreement with WES for the NOV's. As part of that agreement UDAQ is directing a study, funded by WES, that will investigate the execution of Good Combustion Practices (GCP) and evaluate operational changes or equipment modifications that may help the facility meet the future CO limit. In addition, the investigation will consider the relationship between CO and dioxin/furan emissions and will review how these issues have been handled and enforced at other facilities.

HDR was selected by UDAQ to conduct this investigation. The approach to this analysis is outlined by the following Tasks:

TASK 100 – FACILITY REVIEW

<u>Objective</u>

Establish WES' ability to meet GCP criteria.

Subtasks

- 101 Information/data collection. Characterize current CO emissions baseline for normal conditions and wet trash or slagging conditions.
- 102 Facility tour and inspection. The design of the related systems will be noted as well as the condition of operating equipment.
- 103 Operations review. Observe four shifts of operation. This should include at least one shift during wet fuel or slagging conditions, if feasible.
- 104 Maintenance records review. Identify equipment failures that correspond to CO spikes and lead to violations.

- 105 Staff interviews. Talk to Plant Manager, Maintenance Superintendent, and Operations staff to understand their knowledge concerning CO emissions and evaluate their ability to implement GCP.

TASK 200 – COMBUSTION IMPROVEMENT OPTIONS

Objective

Identify operational changes and equipment modifications that may improve combustion efficiency and reduce CO emissions.

Subtasks

- 201 Review previous combustion improvement efforts. Each modification or change made by WES staff to improve combustion will be identified to establish its impact.
- 202 Identify potential combustion improvement options, including, but not limited to, control system changes, combustion air distribution, combustion air quantities, fuel feed system, combustion grate design, refractory, recycling, auxiliary fuel firing, and operator training.
- 203 Characterize each option's ability to improve CO emissions. HDR will render an opinion as to whether or not any or all of these options will allow the facility to comply with the future CO limit at all times.

TASK 300 – ACHIEVABLE CO EMISSIONS

Objective:

Identify what level of CO emissions is possible with existing design and operational constraints.

Subtasks

- 301 Estimate level of CO emissions achievable at all times during normal operation, except start-up, shutdown, or malfunction. This will be based on the emissions data collected, as well as the facility review.
- 302 Estimate level of CO emissions achievable at all times with high moisture or low BTU fuel, except during start-up, shutdown, or malfunction. This will be based on the emissions data collected, as well as the facility review.
- 303 Identify appropriate averaging period for achievable CO limits.

TASK 400 – EVALUATE CO VERSUS DIOXIN/FURAN EMISSIONS

Objective

Establish the relationship of CO versus dioxin/furan at WES.

Subtasks

- 401 Collect available stack test data with concurrent CO and dioxin/furan emissions. This data would be plotted to correlate CO versus dioxin/furans for the test conditions.
- 402 Conduct Survey of MWCs with similar arrangements. Obtain data from willing participants and plot CO versus dioxin/furans.
- 403 Conduct literature search for available CO versus dioxin/furan data from other MWCs. This will include a review of the development of regulations related to GCP and CO limit.
- 404 Identify the impact on dioxin/furan emissions for higher CO emissions in Task 300 (if applicable), based on the established CO versus Dioxin/Furan correlation.

HDR prepared a technical memorandum for each Task which are reprinted in the subsequent sections of this final report.

3.0 TECHNICAL MEMORANDUM NO. 1

FACILITY REVIEW

Background

The objective of Task 100 is to establish the ability of Wasatch Energy Systems (WES) to meet Good Combustion Practice (GCP) criteria as defined by the United States Environmental Protection Agency (US EPA). The ultimate goal of GCP is to minimize trace quantities of potentially toxic MWC organic (dioxins/furans) emissions. Seven components have been identified that are believed to be key to achieving GCP. These components are:

1. Waste Feeding
2. Adequate Combustion Temperature
3. Quantity and Distribution of Combustion Air
4. Mixing of Waste
5. Particulate Matter Carry Over
6. Flue Gas Temperature Prior to Particulate Collection Equipment
7. Combustion Monitoring and Control

There is no practical way to insure that all seven components that define GCP are optimized. Instead, EPA has defined three operating parameters that, when monitored and controlled to established numeric limits, will minimize MWC organics emissions. These three parameters are:

1. Maximum Operating Load
2. PM Control Device Inlet Flue Gas Temperature
3. Carbon Monoxide (CO) in the flue gas

Two of the three parameters, operating load and flue gas temperature, are controlled by existing plant equipment and control systems. The third, CO concentration, is the subject of this study.

Current Operations

In the fall of 2001, WES completed a retrofit of the facility's air pollution control equipment. This retrofit included the addition of a Gas Suspension Absorber (GSA) for acid gas and PM control device inlet temperature control, carbon injection for mercury control, and an upgrade to the existing Electrostatic Precipitators (ESPs). Since that time, stack tests have shown values for facility emissions, including MWC organics, at levels well below both existing and future permit conditions. CO levels, while generally below the current and future permit limits, have had excursions. In consideration of the three operating parameters required to achieve GCP, the CO limit has not been met 100% of the time. The other two operating parameters for GCP are relatively easy for WES to monitor and control.

Maximum operating load is set as a parameter to limit carry over of particulate to which MWC organics can adhere. This is defined as the Maximum Continuous Rating (MCR) of the incinerator/boiler. There is conflicting MCR data in the utility's documentation that was reviewed as part of this study. The original predicted performance summary developed by Zurn shows that the MCR is 57,805 lb steam/hr, per boiler. In the O&M information developed by Seghers, the boilers are described as having an MCR of 51,307 lb steam/hr. In any case, this parameter is controlled automatically by the control system at the facility. WES sets a steam flow set point, normally at 52,000 lb/hr, and the system automatically varies grate cycle speed and airflow to achieve the load. Based on observations made the week of August 19 and October 4-5, the control system does a very good job of maintaining boiler load.

PM Control Device Inlet Temperature is also a parameter that is relatively easy for WES to control. The new GSA injects water along with the slurry into the flue gas stream. The water rate is automatically adjusted by the control system to maintain the desired temperature into the ESP, approximately 275 F. Only an equipment malfunction would lead to temperature excursions.

Current CO Emissions

CO emissions data was analyzed for Units A and B for the two years previous to the fall outage of 2002. This data was put into a spreadsheet with 4-hour block averages calculated for the time period. Any 4-hour average exceeding 100 ppm @ 7% O_2 was highlighted and cross-referenced with the operator's logs and monitor reports to establish corresponding operating conditions. The extensive database was reduced to only the four-hour average blocks that exceed 100 ppm and are tabulated in appendix A. A summary of the CO data points is shown in Table 3.1 for both Units A and B. Table 3.2 contains a summary of data points above 100 ppm that are categorized into operating conditions noted in the logs and quarterly CEM reports.

Table 3.1
CO Data Summary (4 Hour Block Averages)

	Unit A		Unit B	
	# of Points	Average CO	# of Points	Average CO
Total Data Points 2000-2001	1905	84.1	1983	67.1
Total Data Points 2001-2002	1760	62.5	1810	45.3
2000-2001 Data Points Above 100 ppm CO	193	343.1	143	296.3
2001-2002 Data Points Above 100 ppm CO	167	217.9	94	174.4

Table 3.2
CO Characterization

Points Above 100 ppm Related to	Unit A		Unit B	
	2000-2001	2001-2002	2000-2001	2001-2002
Slagging or Removal of Slagging	117	67	93	29
Equipment Malfunction	22	17	12	22
Feed Chute Plug	2	5	0	5
Trash Characteristics (Wet)	1	6	0	6
Grate Piling and Obstructions	2	7	1	0
Nothing Noted (Operator Log)*	49	65	37	32
Poor Refuse Composition	24	14	19	7
Slagging	18	34	15	17
Plugged Ash Extractor	7	-	2	-
Process Equipment Problems	-	4	1	2
Unaccounted	-	13	-	6

* The explanations for these occurrences are listed below, as obtained from the Quarterly CEMS Reports.

By far the greatest number of exceedances occurred during slagging conditions. These points represent 70-75% of the total exceedances during 2000-2001. The slagging effect appears to be reduced during the 2001-2002 time period, representing only 50-60% of the exceedances. Slagging occurs when ash begins to accumulate on the sidewalls of the lower furnace and builds up to where the slag begins obstructing the waste feed and flow on the grate. When this condition occurs, the waste begins to build up behind the slag and fuel (waste) voids occur on the grate. The situation becomes a vicious cycle when the areas void of waste get more air, resulting in significant mal-distribution of air and fuel. As discussed previously, good distribution of fuel and air are paramount to good combustion and low CO emissions. Therefore, this upset condition is expected to lead to high CO emissions.

The removal of slag is accomplished by shooting at the sidewalls with an industrial shotgun. This removal system has been used effectively during the entire operating history of the plant. Key to controlling CO during this operation is recognizing the condition early and removing the slag before it begins to affect the distribution of fuel on the grate. Another key is to continue normal operation of the grate while shooting slag. If the grate speed is adjusted drastically or the fuel feed is stopped, an upset condition occurs which inherently leads to high CO. Interviews with control room operators indicate that they have recognized this problem and are making attempts to identify and remove slag without interrupting grate operation. It should be noted that not all slagging and removal of slag events resulted in CO emissions higher than 100 ppm on a 4-hour block average.

Equipment malfunctions were the second most common cause of high CO levels. These malfunctions include hopper plugs, precipitator problems, grate problems, boiler tube failures and other miscellaneous items. Generally, one would expect that these malfunctions would fall into the category of malfunction as defined by 40 CFR 60, § 60.2. The future CO limit does not apply during periods of startup, shutdown or malfumtion.

The third most common cause of excursions are attributed to waste characteristics or composition. The number of excursions related to this is very close to the amount attributed to equipment malfunctions. Note that all of these excursions are of short duration – lasting one or two hours. Accordingly, the fuel conditions that are causing the problem are not an indication of an overall fuel problem such as wet trash, but a small slug of fuel that upsets the combustion process.

It was observed that CO emissions were improved somewhat after the new ram feed system and the APC retrofit was complete. This retrofit was completed during the fall outage of 2001 and the database years correspond to the year before and the year after the retrofit. The improvement was particularly noticeable on unit B where there were a total of 94, four-hour averages above 100 ppm (four-hour average) for the year after retrofit compared to 144 for the year prior to the retrofit.

Because of the fall 2001 retrofit, CO emissions for the current operation are best represented by the 2001-2002 data. Under normal operating circumstances, the CO levels are in the 10-30 ppm range. CO was less than 100 ppm for 91% of the time on Unit A and 95% of the time for Unit B.

Facility Design

The two areas of the facility that directly affect CO emissions are the furnace and the boiler. The furnace system generally includes the charging hopper and feed chute, feed ram and grate, combustion grates and combustion air fans with associated ductwork. The furnace system was designed and supplied by Katy Seghers. A detailed description of the furnace and boiler are included below. The overall design of the combustion system is consistent with modern designs. Some subtle design modifications could be made such as grate tile design and materials. However, an improvement in combustion performance from the current normal level would not be expected as a result. The air pollution control devices installed during the October 2001 retrofit have had a considerable impact on the reduction of Dioxin/Furan emissions. The retrofit installed APC equipment includes a gas suspension absorber (GSA), improvements to the electrostatic precipitator (ESP) and a carbon injection system. While the primary purpose of the APC equipment is to control acid gases, particulate and mercury emission, it has the added benefit of significantly reducing Dioxin/Furan emissions. Stack tests performed subsequent to the retrofit show that this equipment exceeds the future emission requirements and can be considered 'State of the Art" for this application. As a note, the stack tests have indicated that both mercury and dioxin can be controlled to levels less than the future limits even when the carbon injection system is not operated.

The feed grate's function is to push the fuel onto the combustion grate. The fuel is moved by hydraulic cylinder driven rams. The control of the ram speed is manually set by the control room operator. New feed grates that have longer strokes were installed during the fall 2001 retrofit to allow better control of fuel input.

The four zones of combustion grates are identified as the drying zone, two combustion zones and the burnout zone. Each zone consists of a series of rows of grate tiles. The grate tiles are arranged in a sequence of sliding, tumbling and stationary tiles. The grate comprises the ‘floor’ of the furnace with the sidewalls, and roof composed of refractory block lined walls. There is no heat transfer surface in the furnace section. Over the years, the staff has experimented with different refractory types and cleaning methods that would improve refractory wear and slagging potential. They currently use a high alumina, mullite based cast block with the trade name of MONROX MS-10. The blocks are mortared and bolted in place.

The combustion air system includes undergrate air (UGA) and over fire air (OFA). In the original design of the plant, both systems were supplied by a single forced draft (FD) fan. A modification was done at some point afterward to add a separate fan to supply the over-fire air. The FD fans for both units take suction through a common duct from an intake point inside the storage pit. In the original design, the suction ductwork was common to both units; however, the plant installed a divider plate in the ductwork to prevent mal-distribution of air between units. Control of the distribution of combustion air is entirely manual. The undergrate air sections can be adjusted remotely from the control room; however, the OFA dampers must be adjusted locally. Under normal operating conditions, the plant does not use OFA and maintains relatively low CO emissions without it. Some operating staff indicate that OFA is one tool that is used to help control CO excursions. Its effectiveness is not consistent and depends on the circumstances leading to high CO. OFA is also used to reduce furnace temperatures when required.

The combustion gases exit the refractory wall furnace through an opening (throat) that is somewhat narrower than the depth of the boiler. The furnace with refractory walls continues vertically up about 8 feet where it joins the lower header of the boiler. The first pass of the boiler continues vertically up another 25 feet to the boiler roof. The walls of the boiler are membrane-welded waterwalls. The original design included studs and silicon carbide refractory on the boiler walls, up an additional 14 feet above the lower header. Due to boiler tube corrosion from chloride attack, the studs and refractory have been installed nearly up to the boiler roof in the first pass.

Another important component of the combustion system design is the control system. The control system utilized is a Fisher ProVox. The control logic has been modified to improve the combustion control. Originally, the system was designed such that the steam demand controlled the feed grate and combustion grate speed when the system was in automatic. In automatic, the operator selected the number of strokes per cycle and the control system changed the cycle duration based on steam flow deviation from set point. The total combustion air was controlled to maintain a certain quantity of excess air. The split between UGA and OFA was controlled by positioning a modulating damper positioned based on the temperature at the furnace outlet. Currently, while in automatic, only the combustion grate cycle duration is changed to control load. The feed grate is completely manual.

Facility Condition

The facility appears to be in excellent operating condition. During the outage, HDR observed the maintenance work that had been completed in the furnace area of boiler A. All new block refractory was installed in the furnace section and the rest of the boiler wall studs and refractory were restored. Discussions with various staff members demonstrates a conscientious work force, well versed in the importance of controlling CO and in the means available to achieve low numbers.

SUMMARY

Current operation demonstrates CO compliance, on a four-hour average, approximately 90-95% of time. The facility's current permit limit is based on a 24-hour geometric mean and is complied with nearly 100% of the time.

Wasatch Energy Systems has completed several projects that have improved their ability to control emissions. These include control upgrades, control logic modifications, feed grate replacement, grate tile changes, refractory material changes, and combustion air modifications.

The great majority of the four-hour block averages with CO levels above 100 ppm were the result of slagging, removal of slagging, short-term fuel conditions, or pile rollovers on the grate. Consideration of options to reduce CO (Task 2) should focus on those areas.

In the strictest sense, meeting GCP means meeting the CO limit imposed on the facility. This strict interpretation is not necessarily consistent with the ultimate goal of controlling organic emissions. What is more important, and will be discussed in forthcoming technical memorandums, is the relationship between CO emissions and Dioxin/Furans and the ability of the plant to control organics below the emission limit. In a more practical sense, WES has strived to understand and improve the seven specific components of GCP as defined in the first paragraph of this technical memorandum. Stack tests have demonstrated the ability of the system to meet limits for MWC organics under test conditions with normal CO levels. Two important questions remain to be answered. How can CO be reduced during short periods of elevation and what are MWC organic emissions when CO is elevated?

4.0 TECHNICAL MEMORANDUM NO. 2

TASK 200 – COMBUSTION IMPROVEMENT OPTIONS

Background

The objective of Task 200 was to identify operational changes and equipment modifications that may improve combustion efficiency and reduce CO emissions. Previous efforts at improving combustion made by WES are also identified and discussed. The results of Technical Memorandum 1 lead us to evaluate two categories of solutions that are expected to improve CO emissions. The most well defined operating condition that results in higher CO was classified as 'slagging conditions'. In this condition, the build up of slag on the sidewalls can cause mal-distribution of fuel and air on the grate. The removal of the slag can also directly lead to higher CO conditions as operational changes are made to accommodate the removal method. The second highest category is equipment malfunctions that result in CO excursions on four-hour averages. In general, these excursions involve different equipment and are usually beyond the control of the facility. The majority of these malfunction events would not result in an exceedance of the four-hour limit if the three-hour exemption for equipment malfunction were applied. Coming in a close third is the category related to fuel conditions or composition. These temporary conditions generally last for one or two hours. If a method of reducing CO emissions for the slagging and fuel condition situations was developed, the number of expected CO exceedances would be reduced to an insignificant quantity.

Previous Combustion Improvement Efforts

WES has made previous efforts and implemented projects that have shown improvement in CO emissions. Some of these efforts were made for the express purpose of reducing CO and others were implemented for multiple reasons. Table 4.1 (repeated from TM No. 1) summarizes the CO data for two years. This data bears out the significant improvement that has been made in reduction of CO emissions. The average of the CO emissions for all data points was 26% and 32% lower respectively for units A and B from 2000-2001 to 2001-2002. In addition, the average CO emissions for data points that exceed 100 ppm show even greater reductions. The efforts implemented by WES are discussed below.

Table 4.1
CO Data Summary (4-Hour Block Averages)

	Unit A		Unit B	
	# of Points	Average CO	# of Points	Average CO
Total Data Points 2000-2001	1905	84.1	1983	67.1
Total Data Points 2001-2002	1760	62.5	1810	45.3
2000-2001 Data Points Above 100 ppm CO	193	343.1	143	296.3
2001-2002 Data Points Above 100 ppm CO	167	217.9	94	174.4

During the fall outage of 2001 a new feed grate system was installed at the facility. The new feed rams increased the stroke of the ram from 18” to 48”. The larger stroke allows for a better control over the fuel feed rate and prevents the compacting of fuel when minor blockage occurs. In the event minor blockage does occur, the old shorter stroke kept cycling only to compact more fuel until the point was reached that a large bundle was rolled over onto the grate. The large bundle on the grate would restrict airflow and caused mal-distribution of fuel and air. The direct benefit in terms of CO control resulting from the longer stroke is a reduction of grate piling. From the information obtained in TM No. 1, grate piling was not reported as causing CO excursions very often in the operator logs. The benefit most likely came in the category (from quarterly CEMS reports) of poor refuse composition. This category showed significant reductions, which is more likely not actual improvement in fuel conditions, but the ability of the new feed system and the operators to feed it more evenly.

WES has also implemented combustion control logic changes over the last several years with the express purpose of improving combustion and reducing CO emissions. Most notably, the feed grate system was put into a manual mode. It was found that there was a conflict in controlling boiler load by adjusting both the grate speed and the feed ram speed. The grate speed can automatically control boiler load by increasing and decreasing speed to make up for short term fuel differences and minor grate bed depth differences. However, instability was observed when the feed ram speed was also automatically increased or decreased to control boiler load.

Operator training and awareness of CO emissions has lead to improvements in CO emissions. The CEMS system provides a constant read out to the operators so they are aware of elevated emissions and can react prior to an excursion. The operators are keenly aware of conditions that can lead to elevated CO emissions and generally react to reduce the impact. These conditions can include wet fuel, grate piling, slagging or other upset fuel conditions (i.e., high Btu content). Some of the operators recognize that the upset condition must be reacted to quickly. They also recognize that identifying the potential for an upset condition may lead to early correction without as large of an impact. For example, when slag begins to build up on the sidewalls, early detection allows the operator to take steps to remove it without stopping fuel feed or slowing the grates significantly. On this specific issue, the operators that were interviewed had an awareness of and made attempts to reduce the impacts of slagging on CO emissions.

Reduction of air leakage into the grate area, furnace and boiler is important for CO control. Leaking air represents air that does not get thoroughly mixed with fuel and results in poor combustion. In addition, certain locations of leaking air can have a localized quenching effect on the combustion process that further prevents the conversion of CO to CO_2. Based on the two site visits that were conducted, WES has a good maintenance program in place that includes repair of those areas where leaks may occur. Some of these areas include the furnace sidewalls and refractory, expansion joints, bottom ash discharge conveyor, hopper discharges and poke holes and observation doors.

Improvement Options

Based on the engineering proposal and information developed during the first task the following options are identified as potential emission improvement options:

1. Control system changes
2. Combustion air distribution
3. Combustion air quantities
4. Fuel feed system
5. Combustion grate design
6. Refractory improvements
7. Auxiliary fuel firing
8. Operator training

Control System Changes

As discussed in the previous section, WES has made combustion control logic changes to improve CO emissions. It may be possible to further refine these control loops. One possibility may be to automatically bring in over fire air (OFA) as CO levels increase. The current OFA loop is controlled based on furnace temperature. The operators generally put the OFA fan in manual when they use it. In general, based on the data collected and analyzed in TM 1, the plant normally operates at low CO levels (30 ppm) for steady state and normal fuel conditions. This would seem to indicate that the control system is doing a good job of matching fuel to air to meet boiler demand. The benefit from additional modifications is minimal.

Combustion Air Distribution

As discussed in the control system changes section, the logic seems to do a good job of controlling grate speed and air flow to meet steam demand. However, all of the air is generally provided as undergrate air. Plant operators and staff generally find little benefit from OFA operation except during adverse fuel conditions. For the CO excursions that are caused by short-term fuel conditions or mal-distribution, some benefit would be expected from the operation of the OFA fans. Based on the review of the operator logs, the staff does not generally operate the OFA fans even when those unexplained spikes occur. The benefit of doing so is difficult to quantify because the change in operations of bringing on the OFA fan may take some time to settle out. The unexplained spikes that need to be corrected only last for 2-4 hours. Operation of the OFA fan after the spike begins would not necessarily reduce CO emissions in time to avoid a 4-hour average excursion above 100 ppm. However, it does seem reasonable that the operators could take action within 1 hour of the spike to bring on OFA in an attempt to improve combustion.

One possible approach to improving combustion air distribution is to develop a numerical model of the system to analyze possible improvements to the UGA and OFA systems. In this approach, a qualified company would build a finite element computer model based on the existing configuration. The model would be compared to field data collected for specific operating conditions to verify the model. Once verified, the physical arrangements of combustion air, including OFA nozzle size and configuration can be modified to identify potential improvements. A similar effort was completed on an RDF plant that was being studied for combustion improvements. This effort would be expected to cost \$100,000 - 125,000.

Combustion Air Quantities

Currently the control system automatically controls total combustion air based on steam demand only. Many facilities have an O_2 trim component of the control system that makes minor adjustments in air quantities based on actual measurement of O_2. Based on the data collected and the observations made during two site visits, the O_2 level is generally in the 8-10% range, by volume, when measured at the boiler outlet. This level is consistent with other Waste-to-Energy facilities and the Zurn boiler performance data sheets. Consideration has been given to the addition of combustion air for the purpose of reducing furnace temperatures to reduce slagging. Currently the furnace temperatures run about 1800 F and sometimes approaches 2000 F. The original Seghers furnace exit design temperature was 1750 F and was to be controlled by changing the split between OFA and under grate air (UGA). Controlling the temperature by the addition of more combustion air in the grate would reduce temperatures, however some degradation of combustion would also be expected. There is an optimal quantity of air above or below which the CO emissions can increase. Too much air will have the affect of quenching the flame earlier in the combustion process. Controlling grate temperature by means of additional air would not be expected to yield positive results.

Fuel Feed System

The feed ram's function is to push the fuel onto the combustion grate. Currently, the fuel is moved by hydraulic cylinder driven rams. The control of the ram speed is manually set by the control room operator. As discussed previously, new feed rams were installed that have longer strokes to allow better control of fuel input. Occasionally, fuel gets plugged in the feed ram hopper and the system has to be shut down for the operators to unplug the chute. This generally leads to elevated CO emissions. Fortunately this condition is very rare. It occurred about 5 times during the 2001-2002 data period. Based on the successful operation of the fuel feed system during normal conditions, it is not anticipated that further improvements could be made with modifications.

Combustion Grate Design

The existing grate is comprised of four zones of combustion grates, which are identified as the drying zone, two combustion zones, and the burnout/ash discharge zone. Each zone consists of a series of rows of grate tiles. The grate tiles are arranged in a sequence of sliding, tumbling and stationary tiles. The grate comprises the 'floor' of the furnace with the sidewalls, and roof composed of refractory block lined walls. There is no heat transfer surface in the furnace section. This grate design has demonstrated good combustion characteristics and low CO emissions under normal circumstances. Most conventional grate designs are similar to the Seghers' grate in that the grate consists of moving components that move the waste down an inclined bed as air is introduced up through the grate to cool the grate and provide combustion air. It is possible that other grate designs may have the ability to improve fuel and air distribution to achieve better combustion. However, the demonstrated ability of these units to achieve low CO emissions for the majority of operating time makes it unlikely that other grate designs will be an improvement over the Seghers design.

Refractory Improvements

Over the years, the staff has experimented with different refractory types and cleaning methods that would improve refractory wear and slagging potential. They currently use a high alumina, mullite based cast block with the trade name of MONROX MS-10. The blocks are mortared and bolted in place. As identified previously, slagging is an important contributing factor to controlling CO emissions. The characteristics of the refractory become important in regards to its resistance to wear and its ability to shed ash build-up. If the refractory becomes damaged and worn, air leakage can take place at the voids. This leakage causes local hot and cold spots and inadequate distribution of fuel and air. There is no ultimate solution to refractory repair at this time. The conditions of the furnace area are severe duty with high temperatures and an inconsistent fuel that can have components such as large metal objects, which can impact and damage the refractory. WES inspects and repairs the refractory during its regularly scheduled outages. HDR is not aware of any refractory material or any maintenance methods concerning refractory that would result in lower CO emissions.

Auxiliary Fuel Firing

The burning of an auxiliary fuel, such as natural gas or fuel oil, is a common and conventional approach to lower CO emissions. The down side is that it can be very expensive. In addition, it is unknown what impact, if any, the use of auxiliary burners has upon organics emissions, the reduction of which are the main purpose of GCP. To accomplish the goal of lowering CO emissions from WES, HDR estimates that the burner must be sized to have a heat input equivalent to 1/3 of the total heat input required for full load steam production. In round numbers, a 30 million Btu/hr burner would have the adequate size. The optimal location would be just above the furnace throat in the refractory portion of the furnace as shown in Figure 4.1. There would be a single burner on one side wall for each unit.

Based on the data summarized in TM 1, to reduce CO for every hour that exceeds 100 ppm in a four average that exceeded 100 ppm, the burner would need to operate approximately 318 hours on Unit A, and 191 hours on Unit B, for the year prior to the fall outage of 2002. This would translate to an annual auxiliary fuel input of 15,300 million Btu. At a gas cost of $4 per million Btu the annual auxiliary fuel cost would be $61,000.

The actual CO level that would be achieved during auxiliary fuel firing is hard to estimate. However, it is believed that the CO emissions could be reduced for each excursion to a low enough level that the corresponding 4-hour average would be well below 100 ppm. HDR was directly involved with CO issues at a similar facility in Savannah, Georgia. In general terms, the Savannah facility had higher overall CO emissions compared to WES. Under normal operating conditions, the Savannah facility ran in the 80-90 ppm range (versus 30-40 ppm at WES). The Savannah facility had much more difficulty meeting a level of 100 ppm of CO emissions on a 4-hour average basis. At Savannah (also a Seghers facility), installation of auxiliary burners was implemented for two reasons: first, to boost furnace temperatures to allow proper operation of the SNCR system and second to reduce CO emissions. Mr. Joe Thompson, Operations Superintendent at the plant, reports the auxiliary burners are sometimes used as a tool to reduce CO emissions, but their effectiveness depends upon the cause of the elevated emissions. This method of reducing CO emissions could be applied to the scenarios identified in TM 1 where CO levels were elevated. In short, although auxiliary fuel firing would be expected to be an effective means of lowering CO emissions to achieve 4-hour averages below 100 ppm, there is no guarantee that its use would result in 100% compliance with the future CO limit.

The total cost of installing an auxiliary burner in both units is estimated to be approximately $678,000. A summary breakdown is shown in Table 4.2. The cost estimate was based on having the auxiliary burners capable of burning either fuel oil or natural gas. Currently the facility only has fuel oil available as a back up fuel. It was assumed for this opinion of probable cost that new fuel oil forwarding pumps would be required, and that the existing fuel oil storage tank is sufficient for the infrequent use of the auxiliary burners. The auxiliary burners would be stand-alone units with their own combustion air fan and burner management system. Natural gas would be a much less expensive fuel to combust under normal market conditions. While natural gas is currently not available at the plant, a new service could be run. HDR contacted the local gas service provider, Qwestar, for information on a new service. Qwestar indicated that gas is available in the area and could easily be run to the facility. Six hundred (600) feet of underground gas pipeline was included in the cost estimate.

Operator Training

As noted in TM-1, the operations staff at WES seem to be well trained and competent in operating the facility. The staff is aware of the responsibility to monitor emissions and to take action as required and also generally aware of the tools available to achieve required emission levels. One notable finding in the analysis of the data in TM-1 was that many of the CO emission excursions lasted for a period of 1-3 hours. The excursion was long enough to result in an average greater than 100 ppm for the corresponding four hour average. These two facts indicate the importance of early action by the operators. When the CO emission levels are high for several minutes, say 15-30, action must be immediately taken to attempt control. It may be the case that once the elevation occurs, it is impossible to bring CO back in control in a short enough time frame to prevent the four-hour average above 100 ppm. In any case, it seems operator training specific to controlling CO excursions may be beneficial. This training would focus on early identification of excursions (within 15-30 minutes), analysis of the cause and identification of actions to reduce the emission levels.

Summary

Of the options identified in this report as providing emission improvements, auxiliary fuel firing and operator training, as described above, are seen to have the greatest potential to effectively lower the CO emissions to achieve 4-hour averages below 100 ppm. Auxiliary fuel firing comes at significant capital and operating expense. Because of the temporary nature of the CO emissions above 100 ppm (i.e., 2 to 3 hours above 100 ppm), the ability of the other combustion improvement options described above in reducing the frequency of 4-hour averages above 100 ppm is undefined.

5.0 TECHNICAL MEMORANDUM NO. 3

TASK 300 – ACHIEVABLE CO EMISSIONS

Background

The objective of Task 300 was to identify what level of CO emissions are possible with existing design and operational constraints. The original intent of the study was to identify CO emissions that were achievable during normal operation and CO emissions during operation with high moisture or low Btu fuel. Normal operation is defined as when the unit is at or near full load conditions, not in start-up, shut down or malfunction. Equipment malfunction does not include the slagging condition that is discussed in Technical Memos No. 1 and 2. The condition of high moisture or low Btu fuel was identified at the beginning of the study as one that possibly resulted in elevated CO emissions. In fact, data analyzed to date and included in Technical Memos No. 1 and 2 indicate that very few CO excursions are related to fuel conditions. It has become apparent that the major cause of CO excursion is the slagging and the removal of slag from the boilers. Therefore, slagging conditions will be the second condition for which achievable CO emissions will be identified in this study.

CO Emissions During Normal Operation

HDR has taken the database that was created for the previous analysis in Technical Memo No. 1 and further manipulated it to obtain CO emissions during "normal" operating conditions. To obtain "normal" conditions, all one-hour averages related to start-up, shutdown, malfunctions and slagging were removed from the data base. The malfunction events that were deleted from the data base included, but were not limited to, the following:

1. Feedhopper plugging
2. Feedgrate problems
3. Ash extractor plugging
4. Tumbler ram malfunction
5. Feed ram failure
6. Shaker table break down

An overall average was taken of the remaining hourly average for both Units for the 2000 – 2001 and 2001 – 2002 operating periods. A summary of this data is shown in Table 5.1. The summary data shows lower CO emissions during normal operating conditions during the 2001-2002 data, which corresponds to the period after the new feed system was installed and the APC retrofit was completed for both Units. Unit B characteristically shows a lower absolute level of CO for both the defined normal levels and during the slagging condition. The 2001-2002 data during normal operation is 40-50 ppm. This effectively represents what is achievable during normal operation and is well within allowable levels.

CO Emissions During Slagging Conditions

The greatest number of CO excursions occurred during slagging conditions. From data included in the previous Technical Memos, these points represent 70-75% of the total excursions during 2000-2001. The slagging effect appears to be reduced during the 2001-2002 time period, representing only 50-60% of the excursions. Table 5.1 also provides a summary of the average hourly CO emissions during slagging conditions. Slagging occurs when ash begins to accumulate on the sidewalls of the lower furnace and builds up to where the slag begins obstructing the waste feed and flow on the grate. When this condition occurs, the waste begins to build up behind the slag and fuel (waste) voids occur on the grate. The situation becomes a vicious cycle when the areas void of waste get more air, resulting in significant mal-distribution of air and fuel.

Table 5.1
Average of hourly CO emissions (ppm @ 7% O_2)

Unit	Operating Conditions	2000 – 2001	2001 - 2002
A	Normal	59	50
	Slagging	658	257
B	Normal	51	41
	Slagging	531	244

The resolution to this condition is to remove the slag by means of a shotgun. This sometimes requires slowing or stopping the grate, which can also lead to an upset condition and elevated CO emissions. Interviews with control room operators indicate that they have recognized this problem and are making attempts to recognize slag and remove it without interrupting grate operation. Quick and early response by the operator typically allows removal of slag with minor interruptions and CO spikes. This is readily apparent when comparing the hourly CO emissions during slagging conditions during the 2000 – 2001 and 2001 – 2002 operating periods for both Units. The average CO emissions during slagging conditions decreased by 61% and 54% for Units A and B, respectively. Credit for this improvement can be given to the projects completed to date and also to the diligence of the staff in learning to recognize and react to the operating conditions before and during a CO excursion. While the improvement is remarkable, it did not allow operation within the future 100 ppm limit on a four-hour average. Based on the information provided and the data analyzed to date, it is not expected that continued improvement will result in reaching the CO limit on the basis of a 4-hour average. In addition, the average shown during slagging conditions represents a broad range of CO emission levels. It is not reasonable to expect operational improvements are available to achieve an average CO emission of less than 200-250 ppm on a 4-hour basis during these conditions.

24-Hour Averaging

This task of the study is intended to identify an appropriate averaging period for CO emissions. In the arena of CO emissions on municipal waste combustors, only two averaging periods are utilized, the 4-hour and 24-hour durations. The WES facility is currently required to meet CO emissions on the 24-hour average basis. WES has shared additional data for the period of time after the fall 2002 outage. To date, WES has not been in violation of exceeding the CO limit of 100 ppm on a 24-hour average. TM No. 4, which will follow this TM, will discuss the relationship between CO and Dioxin/Furans. TM No. 4 shows that the correlation of high Dioxin/Furans at high CO levels, which existed at uncontrolled levels prior to acid gas retrofits, does not exist on the post retrofit data that has been obtained. It is for this reason that HDR feels a CO emission limit based on a 24-hour block average poses no additional environmental or health risk and is a condition that WES can meet.

Summary

CO emission levels of 40-50 ppm, during normal operation, is achievable. CO emissions during slagging conditions may have some room for improvement, however it is not reasonable to expect that all excursions, based on the 4-hour averages will be eliminated. HDR would support an averaging period of 24-hours for CO emissions that would result in a high level of compliance for the WES facility.

6.0 TECHNICAL MEMORANDUM NO. 4

TASK 400 – CO VERSUS DIOXIN/FURAN EMISSIONS

Background

The objective of Task 400 is to discuss the relationship between CO concentration and dioxin/furan emissions from the WES municipal waste combustors. During the development of the emission guidelines for both large units (40 CFR Part 60, Subpart Cb) and small units (40 CFR Part 60, Subpart BBBB), EPA consistently cited a correlation between CO concentration and dioxin/furans emissions. This correlation was based on a body of test data compiled from a number of facilities and unit types. Another significant correlation determined during the rulemaking process was the one between particulate control device inlet temperature and dioxin/furan emissions.

The full set of information from the rulemaking docket is not readily available. Other EPA documentation[1] (MWC BID) contains some useful information in regards to the CO standards and averaging periods. The MWC BID states that "[s]tate of the art mass burn waterwall MWCs have inherently stable combustion characteristics and low CO levels. A 100 ppm CO emission limit with a 4-hour averaging time has been established for these types of units."[2] Subsequent paragraphs in the MWC BID discuss some of the facilities from which test data was reviewed during development of the CO limit. As to the averaging period, "[t]he 4-hour CO emission averaging time is roughly the time period required for a dioxin/furan emissions test. It is also a reasonable minimum averaging period for combustors with relatively stable operating conditions. **A 24-hour averaging period is needed for combustors that are prone to combustion upsets."[3] (emphasis added)**

This 24-hour averaging period, along with the development of the higher CO limit of 150 ppm for refuse derived fuel stoker units, is briefly discussed in the MWC BID as well. The MWC BID says that "[a] statistical evaluation of CO emissions data from the Detroit [the Greater

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[1] *Municipal Waste Combustion: Background Information Document for Promulgated Standards and Guidelines – Public Comments and Response*, EPA Document Number EPA-453/R-95-0136, (October 1995), U.S. Environmental Protection Agency – Office of Air and Radiation – Office of Air Quality Planning and Standards, Research Triangle Park, NC.

[2] Ibid, page 3-58

[3] Ibid, page 3-60

Detroit Resource Recovery Authority Facility] facility indicated that although it could achieve average long-term CO emissions of 70 to 80 ppm, it could only achieve an emission limit of 150 ppm on a 24-hour basis due to CO excursions associated with feed upsets."[4] Apparently based on this single facility statistical analysis, the promulgated CO limits for large unit RDF stoker MWC units are 200 ppm for existing units and 150 ppm for new units, both on a 24-hour block average basis.

Based on these excerpts, it appears that EPA recognized the potential variability of CO emissions from RDF stoker facilities by basing the final limit on a statistical analysis of a single facility. However, such consideration was not given to mass burn facilities, which were instead apparently seen as being immune to process upsets that lead to elevated CO levels.

Facility CO and Dioxin/Furan Test Results

HDR obtained the results of WES facility stack tests performed during the years 1993 – 2002. This data spans facility operations both prior to and after facility retrofit, which came on line September 1, 2001. Plots of the results for Unit A are shown in Figure 6.1, while the results for Unit B are shown in Figure 6.2. For informational purposes, Figure 6.3 presents a comparison of ESP inlet temperature versus total dioxin/furan emissions for both Units A and B prior to and after the retrofit.

Review of the information presented in Figures 6.1 and 6.2 indicates that for both WES units, the retrofit resulted in a reduction in average CO concentrations along with more than an order of magnitude in dioxin/furan emissions. As a note, this reduction in average CO concentrations is also supported by the discussion of facility CEM data presented in Section 3.0. Although both CO and dioxin/furans decreased as a result of the retrofit, no direct correlation between CO and dioxin/furan emissions is evident from review of Figures 6.1 and 6.2. In fact, the significantly larger dioxin/furan reduction as compared to the rather limited reduction in average CO concentrations, further demonstrates the lack of a correlation between CO concentrations and dioxin/furan emissions from WES.

The decrease in CO emissions and dioxin/furan emissions are likely due to two separate causes. The decrease in CO (and, to some extent, dioxin/furan) emissions can be attributed to improved combustion practices implemented at the facility (e.g., upgraded feed ram system, better

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[4] Ibid, page 3-59

awareness of slag management, etc.). Figure 6.3, which shows the relationship between ESP inlet temperature and dioxin/furan emissions, indicates that the order of magnitude decrease in dioxin/furan emissions is directly related to control of the ESP inlet temperature. This control of ESP inlet temperature to approximately 300 °F, resulting in lower dioxin/furan emissions, is consistent with particulate matter control device inlet temperatures recommended by a variety of literature sources, including a publication by the National Research Council[5].

It is important to note that no data was available for the Wasatch facility units at CO levels above 100 ppm. The level of actual total dioxin/furan emissions during CO spikes at this facility is unknown. Likewise, data from other mass burn facilities operating at higher CO levels is not available.

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[5] *Waste Incineration and Public Health*, (2000), National Research Council, National Academy Press, Washington, D.C., page 56

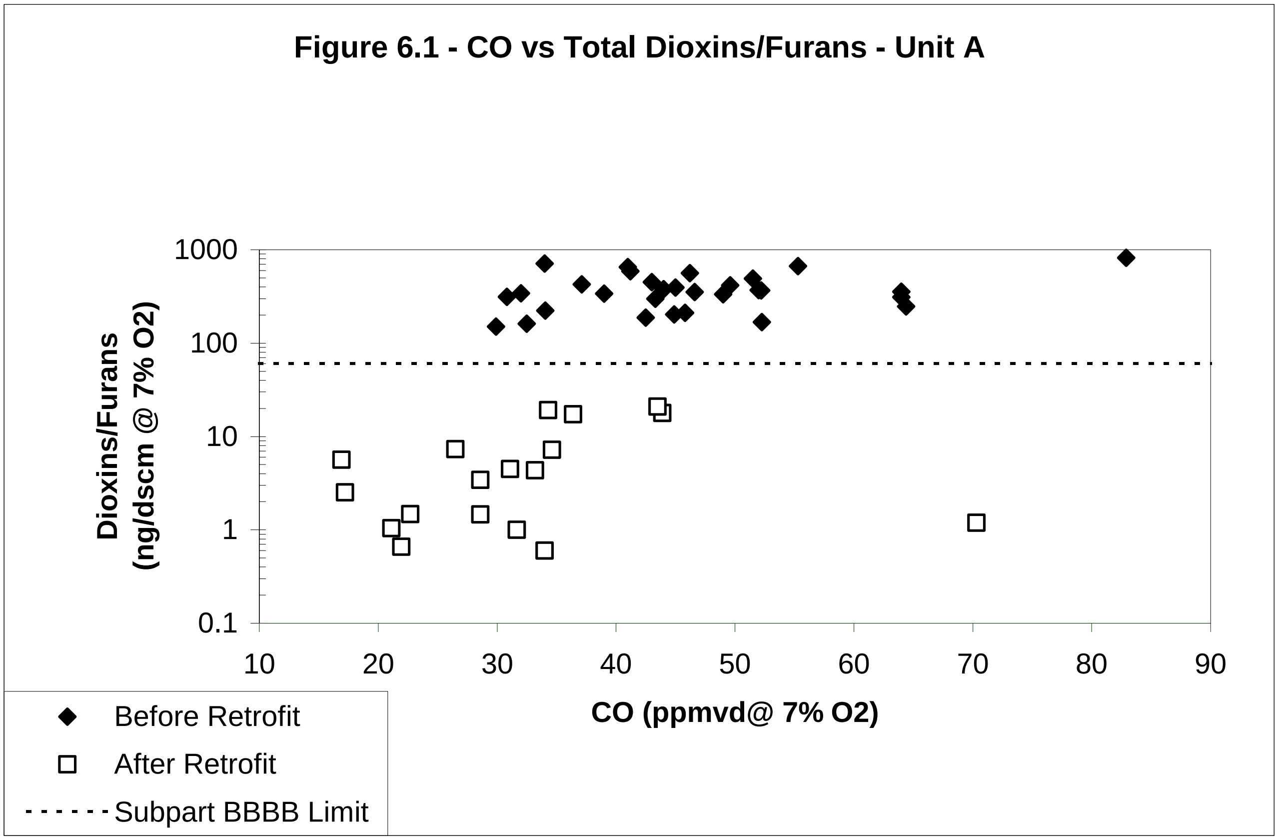


Figure 6.1 - CO vs Total Dioxins/Furans - Unit A
1000
100
10
1
0.1
Dioxins/Furans (ng/dscm @ 7% O2)
10
20
30
40
50
60
70
80
90
CO (ppmvd@ 7% O2)
◆ Before Retrofit
☐ After Retrofit
- - - - - - Subpart BBBB Limit

Figure 6.2 - CO vs Total Dioxins/Furans - Unit B

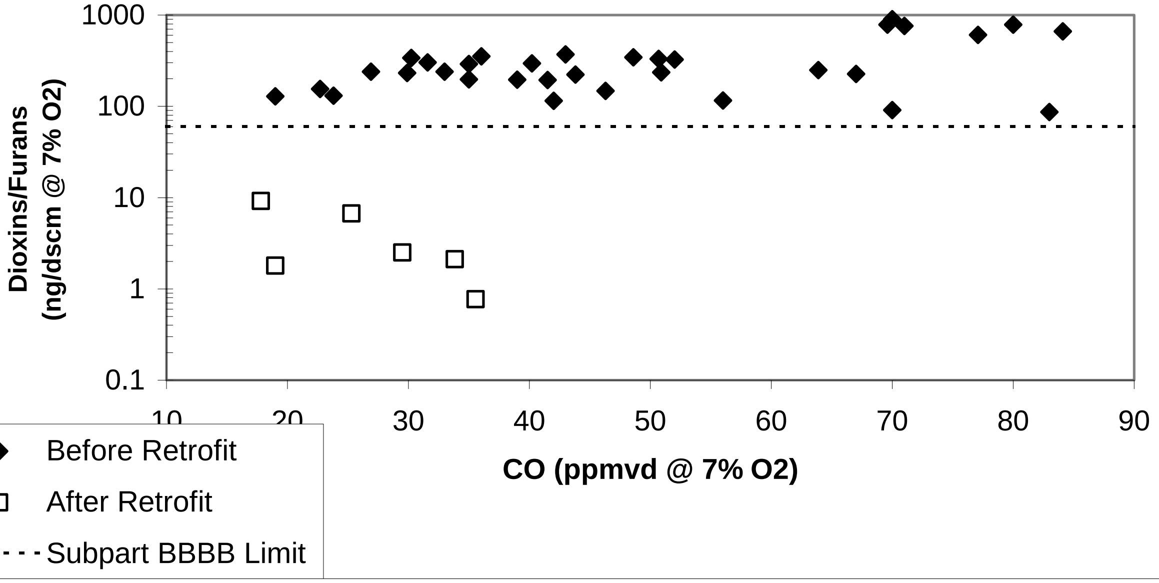
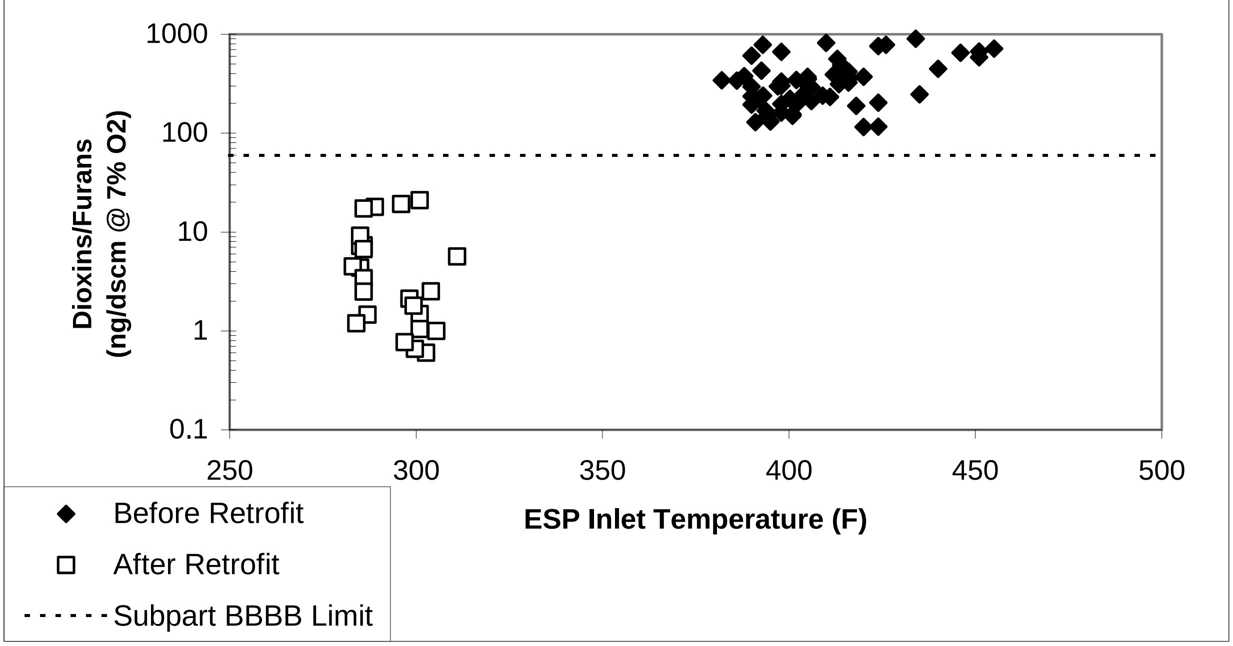


Figure 6.3 - Temperature vs Total Dioxins/Furans - Units A and B



Other Facility CO and Dioxin/Furan Test Results

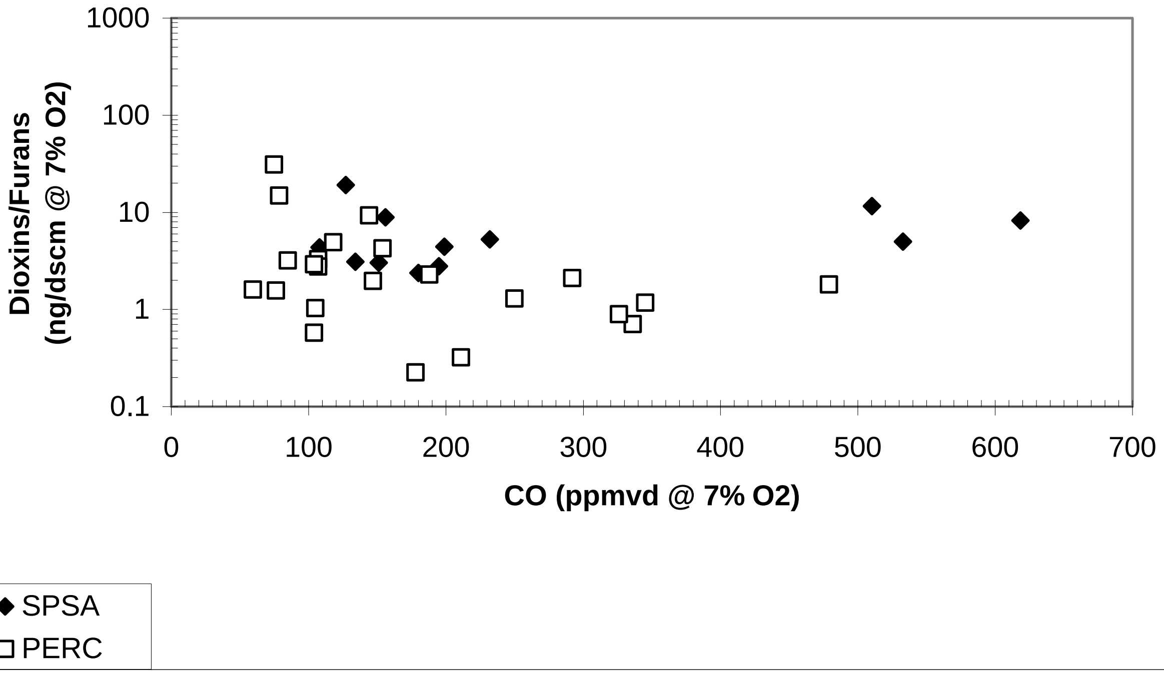
HDR obtained the results of stack testing from two other facilities. These results are from testing performed before and after the compliance deadline of 40 CFR Part 60, Subpart Cb. In addition, as RDF stokers, units at the two plants are subject to a 200 ppm (24-hour block average) limit.

- SPSA Southeastern Public Service Authority – RDF plant equipped with spray dryer absorber and baghouse

- PERC Penobscot Energy Recovery Company – RDF plant equipped with spray dryer absorber and baghouse

These two plants are equipped with somewhat different control equipment than that present at WES. The acid gas control systems are similar in how they fundamentally control acid gas emissions. The ESP at WES removes particulate matter by a different manner, but overall particulate matter control efficiency is similar. Review of the CO concentration versus dioxin/furan emissions relationship for SPSA and PERC is instructive. As with the WES test results, no correlation between CO concentration and dioxin/furan emissions is apparent from a review of the data, which is presented graphically in Figure 6.4. Unlike at WES, the SPSA and PERC data sets do include points at CO levels above 100 ppm and up to 600+ ppm. Even at these higher CO levels, no relationship is observed between CO and dioxin/furan emissions.

Figure 6.4 - CO vs Total Dioxins/Furans - Other Facilities



Attempts were made by both WES and HDR to collect information from the facility located in Savannah, Georgia. The Savannah facility has a similar design to that of Wasatch Energy and was thought to be a good candidate for representative data. However, the Savannah facility did not actually supply any emissions data to either HDR or WES.

Literature Search for Available CO versus Dioxin/Furan Information

As discussed previously, EPA has a large set of information for various waste combustor types and facilities that was collected prior to retrofit of units. However, no such information database for post-retrofit facilities was found during searches of various EPA data repositories via the Internet. In addition, general searches on the Internet for CO concentration and dioxin/furan emissions information found only references to pre-retrofit information. However, even if post-retrofit data was available for a large enough set of facilities, it would be difficult, if not impossible, to quantitatively determine the level of dioxin/furan control achieved by combustion efficiency improvement versus those achieved by flue gas temperature control. This is because the combustion efficiency upgrades and flue gas temperature control modifications were performed at the same time for most retrofitted facilities.

The lack of a correlation between CO concentrations and dioxin/furan emissions at WES, SPSA, and PERC indicated in Figures 6.1, 6.2 and 6.4 of this memorandum directly contradicts EPA's assertion that the two are correlated[6]. Conflicting statements contained in a Royal Society of Chemistry document on waste incineration epitomize this issue of the correlation between CO concentrations and dioxin/furan emissions[7]. First, the document cites two studies that result in the following conclusion:

> *"Correlations with combustion parameters such as temperature, excess air level (O_2) and CO, and the emissions of PCDDs and PCDFs would therefore be expected. The emission of CO from incinerators is used as a measure of efficient combustion, such that minimum CO correlates with efficient combustion. A number of workers have indeed found a correlation between PCDD and PCDF emissions, and furnace temperature, CO, oxygen concentration, and to a lesser extent furnace residence time."*

But one sentence later[8], the following is stated, based on four other studies:

> *"However, in contrast, other workers have shown that there is no direct relationship between furnace temperature, CO concentration, or combustion efficiency and PCDD and PCDF emissions. This group of workers suggested that the de novo synthesis dominates the formation of PCDDs and PCDFs. PCDD and PCDFs may be destroyed at the high temperature of the furnace with efficient combustion control, but the overall emissions of PCDDs and PCDFs from an incinerator are not affected by this destruction since formation of these compounds takes place in the cooler parts of the incinerator system, downstream of the furnace. Commoner, et al.*[9] *showed that PCDD and PCDF emissions from an incinerator furnace outlet were negligible, but much larger concentrations were found in the cooler parts of the incineration system prior to the stack due to de novo synthesis in the heat exchangers."*

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[6] MWC BID, pages 3-61 through 3-63, among others.
[7] *Waste Incineration and the Environment*, (1994), The Royal Society of Chemistry, page 44
[8] Ibid, page 45
[9] *Waste Manag. Res.*, (1987), B. Commoner, K. Shapiro, and T. Webster, page 327

Summary

As stated in previous technical memos, WES is achieving excellent CO control, with only occasional spikes that currently cause the units to go over the future applicable 100 ppm on a 4-hour block average limit of 40 CFR Part 60, Subpart BBBB. The test results discussed in this document for WES, SPSA, and PERC indicate that there is no apparent correlation between CO concentration and dioxins/furans emissions for these three facilities. The more appropriate correlation, at least as indicated by WES test results and supported by the literature, is control of the particulate control device inlet temperature.

Because of this apparent lack of correlation between CO concentration and dioxin/furan emissions, HDR does not expect that raising the CO emission limit or changing the averaging period to a 24 hour block (or, alternatively, a 24 hour geometric) average basis would cause the units to emit dioxin/furans at levels exceeding the 60 ng/m^3 limit of 40 CFR Part 60, Subpart BBBB. In fact, EPA has already at least tacitly acknowledged that a higher CO concentration determined over a longer averaging period does not lead to higher dioxin/furan emissions. In the existing small unit rules, some incinerator designs (i.e., mass burn rotary waterwall and RDF stokers) have a higher CO concentration limit (250 ppm and 200 ppm, respectively), both on a 24-hour block average basis, but have the same dioxin/furan limit as the incinerator designs with the 100 ppm on a 4-hour block average basis limit.

7.0 CONCLUSIONS

Wasatch Energy Systems (WES) has demonstrated knowledge of and an interest in addressing the control of CO emissions. Analysis of the current operation demonstrates that CO emissions are less than 100 ppm virtually all of the time on a 24-hour basis and more than 95% on a 4-hour average. This performance has been realized due to specific modifications that were made, as well as increased operator awareness and training.

Additional modifications or operational changes were considered for improvements in CO emissions. None of the conventional options considered were deemed as feasible to reduce the short excursions of CO to a point where 4-hour violations would not occur. During normal operation, emission levels of 40-50 ppm and lower are achievable.

Stack test results for this facility and other facilities that have acid gas and particulate control show a lack of correlation between CO emissions and dioxin/furan emissions. Therefore, revising the emission limits on the WES facility to allow higher CO emissions or a longer averaging period is not expected to result in dioxin/furan emissions above the future permit limit of 60 ng/m^3.

APPENDIX A
EMISSIONS DATA