18th Annual North American Waste-to-Energy Conference

ALTER NRG

A LEADING PROVIDER OF CLEAN ENERGY SOLUTIONS

Orlando, Florida - May 13, 2010

ALTER NRG

Westinghouse Plasma Corporation

a division of Alter NRG Corp.

HISTORY OF PDMR DEVELOPMENT

1997
- PDMR Development Agreement -Hitachi Metals & WPC

1998
- WPC Testing – Madison PA
- Yoshii Test Plant Construction
- Eco Valley - environmental assessment

1999
- Yoshii – one year of MSW testing
- Eco Valley – 7 meetings with Residents

2000
- Yoshii – JWRF certification received in September
- Eco Valley – construction began
- Mihama-Mikata – presentation to government

2001
- Mihama-Mikata – construction began

2002
- Plasma Component Manufacturing Agreement – Hitachi Metals & WPC
- Eco Valley – commissioning
- Mihama-Mikata - commissioning

2003
- Eco Valley - operational (ASR & MSW)
- Mihama-Mikata – operational (MSW & Sludge)

2004
- Eco Valley – freeboard refractory replaced

2005
- Eco Valley – bottom shape remodeled & refractory structure of PFMR changed
- Refractory materials of Afterburner changed

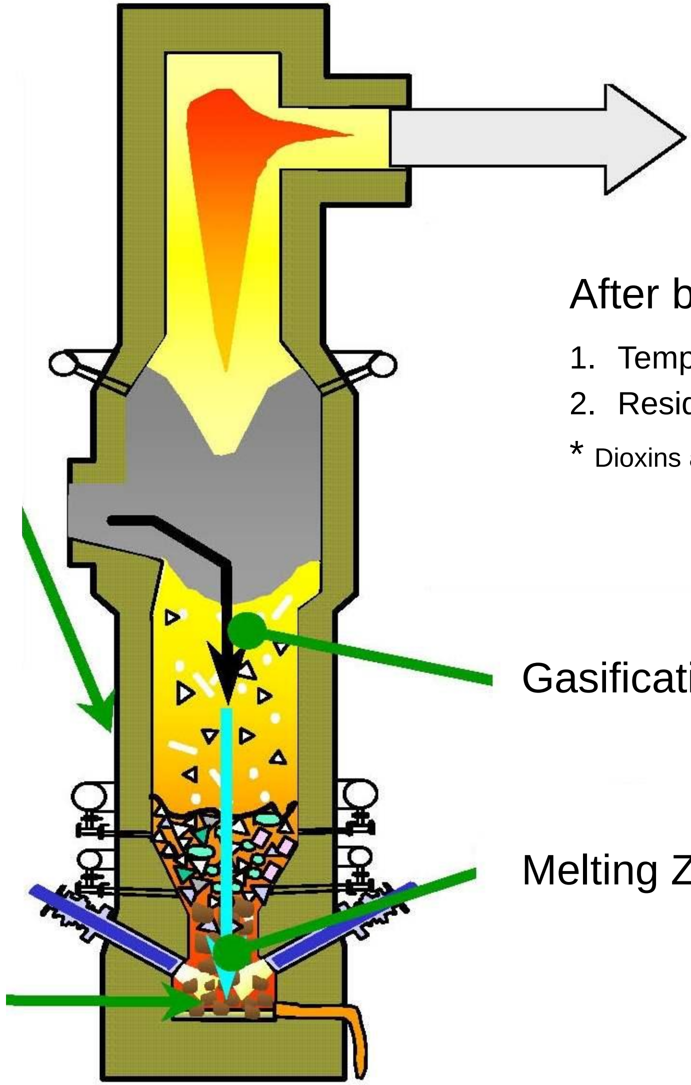
2006
- Plant tours begin
- Eco Valley – refractory materials of Afterburner changed
- Mihama-Mikata – 3 year guarantee ended

2007
- Eco Valley – temperature control changed during commercial operation

ADVANTAGE OF PDMR

Gasification/melting zone combined-type shaft furnace

1. Simple structure – no internal drive unit
2. High volume of accumulated heat – MSW can also be treated
3. Melting zone 1,550° C or higher – high quality slag and metal are discharged



Plasma Torch & Coke Bed

1. Output easily adjusted
2. Smooth continuous discharge of molten slag and metal

THE JAPANESE FACILITIES

Hitachi Metals' Eco-Valley Utashinai WTE Facility

Hitachi Metals' Mihama-Mikata WTE Facility

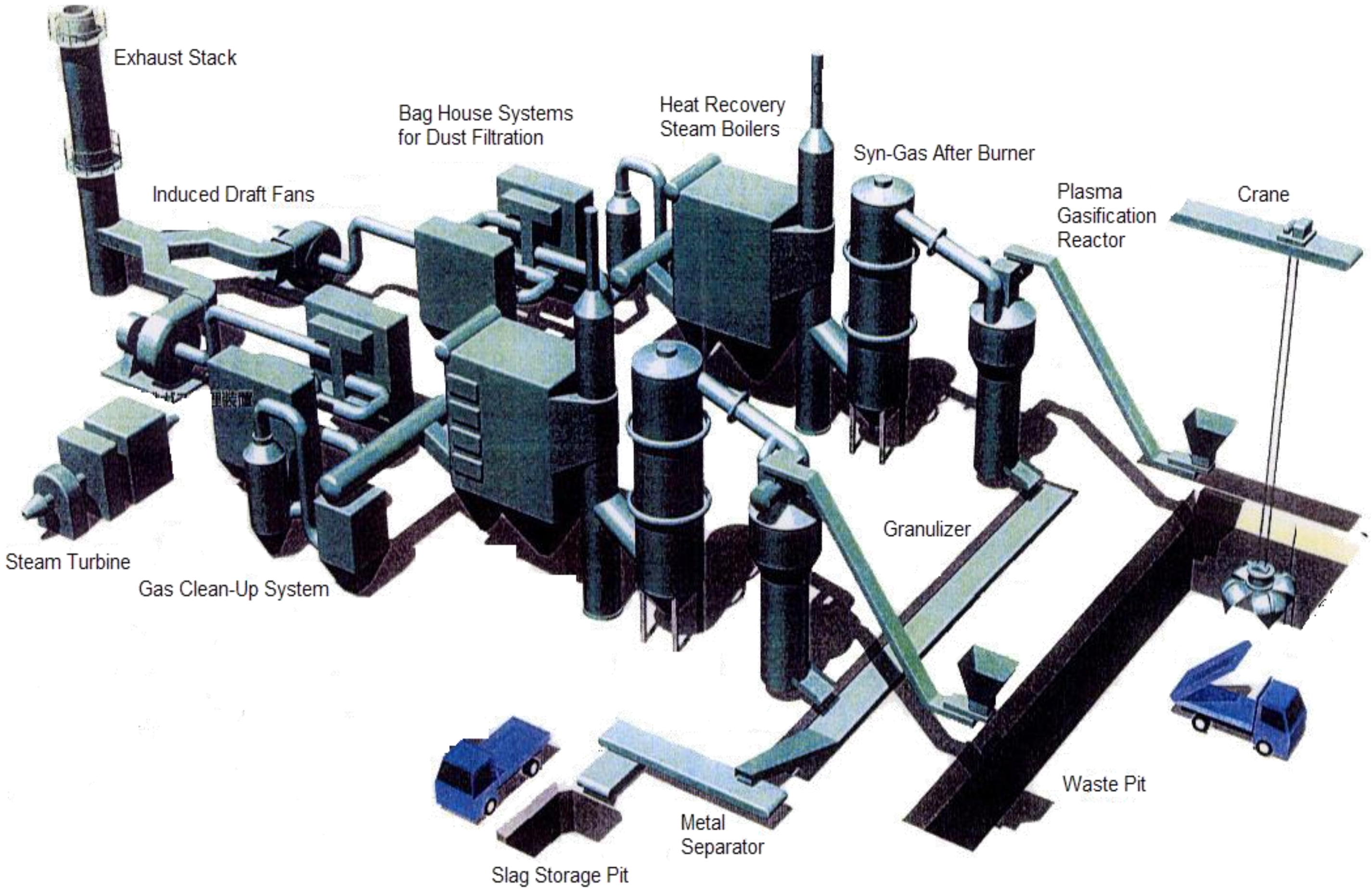
ECO – VALLEY UTASHINAI WTE FACILITY

- The largest facility is named Eco-Valley and is located in Utashinai, Hokkaido. Built over two years, it was commissioned in 2002 and has been fully operational since 2003
- The Eco-Valley was designed to process MSW and auto shredder residue
- Eco-Valley is operating with 8 Marc-3a Plasma Systems
  - Two operating gasification islands with four torches each

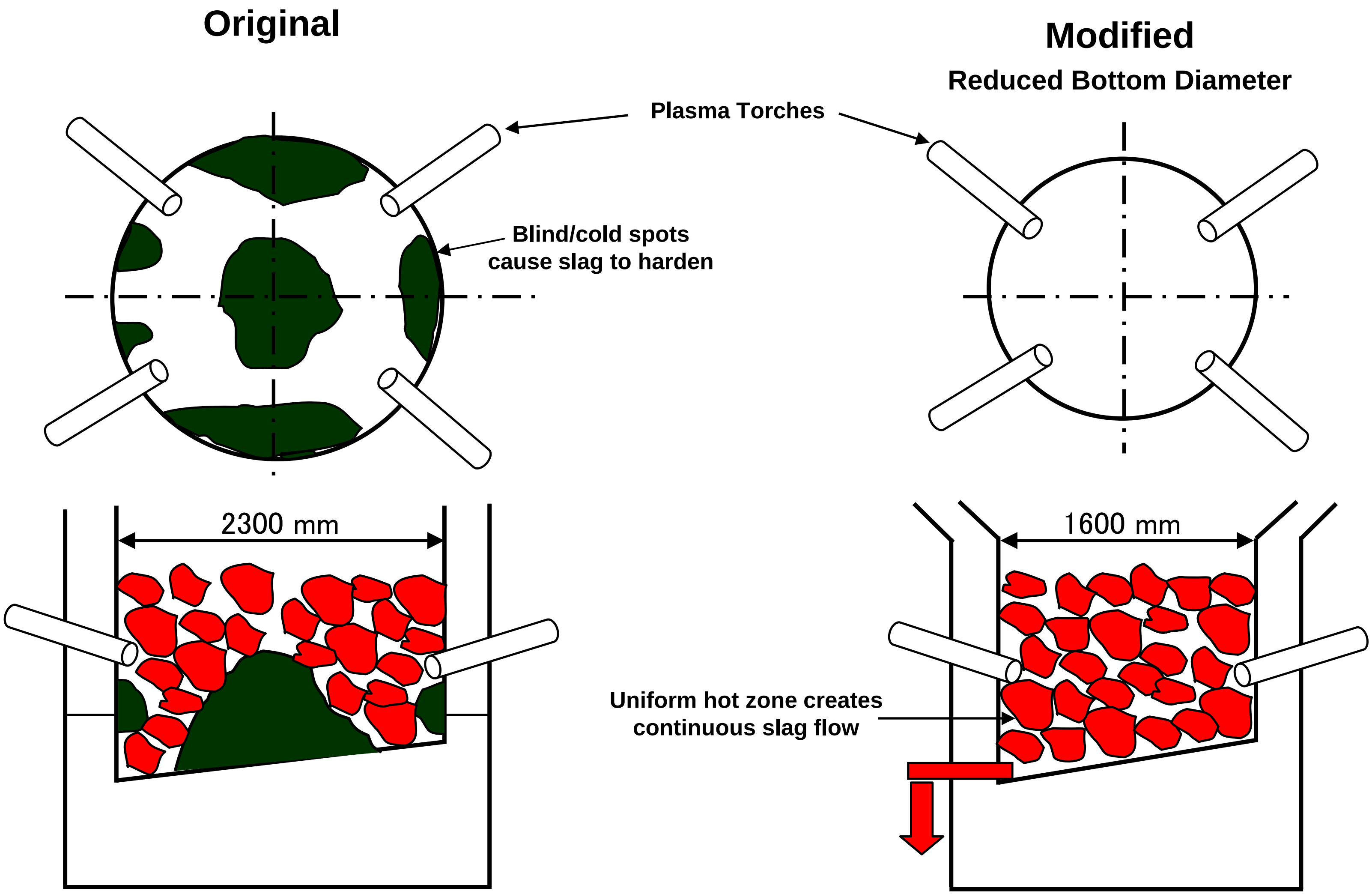
Specifications of the Eco-Valley, Utashinai Facility	
Design Capacity	165 metric tons/Day (24 hours) of auto-shredder residue as fuel
Number of trains	2 trains operating at 82.5 metric tons per 24 hours/train
Power Generated	7.9MW
Power Exported	4.3MW

Inside the Eco Valley, Utashinai Facility

UTASHINAI PROCESS FLOW DIAGRAM



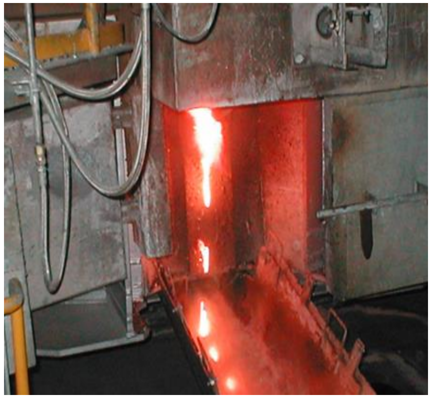
OPERATIONAL ISSUE #1: BOTTOM DIAMETER TOO LARGE



OPERATIONAL ISSUE #1: BOTTOM DIAMETER TOO LARGE

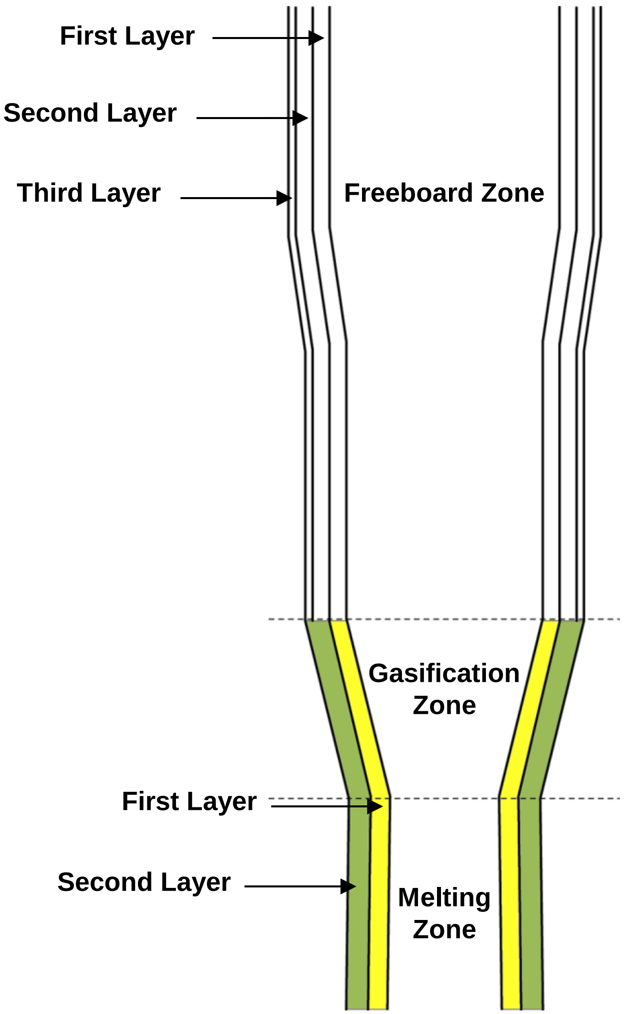
Slag Buildup on Reactor Bottom Section

Slag Close-up Below Torch Tuyeres



Slag Tapping – smooth flow

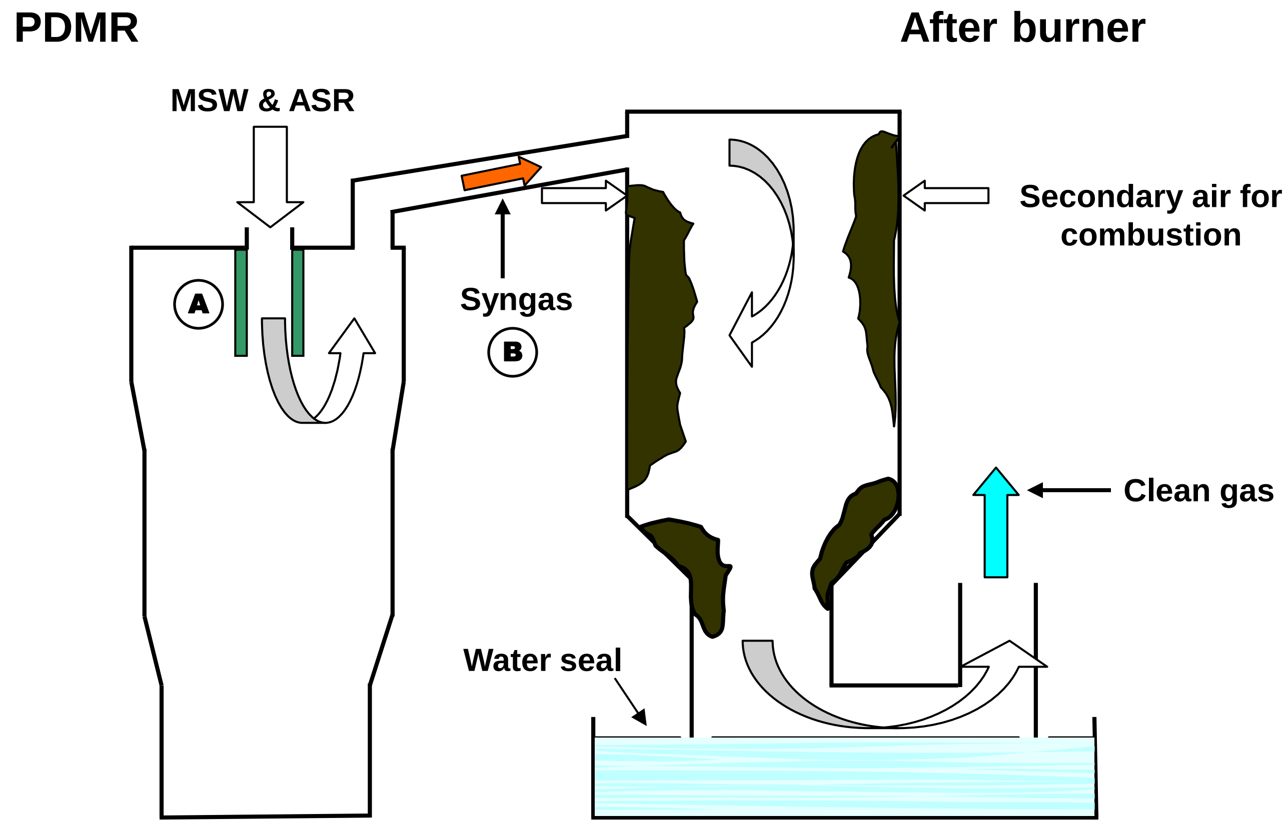
OPERATIONAL ISSUE #2: INCORRECT REFRACTORY



	Original			Improvement		
	Structure		Material	Structure		Material
Freeboard Zone	3 layers	1st layer	High Almina	3 layers	1st layer	High Almina
		2nd layer	SiO_2/Al_2O_3		2nd layer	SiO_2/Al_2O_3
		3rd layer	insulation		3rd layer	insulation
Gasification Zone	3 layers	1st layer	High Almina	3 layers	1st layer	SiC
		2nd layer	SiO_2/Al_2O_3		2nd layer	High Almina
		3rd layer	insulation		3rd layer	
Melting Zone	2 layers plus water wall	1st layer	High Almina	2 layers plus water wall	1st layer	SiC
		2nd layer	SiC		2nd layer	High Almina

Very short life span in the Melting and Gasification Zones → ***Life span increased to 4 years in the Melting and Gasification Zones***

OPERATIONAL ISSUE #3: PARTICULATE CARRY-OVER



Improvement	
Method	**Effect**
A: feed pipe for prevention of short pass	• ash carry-over was reduced by 50% • feed pipe melted
B: Temperature Control of exiting syngas 1000°C 750~800°C	• not molten but accumulated inside • not molten and not accumulated

OPERATIONAL ISSUE #3: PARTICULATE CARRY-OVER

Slag and Ash Accumulation Inside the Afterburner

Before modification – large accumulation

After modification – accumulation reduced

SUMMARY OF ECO VALLEY EXPERIENCE

1. Eco Valley experienced many problems with ASR in the early year of operation, which led to numerous improvements
2. Eco Valley has established the PDMR system for use with MSW
3. Eco Valley has continued commercial operation with MSW since 2003
4. Plant has proven relatively easy to operate
5. Plasma torches are proven to be reliable and robust

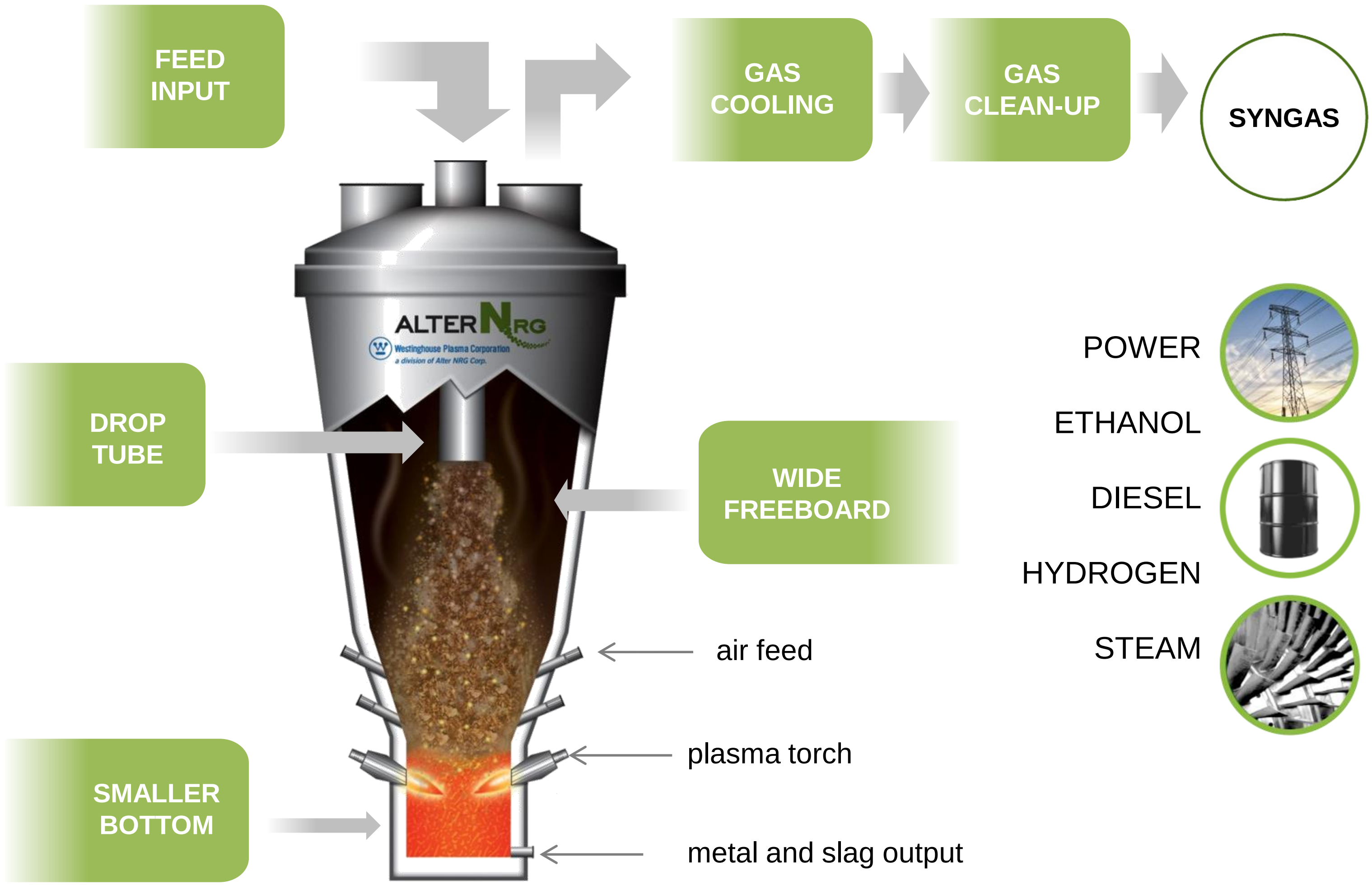
NEXT GENERATION GASIFER DESIGN

- Alter NRG Corp. purchased Westinghouse Plasma Corporation in 2007
- Alter worked closely with Hitachi Metals to understand operation of Utashinai
- Re-work of the original design through 2008/2009 to incorporate Utashanai experience
- Use of advanced engineering tools to enhance design further
- Strategic partnerships with engineering companies and material supply companies (e.g. refractory)
- Modifications and improvements to pilot plant in Madison WI to further prove new design elements

UTASHINAI ISSUES ADDRESSED IN NEXT GENERATION DESIGN

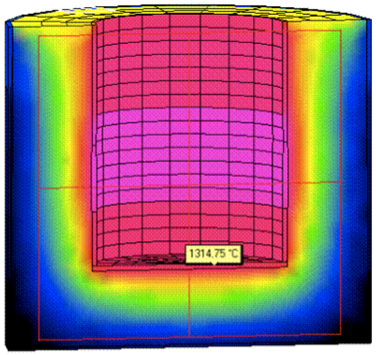
- Issue 1 – Bottom diameter sizing
  - Using available thermal modeling tools,
  - Comparison of existing plant data
  - Approximation of steady state heat flux to ensure internal temperature is well above ash melting point
  - Validation/testing in our pilot plant
- Issue 2 – Refractory
  - Approximation of slag freezing plane through thermal modeling work (Hatch)
  - Working with Saint Gobain on best suited materials selection → conductive inner layer, similar to Eco-Valley
- Issue 3 – Carryover issues
  - Internal partial water quench solidifies molten and sticky particulate
  - CFD work ensures that bulk gas flow is cold enough prior to any changes in direction
  - Drop tube design available for suitable feedstocks, minimizing entrainment of fines

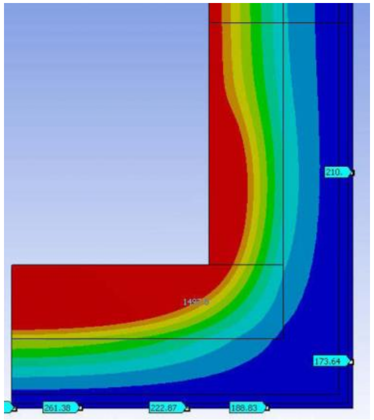
ENHANCED GASIFIER DESIGN



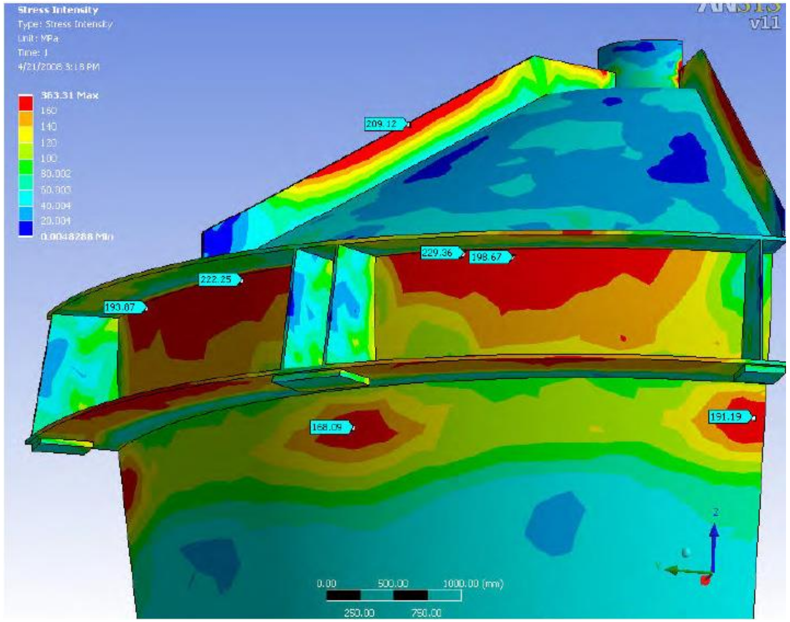
SOLUTIONS TO PROBLEMS IN CURRENT DESIGN

Issue #1 (Bottom Diameter) & #2 (Refractory): Thermal modeling Work



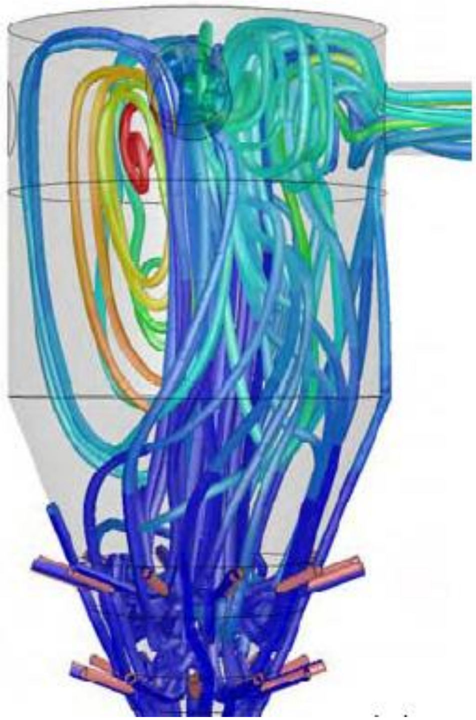


Prediction of slag freezing plane (emulating Eco Valley refractory performance)

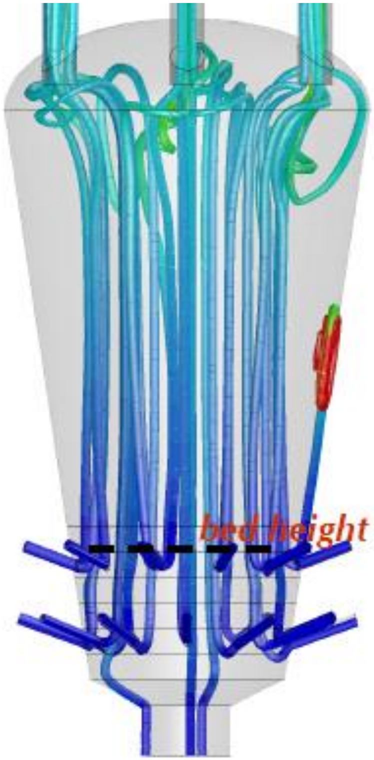


Finite Element Analysis for vessel mechanical integrity

SOLUTIONS TO PROBLEMS IN CURRENT DESIGN



Issue #3 (Particulate Carryover): CFD Modeling – gas flows, temperatures



Optimization of flow reducing High velocity zones, minimizing carryover

FURTHER INVESTIGATION OF PROBLEMS

Madison Gasification Facility (WPC)

Oxygen Blown Operation
Biomass Fed

→

Particulate Removal
Syngas Cleanup
Compression

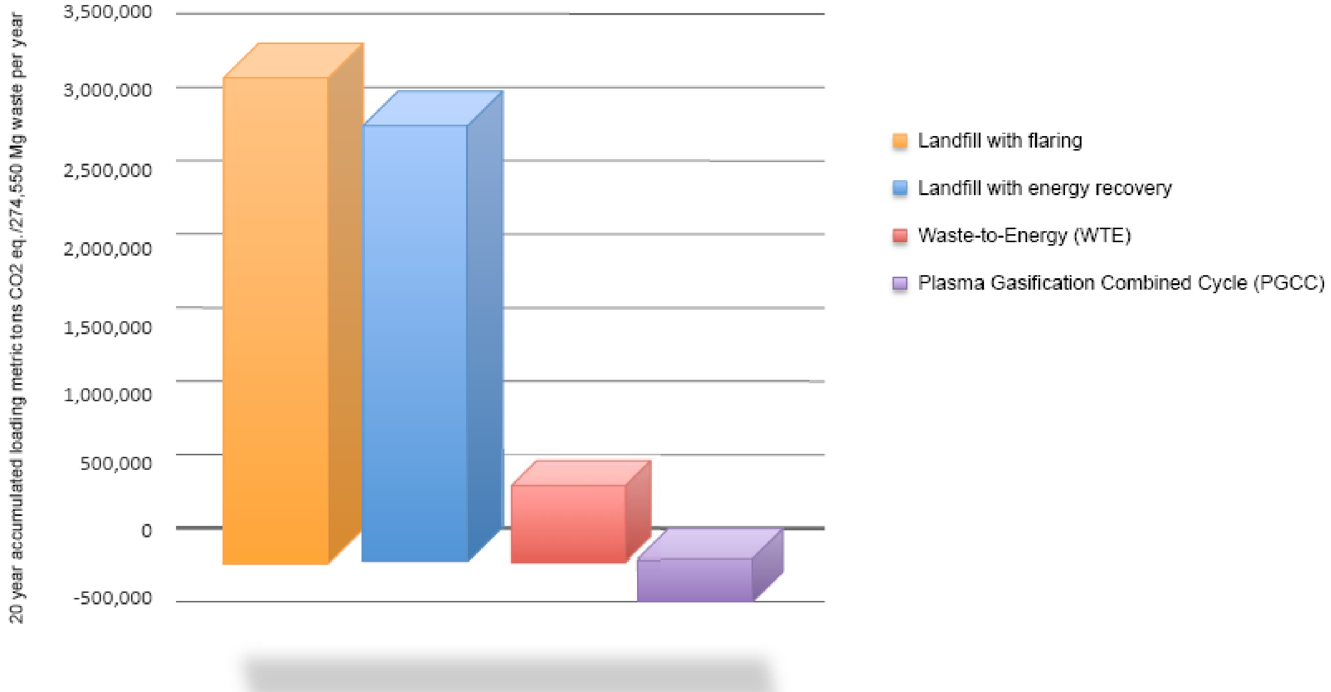
↓

Ethanol Production Facility (Coskata)

CO_2 EMISSIONS

Third party comparison of life cycle CO2 equivalent emissions of landfill, Landfill with flaring, Waste to Energy, and Plasma Gasification Combined Cycle

Scientific Certification Systems report, January 2010



Twenty year accumulated GHG loading for four waste disposal options. Results compared on a basis of 274,550 metric tonnes of MSW per year. The zero axis on the chart represents emission level form baseload regional grid emissions in the Northeastern Power Coordinating Council (NPCC) National Energy Reliability Council (NERC) subregion.

The main advantage of PGCC is derived from its ability to operate with combined cycle power island.

TYPICAL HEAT & MATERIAL BALANCE

Confidential Heat and Material Balance

SALES KIT SIMULATIONS

Low Btu (i.e. HHV: 5000 Btu/lb) MSW Gasification - Oxygen Blown (One G65 Gasifier)
10SKS01 - HMB202R00
1-Apr-10

Inputs		HHV		LHV		As Received		Dry, Ash-Free					
FEED in	kg/hr	kJ/kg	Btu/lb	kJ/kg	Btu/lb	M.C.	Ash	C	H	O	N	S	Cl
*1105Medium Btu MSW	41,667	11,630	5,000	10,779	4,634	25.20%	21.00%	52.23%	7.25%	38.29%	0.74%	0.56%	0.93%
Coke	1,667	29,834	12,826	29,834	12,826	1.18%	7.03%	99.13%	0.00%	0.00%	0.00%	0.87%	0.00%
Total excl. coke [Note 7]	41,667	11,630	5,000	10,779	4,634	25.20%	21.00%	52.23%	7.25%	38.29%	0.74%	0.56%	0.93%
Total incl. coke	43,334	12,330	5,301	11,512	4,949	24.28%	20.46%	55.23%	6.79%	35.84%	0.70%	0.58%	0.87%

FLUX in		
Flux	5,891	kg/hr
Flux Material	Limestone	
STEAM in		
LP Steam	0	kg/hr
Pressure	308	kPa
Temperature	150	°C
Shroud Steam	0	kg/hr
OXIDANT in		
Oxidant (total)	15,923	kg/hr
Combined Oxygen Purity	92%	mass basis
Oxygen Stream @ 93 mol% purity	15,923	kg/hr
Air Stream	-	kg/hr
Pressure	136	kPa
Temperature	25	°C
Shroud Air	6,000	kg/hr
Shroud Oxygen @ 93 mol% purity	1,260	kg/hr
Pressure	136	kPa
Temperature	25	°C
Plasma Torch Air	570	kg/hr
Pressure	1,136	kPa
Temperature	25	°C
PLASMA TORCH Energy		
Type of Torch	Marc 11L	
No. of Torches / Gasifier	6	
Electric Energy Use	2.31	MW
Thermal Energy Transferred	1.96	MW
Simulation Indicators		
Cold Gas Efficiency:	69%	
Shroud Gas to Torch Air Ratio	12.74	
Slag Softening Temperature (ST)	1,278	°C
Shroud Oxygen Content	17.4%	of flow
Coke Usage	4.0%	of feed
Torch Power	1.6%	of input energy
Slag Base/Acid Ratio	0.90	
Tuyere Tip Temperature	871	°C
Others		
Quench Water [Note 5]	4,086	kg/hr

124.6 MW Feedstock, LHV
13.8 MW Coke, LHV
-2.9 MW Limestone Calcination

	LHV	HHV
Sensible (MW)	26.9	26.9
Latent (MW)	10.2	10.2
Solids Chemical (MW)	1.9	1.9
Syngas Chemical (MW)	95.1	100.7
Total (MW)	134.2	139.7

Heat Loss: 3.3 MW

0.0 MW Steam
0.0 MW Oxidant
2.3 MWe Plasma Torch
2.0 MWt Plasma Torch
0.0 MW Shroud Air/Oxygen

Slag: 4.4 MW
Metals: 0.0 MW

Outputs				
RAW SYNGAS (Excluding Solids)			**Partially Quenched Syngas**	
Volumetric Flow	58,510	Nm³/hr	62,716	Nm³/hr
Mass Flow	60,746	kg/hr	64,832	kg/hr
Temperature	1,000	°C	850	°C
Pressure	101	kPa	101	kPa
Composition	Wt %	Vol %	Wt %	Vol %
CO	32.156%	27.121%	30.129%	24.922%
CO_2	25.363%	13.615%	23.764%	12.511%
O_2	0.000%	0.000%	0.000%	0.000%
N_2	9.109%	7.682%	8.535%	7.059%
Ar	1.543%	0.913%	1.446%	0.839%
H_2	1.003%	11.749%	0.939%	10.797%
CH_4	0.693%	1.021%	0.650%	0.938%
C_2H_6	0.520%	0.408%	0.487%	0.375%
C_2H_4	0.243%	0.204%	0.227%	0.188%
C_3H_8	0.381%	0.204%	0.357%	0.188%
C_4H_{10}	0.502%	0.204%	0.471%	0.188%
HCl	0.353%	0.229%	0.331%	0.210%
H_2S	0.309%	0.214%	0.289%	0.197%
COS	0.060%	0.024%	0.057%	0.022%
SO_2	0.000%	0.000%	0.000%	0.000%
NH_3	0.083%	0.116%	0.078%	0.106%
HCN	0.005%	0.005%	0.005%	0.004%
H_2O	27.676%	36.292%	32.235%	41.457%
Total	100.000%	100.000%	100.000%	100.000%
H_2/CO	0.43			

CARRY-OVER SOLIDS		
Solids [Note 3]	1,754 kg/hr	
Carbon Chemical Energy	1.9 MW	
ENERGY DENSITY	HHV	LHV
kJ/kg†	8,382	7,917
kcal/Nm³†	2,360	2,229
Btu/scf †	251	237
MJ/Nm³†	9.9	9.3
Syngas Chemical Energy (MW)	100.7	95.1
†dry basis		
SLAG & METAL OUT		
Slag & Metals Stream	10,477 kg/hr	
Pressure	101 kPa	
Temp	1,650 °C	
Overall Energy Balance on LHV Basis (MW)		
	In	Out
Feedstock	135.52	
Torch	2.31	
Oxidant Streams	0.00	
Steam	0.00	0.00 ‡
Feedstock Moisture/Steam		6.40 ‡
Chemical		96.97
Sensible		26.94
Heat Loss		3.35
Slag		4.39
Metals		0.00
Solubility Adjustment	0.22	
Total	138.05	138.05
Overall Material Balance		
	In	Out
kg/hr	72,977	72,977

‡ Heat of Vaporization Adjustment for LHV balance

Notes:
1. **All values are illustrative in nature and are provided for discussion purpose only.**
2. Heat balance is provided on lower heating value (LHV) basis.
3. Quantity of carry-over solids is affected by feedstock particle size distribution, which will be evaluated during detailed engineering.
4. Energy balance computed by VMG on a heat of formation basis. LHV balance provided for display purposes only.
5. Gas will undergo a partial water quench to 850 °C.
6. Indicative heat and material balance, to be confirmed via pilot testing of actual feedstock.
7. Feedstock feedrate is based on the average particle size of 125 mm and bulk density of 250 kg/m³.
Actual feedrate will be determined during the Pre-FEED and/or detailed engineering based on the actual particle size distribution and bulk density of the feedstock.

CONCLUSIONS

- Incorporated learnings from Utashinai operating issues into design
- Enhanced design tools (flow analysis, refractory, etc.)
- Utashinai gasifier running extremely well after modifications
- New design incorporates modifications resulting from operating problems experienced at Utashinai

MIHAMA-MIKATA VITRIFIED SLAG

Slag from the Mihama-Mikata facility has been put through a number of leachate tests including the Japanese JLT-46, NEN-7341 and the American TCLP analysis. These tests were conducted by two independent laboratories Shimadzu Techno-Research Inc. and ALS Laboratory Group. The results show that the Mihama-Mikata slag components are below the test detection limits and the slag is considered non-leaching. Below is a chart showing some of the results from the JLT-46 tests

MIHAMA-MIKATA SLAG JLT-46 TEST RESULTS				
Heavy Metal	**Unit**	**Method Detection Limit**	**Average Measured Value of Slag**	**JLT-46 Limit**
Arsenic	mg/L	0.001	<0.001	0.01
Cadmium	mg/L	0.001	<0.001	0.01
Chromium VI	mg/L	0.005	<0.005	0.05
Lead	mg/L	0.001	<0.001	0.01
Mercury	mg/L	0.0001	<0.0001	0.005
Selenium	mg/L	0.001	<0.001	0.01
Notes: mg/L = parts per million (PPM) JLT-46 performed by Shimadzu Techno Research, Inc., Kyoto Japan on Mihama-Mikata slag samples received from Kamokon				

SHIMADZU

ALS

COMPARISON OF TECHNOLOGIES

	Plasma Gasification	Pyrolysis	Incineration
Temperature	2,000-2,500^{0}F (gasification zone)	750-1400^{0}F	Up to 2,192^{0}F
By-product	Inert, non-hazardous glassy slag	Carbon char, silicon, metals and glass	Hazardous Fly Ash and Incinerator Bottom Ash
Feedstock Preparation	Pre-processing is minimal with shredding	Pre- processing is necessary in most cases as MSW is too heterogeneous	Sorting
Feedstock	Carbon material Coke is added to aid the reactions	Any carbon-based material	MSW, Medical Waste, Sewage Sludge
Syngas Composition	Carbon Monoxide and Hydrogen	Methane, Carbon Monoxide, and Hydrogen	Not produced
Typical Size (commercially)	Up to 250tpd (750-1000tpd in development)	Up to 300tpd	Up to 3,000tpd
Typical Uses	Melting incinerator ash, destroying hazardous and medical waste, processing municipal solid waste	Make charcoal from wood, process tires and produce carbon black, steel and fuel, created activated carbon	Waste disposal and to generate power & heating

ENERGY RECOVERY FROM WASTE – PLASMA GASIFICATION IS CLEAN

- ENSR validated Alter NRG's anticipated emissions levels for a 750tpd MSW integrated gasification combined cycle (IGCC) facility which concluded that emissions for NOx, PM, SO_2, HCl, CO, Hg and PCDD/PCDF would all be lower that EPA regulated standards and lower than six recently approved incineration facilities in the USA

ENSR | AECOM

Comparison of Resource Recovery Incinerator Permitted Emissions Limits to Anticipated Alter NRG IGCC WTE Emissions Levels (US EPA Units)

Pollutant	units	Recently Permitted Incineration Facilities in USA (200-800 tpd MSW)	Canada - CCME	US EPA New Source Performance Standards	US EPA Section 111(d) Emissions Guidelines	Alter NRG MSW IGCC WTE (750 tpd MSW)
NOx	(ppmvd)	110-205	293.32	150	205	36.66
PM	(mg/dscm)	16-27	28.08	20 - 24	25 - 27	4.21
SO2	(ppmvd)	26-29	136.94	30	29 - 31	1.05
HCl	(ppmvd)	25-29	69.4	25	29 - 31	6.48
CO	(ppmvd)	100	68.66	100	100	19.27
Hg	(µg/dscm)	28-80	Tier 3 Metals	50 - 80	80	<1.4
PCDD/PCDF	(ng/dscm)	13-30	0	13 - 30	30 - 60	0