April 17, 2017

Waste Treatment Facility Proposal For:
The United States of America

By Means Of;

Plasma Arc Reactor For Production of Liquid Fuels and Electricity

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Waste Treatment Facilities Proposal For:
The U.S.

By Means Of;

Plasma Arc Reactor
For Production of Liquid Fuels, Liquid Fuels and Electricity

Prepared For:

For benefits of The U.S.

Prepared By:
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Dated: April 17, 2017

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We are surpassed the deadline for meeting the new US-EPA regulations for Landfill operation by year 2010-12 that could shut down just about every landfill currently in and around United States those countries members of WTO and United Nation. For make such a preparation, only city of Los Angles has contracted the construction of new landfill to meet the 2010 standard that is currently operational. Strangely, none of the other cities or countries has any immediate plans to deal with these new requirements and most responsible parties are keeping blind eyes on this matter and perhaps they consider this matter is not their problem but it will be part of their successor dilemma. Interestingly, even the two Asbestos landfills owned by US Government do not meet these new requirements.

On the other hand, The American authorities are seeking a solution for their current waste collection and absence of adequate landfill operations and collectively their fuels production and perhaps power generation dilemma. The current wastes productions are estimated at 3,000,000 to 4,000,000 MT per year in major cities not including additional industrial wastes of about 4,000,000 MT per year/each major city. The presented plant must have the ability to receive both MSW and Commercial, Industrial and convert the produced syntactic gas to Liquid Fuels and Electricity without producing any emissions or landfill materials. .

After reviewing and analysis of our technologies by American authorities, DuTemp has been given the mandate to provide a comprehensive solution for the benefits of The U.S.. This solution must eliminate the needs for incineration facilities, and Pit Practices, reduce the transportation costs, and eventually process the currently deposited wastes in the local open landfills; to eliminate the disease factors into environment and leaching problems.

The U.S. solution will be far more efficient than those envisioned by the city of Los Angles that still does not address a remedy for its older landfills and it faces massive logistic cost for transporting of their daily collecting wastes to its future landfill (Granada Hill). With a distance of 20 miles to 50 miles that it is unfeasible due to the current higher fuel pricing in the market place. (All older landfills must be relocated or the content shall be removed to install liners and water capturing/collection/treatment facilities with integration of Methane capturing facilities that it is uneconomical).

Furthermore, The U.S. model will reduce greenhouse gases emitted from trucking by cutting the traveling distances (each garbage truck uses 2 gallons to 3 gallons of fuel per mile).

Other cost elimination to The U.S. would be the needs for/elimination of sorting facilities that their revenues from recovered materials are 3 times less than its operating expenses, up keeping costs and additional of transportation costs.

Moreover, these plants shall have the capacity to receive Bio-Hazardous wastes plus Bio-Radioactive up to level V including residues from power plants currently operating in the region.

Without further ado, I present you with our Executive Summary as follows:

Executive Summary

We are proposing to implement multiple Plasma Arc Reactor facilities that will consume the local Municipal Solid Wastes (MSW), Hazardous Wastes (HZW) from industrial complexes and Bio-Hazardous wastes (BHZW) from hospitals in The American cities to produce Syngas as the primary product and Liquid Fuels or other Core Polymers plus electricity as finished product.

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In addition, the produced Syngas will produce between 2.7 barrels/ton to 3.2 barrels Liquid Fuels for per ton of MSW. If the blends of waste are too wet (it is a plus for operation), we must add 12% to 15% shredded tires to create a balance between wetness of wastes and carbon molecules presence in the feedstock.

Syngas fermentation for production Liquid Fuels is very viable in our plant due to high purity level of produced syngas. Most Liquid Fuels plants currently operational are producing massive amount of CO2 and other wastes that has been ignored by officials. Our plant would not produce any type of wastes, wastewater or CO2 for discharge as all other contaminates resulted from production processes are recycled back to the plasma reactors for destruction and use as feedstock.

Excessive heat generated from facilities are used to produce partial electricity needs for the operation of the plant thus, no cooling tower is needed for operation of our facilities.

We are projecting the plant's size around 12,000 MT/day installed 13 x 1,000 MT/day reactors with processing capacity of 12,000 MT/day MSW, 1,000 MT/day Hospital wastes, 2,000 MT/day slurry sludge from wastewater plants while one 1,000 MT/day reactor would be on reserve for maintenances of other reactors.

Our plan calls for 4 plants around each major city located at outskirts of towns. With this model, we are guaranteeing the ability to receive all generated wastes including commercial and industrial wastes plus start processing deposited wastes into current landfills with 500 miles proximity of each city. As needed, implementations can stats with 48,000 MT/day of wastes immediately or reach the total 48,000 MT/day eventually.

Fuel Production would be between 29,700 barrels per day of Liquid Fuels equal to 1,247,400 gallons per day on the low side or 35,200 barrels of Liquid Fuels per day equal to 1,478,400 gallons per day on the high side.

Electricity production from heat recovery is estimated at 150 MW/Hour or higher pending the adaptation of New technologies Vs. Older technologies. Thus there maybe be a deficit of needed power for operation plant at around 95 MWH to 115 MWH that must be generated from use of produced syngas. It is our intents to use most efficient Co-Gen power generation techniques.

The future plant would meet all new US-EPA mandates with Mercury and Lead capture as able to collect the said metals in pure. This plant would requires Hazardous Permit in place that is required for removal and process of the Mercury and Lead Filter Canisters within our facilities. Why this matter? Because U.S. abides by WTO rules and Mercury Capture became integral part of any current and future operation. All captured Mercury shall be delivered to U.S. designated "Mercury Bank".

The main advantage of building these facilities are:

1. The permanent elimination of future landfills
2. The elimination of existing landfill waste and their contaminants
3. The ability to return existing landfill sites to their original and natural state
4. The reduction of soil, water and wildlife contamination
5. The reduction of green house gases and other air pollutants entering our atmosphere
6. Healthier living conditions and lower health care costs
7. Environmentally friendly solutions for those without access to recycling services

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8. Time and money savings, as sorting of the waste is not required.
9. Waste disposal and recycling costs, may be reduced or eliminated
10. Strengthening the economy by reducing tax burdens and creating over 400 permanent, high income, green, sustainable jobs per location
11. The ability to lead the world by demonstrating healthy, economic and environmentally friendly alternatives to incineration and landfills
12. Peace of mind for all American families and the government

The high cost saving is another strong point of our proposed facility compared to sorting, incineration and open burn landfill operation. Additionally, there is currently no feasible solution for wastes such as Tires, Refrigerators, Mattresses, and plastic or e-waste. On other hand, a Plasma Arc Reactor will not only solve these matters forever, but also will accomplish it in the feasible way.

Under the new EPA (USA and European Union guidelines) and WTO, all incineration of Hazardous and Bio-Hazardous wastes including Fluidized Bed incineration went in ban by the year 2010. Moreover, the new ruling set by international communities for e-waste treatment known as; WEEE, went into effect late 2006 for European Union and even though USA was delayed to adapt this practice, it became enforceable in summer of 2007. If the State decides to designate our facility to receive Electronic Wastes in near future, we can always expand to meet the new load requirements within Eight months. Electronic Waste cannot be mixed with MSW and must have its own dedicated reactor(s).

These EPA guidelines will have a direct effect on the medical industry, especially the hospital systems and medical service facilities of all kinds and categories. Implementation of our proposed facilities will reduce the cost of operation to hospitals (40% reduction on destruction cost). These implementations could be placed in any City that would further facilitate for development of new medical facilities since these new mandates from both the EPA and the European Union would prevent hospitals to receive any type of grants for construction, operation, or research without implementing proper means of destruction. We strongly encourage the American Government adopt the same philosophy. (Incinerating / Fluidized Bed are not acceptable method of destruction of Bio-Hazardous Wastes by Federal government agencies).

The liability of Medical Wastes and other type of wastes dose not expires with making a payment for its transfer from one location to other sites. Liabilities shall remain in effect until such a waste has been eliminated. "Quoted from U.S. Supreme Court and their recent rulings'

Job creation will be an additional factor of this implementation. Directly, over 400 new permanent jobs will be added and we are planning to retrain and absorb the task force currently working in same industry. Indirectly, over 1000 jobs could be created through new manufacturing to the local workforce however, with future expansion and receiving wastes from neighboring areas including closed by cities, these numbers will grow to a sizable task force.

With respect to gasification systems, a Plasma Arc Reactor is the best method for gasification compared to all other systems due to its:

- ease of operation,
- low cost of operation,
- high return on gasification with no residue, and
- 0% residuals and every byproduct is 100% marketable and useable.

There are many major oil companies currently using and/or considering the replacement of old refining technologies with Gasification + Gas to Liquid (GTL) technology to improve

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their productivity and increase their revenues. On the other hand, every State is considering Integrated Gasification Combined Cycle (IGCC) for production of electricity, but the limitation has been the development of a feasible gasification engine that is not producing CO2 and landfill wastes. Now with introduction of our 500 MT/day, 725 MT/day and1000 MT/day Plasma Arc Reactors this vision is viable. None of current standard atmospheric gasifiers are able to meet the permitting requirements by the US-EPA in the past three years due to emissions produced in these units.

Our system with over 30 year track record (US Government has been the primary user of our technologies) has proven it superiority to all other technologies in the market when dealing with waste destruction or refining crude oil to produce hi-end Carbon Based products.

While our facilities are able to receive MSW, HZW and BHZW as their primary feed stocks, they will also be able to receive other Carbon Based products as a secondary or mixture and/or alternative feed stock. Alternative Carbon based products are:

- Heavy Crude Oil, Coal, sludge and Asphalt like Products,
- Sand Tar or Oil Shale, Recycled motor oil or cooking oil, etc.

If the primary feedstock is changed from solid to liquid, then only the feeding system requires modification and this shall become part of the engineering phase and based on the type of feedstock.

DuTemp shall be the operator of these Reactors and will be providing all required maintenance.

Other Issues:

- Are we competing with local Waste Management Companies? No, we will be complementing their operation by providing a viable solution to waste destruction.
- Are we causing additional costs to the City? No, since we will eliminate the need for waste sorting and landfill relocation or upgrades.
- Will our operation have a positive impact on air and water quality? Yes, please see page 15.
- Are we competing with any local finished product producers? No.

This facility will pay for itself in less than Five years and its life expectancy shall be more than 50 years with proper maintenances and solid operator.

Other issues are waste collection that will require evaluation in a feasibility study done individually to address their long-term needs based on different city's configurations and best method of waste collection. In this matter, we may introduce compaction facilities in and around the city with a shrink-wrapping process that would allow easier transport and safer handling of the different wastes. Implementation cost of each compacting facility will be about $17,200,000.00 per location. These compacting facilities can be implemented in various locations within the city to receive their waste to our facility as well (not part of this proposal).

DuTemp in collaboration with the local waste management companies and their ongoing experiences will adapt the best system of collection to suit the city.

We are committed to bringing this solution to The U.S. without any hesitation and trust in your vision to conclude this opportunity as visionary with us.

Assumptions:

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The Assumptions was provided based on typical wastes produced in United States cities as following:

Size/Through Put

The proposed Facility will be designed, constructed and operated to process, using Plasma Arc gasification technology, with a nominal capacity of 12,000 Metric Tons per day of municipal solid waste (MSW). The facility will be designed to handle MSW as primary feedstock.

Feedstock Characteristics

The waste stream will be typical "as received" (no presort) MSW generated in a large US city containing the following components:

	Wet basic %	**dry basis %**
Carbon	25.6%	34.2%
Hydrogen	3.4	4.5
Oxygen	20.3	27.1
Nitrogen	0.5	0.7
Chlorine	0.5	0.7
Sulfur	0.2	0.2
Inorganics (ash)	24.4	32.0
Moisture	25.1 to 35	0.0
HHV (btu/lbs)	4,830	6,372

MSW COMPOSITION (% by weight)

Food scraps	<11.7%
Metals	>8.0%
Paper	>35.2%
Plastics	<33.3%
Yard trimmings	>1.1%
Other	3.4%
Wood	5.8%
Glass	>5.3%
Rubber, leather, and textiles	>7.4%

In addition to the MSW, we will design the option to use approximately up to 2000 tons per day of sewage sludge filter cake produced at the city's waste water treatment plant. We prefer the sludge be transported via tank truck or pipeline in wet status instead of Cake that will reduce up to $85 per ton use of fuels to turn to cake. Delivered wet slurry shall be mixed with the MSW feedstock during reactor operations with direct injection methods. The sludge will have the following approximate characteristics:

Solids (%)	25 - 30

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Nitrogen (%)	3.8
Phosphorus (%)	1.0
Potassium (%)	0.4
Copper (ppm)	236
Molybdenum (ppm)	5
Zinc (ppm)	321
Arsenic (ppm)	1
Cadmium (ppm)	4
Chromium (ppm)	10
Lead (ppm)	17
Nickel (ppm)	33
Mercury (ppm)	2
Selenium (ppm)	1
pH	12

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Facility Footprint

The Facility could be located in any suitable area within the U.S. The proposed site must be approximately 150 to 400 acres in size and bounded on the road, rail spur or Canal systems. Minimum needed acreage must exceed 50 acers when land is in short supply.

End Products

The facility will be used to gasify MSW to produce Liquid Fuels and electricity mostly with Co-Generation activities from use of generated heats in plants' operations. From time to time, plant operator may be buying electricity from the grid while always generated and delivered extra electricity to the grid.

Buffer Zones

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The current "buffer zones" and limitations as regulated by the state, city and municipality for a facility/plant of this nature and type are:

Height: Assume 70 feet (TBD. Consistent with current structures)
Sound: Assume 57 dba
Setbacks: 300 yds from residential areas (none within 0.5 mile)
Visual: Industrial zoning.
Emissions: Subject to 40CFR Part 75 and Part 60
Storm water: NPDES permit needed. Storm water retention/detention ponds discharge to the river.
Operational Hours: 7 x 24 x 365

Disclaimer:

(Validation and acceptance of above parameters shall be concluded through FEED Study only and by computer modeling and stimulations. This package is not accepting or rejecting any of the above assumptions).

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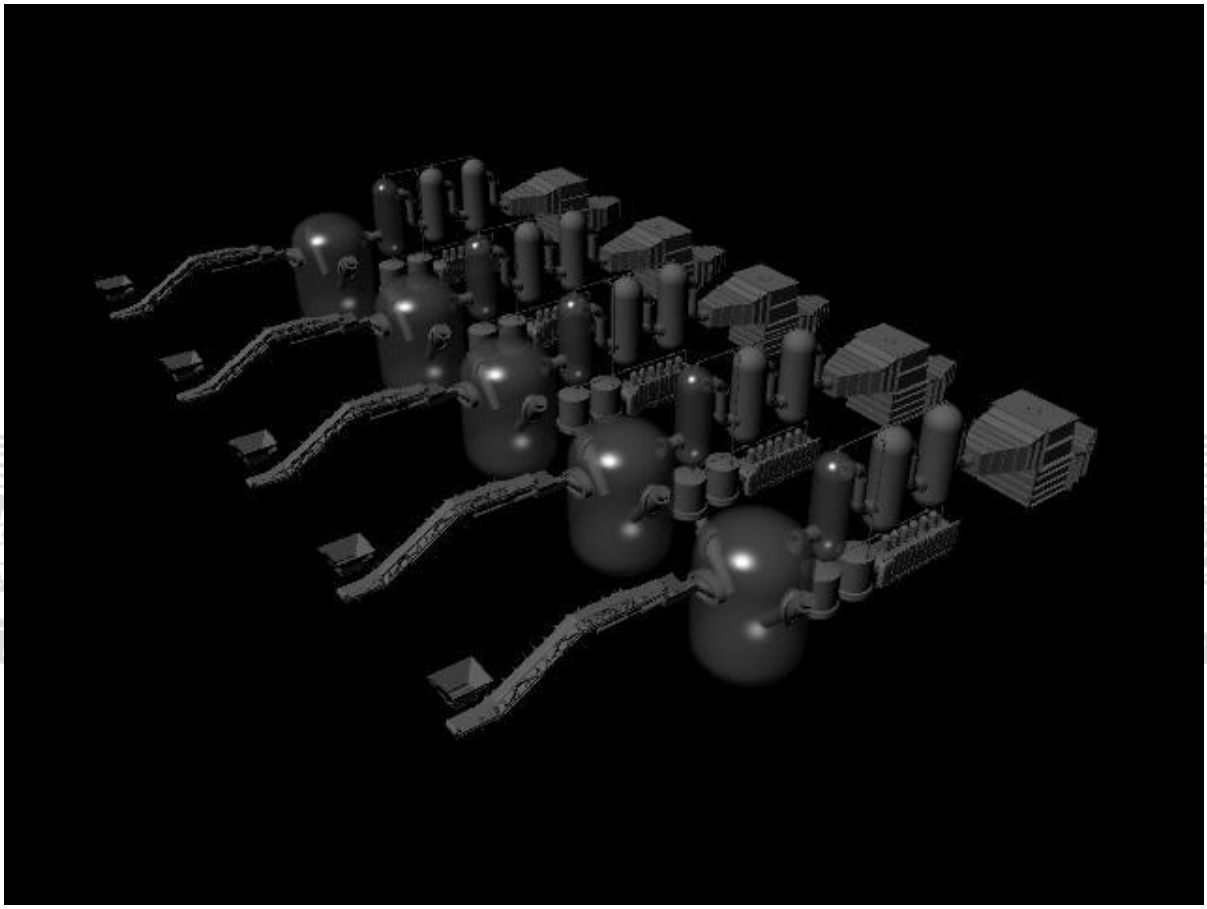
Proposal for a Waste to Energy Conversion Facility



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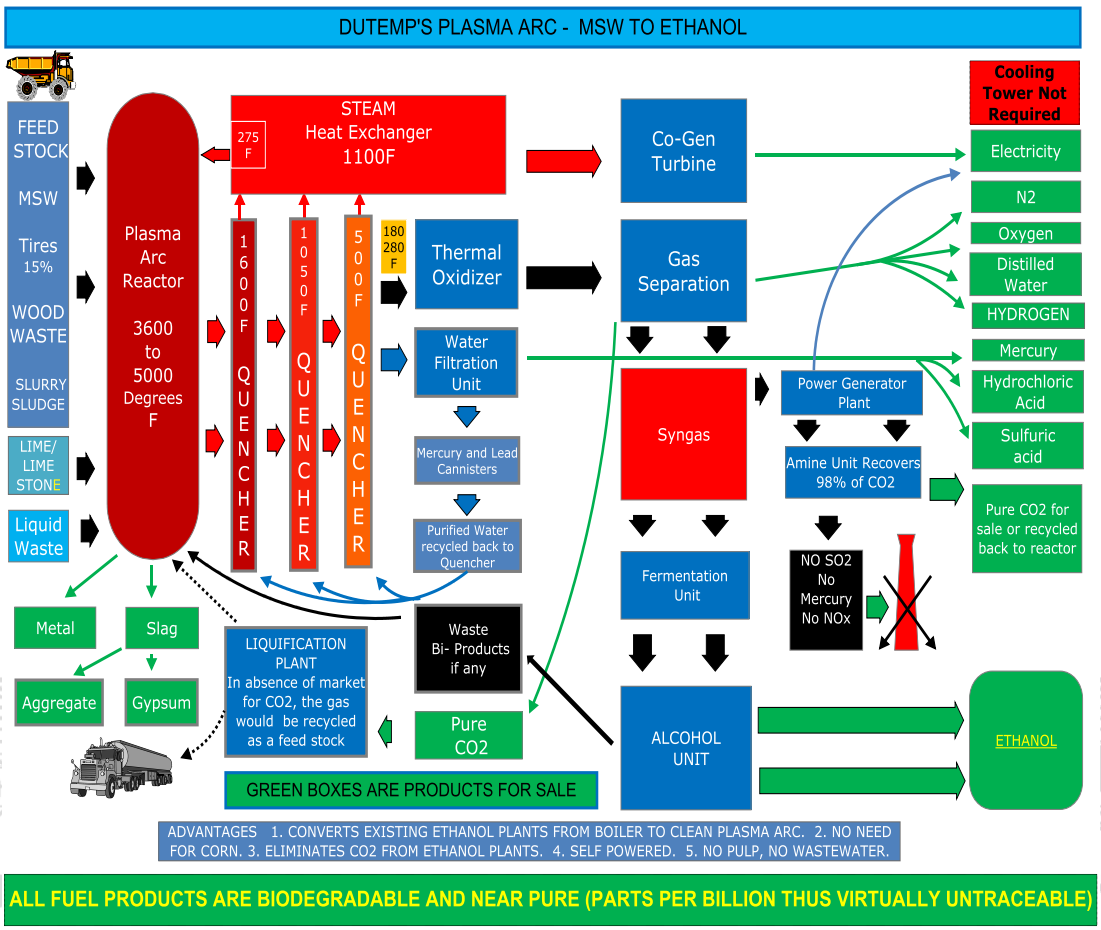

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PROPOSAL SUMMARY & RATIONALE

1. Introduction

This document is a proposal to supply a 12,000 MT/day plant with nominal processing capacity of 12,000 MT/ Day waste to liquid/energy plant(s). The purpose of this proposal is intended for large municipalities, companies and countries.

It is believed that the municipal and wood waste disposition and/or treatment problems in many urban areas, efficient utilization of agricultural waste, municipal and medical waste, combined with the developing countries and of small cities economic and business environment requires an efficient and economical solution, within the financial means available to these communities and businesses. Most of the major populated centers in these countries as well as industries and businesses require immediate establishment of low cost, efficient and economical, large turnkey independent waste treatment units. These units must be compatible with their sanitation, power supply requirements and financial capabilities.

This short proposal will generalize a waste to energy conversion plant, using exclusively solid waste as the main source of feedstock.

The economic rational and the expected buyers' high return to be generated by these units is based on the following facts:

- The present economic environment of most developing countries and small or large communities in the U.S. require an adequate and low cost solution to their ever-increasing urban center's sanitation problems.

- Most of the developing and developed countries' energy resources are composed to a large extent, of low solid fuels such as Agricultural wastes, forestry wastes, as well as industrial, municipal and medical wastes. These resources are seldom used, if any.

- The increasing problem of municipal and wood waste discharge in the major urban centers, combined with the frequent lack of logistical means for waste disposal, and insufficient financial resources, requires an overall optimal technical and financial solution.

- The requirement for use of multiple energy source simultaneously with the necessity so increase the added value of the country's natural resources, demand a solution that minimize imported energy and maximizes reliance on the existing and abundant low calorie biomaterial fuels and recycled materials.

- Most of the developing countries, as well as many developed countries, do not have significant hydroelectric capabilities and have limited other energy sources.

In view of these considerations, environmental protection restrictions, and the present and future energy demand, several alternatives have been evaluated. Given the ever-rising sanitary problem within populated centers the decision was made to propose a versatile combustible Derived Solid Fuel (DSF) fuel using power plant. This proposed small waste to power conversion unit is highly competitive with other types of electric generating plants and complies with the most restrictive environmental protection requirements.

The new Gasification technology, developed originally by the 2 largest space agencies in the world, and commercialized only a few years ago enables us to satisfy all the above objectives, constraints and requirements.

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This document proposes the implementation of a waste to energy conversion plant as a turnkey project. This plant will operate to satisfy the energy need of population centers and their vicinities. The power generated from these plants can be transmitted to local power regional or national distribution systems with no need for large fuel unloading terminals and transformer stations. The versatility of plant's energy use allows the use of any waste stream and eliminates any dependency on, scarce energy sources such as diesel, natural gases and other. The plant's size, and the technology used provide and guarantee the necessary environmental protections, and the required operational flexibility.

2. Proposed Project Outline

2.1. The Plant

The plant will be comprised of two facilities:

A) Waste to Energy Conversion Unit:

State of the art **facilities** will be built to process 12,000 Metric Tons per day of waste. It will adhere to the most stringent engineering, safety and building codes. Unlike conventional incinerators and combustors, the building itself along with the advanced technology used, will have an aesthetically pleasant and clean look and style.

B) Power Generation Unit:

The power generation facility will comprise a number of turbines. We have not decided yet for the number of turbines to deploy. Theses supporting Units will be built in a separate facility next to the Plasma conversion building. **Syngas (Near Pure Methane CH4)** will be supplied from the conversion unit through pipes to secondary production facilities.

Upon implementation of these facilities, we believe there may be another immediate expansion due to requests from other/smaller municipalities within a 500 mile radius for treatment of their wastes through our localized Compression and Shrink Wrapping process and plasma arc reactor receiving facilities in The U.S. as a cheaper alternative to Landfill operation.

As it has been planned, this venture will become a very respectful operation that not only will secure its financial prosperity but also will create many job opportunities that otherwise may not be possible.

Upon acceptance and implementation of this proposal, we wish to address the waste water issue for production of clean water that will reduce the discharge of semi raw sewage into the water way systems and it create alternative source of water for lawn keeping or agricultural purposes.

Our Pulse Power water treatment system will complement our plasma arc facilities to receive the produced sludge from this process for proper treatment and reduction of landfill contamination.

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2.2. Project Terms

Description of Project:

DuTemp Corporation will construct 13 X 1,000 MT/Day Reactors that One 1000 MT/Day Plasma Arc Reactors will be used as spare for maintenances of other Reactors. DuTemp Corporation will be the Owner, provider of project management, will complete EPC and will be the owner and operator of the facilities for its life.

DuTemp proposes to establish a local company (Subsidiary of or independent) to build and operate the plant, which is the most efficient model. The company will be the responsible for building, running the facility under the following terms:

DuTemp will:

1. Build and operate the proposed facility within the law and labor laws of the host State and in compliance with the construction and engineering regulations. DuTemp shall adopt U.S.-EPA and EURO VI with emissions mandates.
2. Guarantee the constant production of Liquid Fuels and power in the minimum volume stated in the FEED study and based on the volume of waste supplied. Rates shall be negotiated.
3. Receive tipping fees from the **Municipality at the rate of $175.00 per Metric Ton for the period of services at an extended periods without increase of rates for first 10 years and 3% annual inflation adjustments for following second 10 years and capped for life at that rate**.
4. Provide the necessary tools, spare parts and whatever is needed to ensure the maximum up time of the facility (365 days).
5. Maintain and operate the plant in strict compliance with international standards. ISO certification shall be obtained and maintained accordingly for the lifetime of the project.
6. Commence mobilization and construction on site immediately would proper finance is in place.
7. Complete the construction of 13,000 MT/Day Reactors with 12,000 MT/Day capacities within 24 months.
8. Following is our schedule Tipping-Fees for the Owner's consideration :

- Pre-recycled Municipal waste: $275.00 per MT
- Non-recycled Municipal waste: $175.00 per MT
    i. MSW contain 5% to 7% of Hazardous wastes with different tipping fees schedule,
- Bio-Hazardous waste: $2650.00 + per MT
- Hazardous, Petroleum &Chemical Waste: $3000.00+ per MT.
    i. Radioactive wastes' are not accepted by this plant.
- Asbestos, PCB and etc.: $450.00 + per MT.
- Refrigerators, Mattresses: $125.00+per MT.
- Tires (every 22 pounds): $5.00 per tire or $125 per ton.
- Computers: $50.00 per unit.
- E-wastes: $125.00 per MT.
- In some cases, the Tipping Fee must be negotiated based on the Nature of Waste.
- Collection and Delivery of the said wastes to our plant is not part of this proposal.
- It is the Owner's business to negotiate any point.

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- Municipalities are not responsible for financing of these implementations while they must agree in writing with their commitments to use our fasciitis at said processing prices for minimum of 20 years.

All other type of wastes not qualified under MSW and delivered to these facilities will be processed at a different rate and the difference shall be settled within 30 days after receipt of wastes into the facility's compound by the municipality Authorities.

3. Economic Impacts and Benefits

For any major city, or urban center, the proposed waste to power conversion plant will generate obvious economic benefits, such as:

- Creating permanent and temporary employment, during the construction and operation periods.
- Providing economic solution to the ever increasing municipal, industrial and especially medical waste discharge needs, jointly with the production of substantial electric power, necessary for the city and the regional development, all at a rate comparable to the present real cost of energy production.
- Creation of a nucleus for economic activities to enhance economic development in the region.
- Reducing the dependency on one or more energy sources, while increasing the value added of the domestic or regional agricultural, food processing and other industries.
- Eliminating waste dumping problems and costs.

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3.1. Investment

The proposed waste to Liquid Fuels plants using Plasma Arc Gasification system are extremely efficient and are equally expensive to build and operate.

Considering our plasma plant additional to Liquid Fuels production capacity, the total project investment will exceed **USD One Billion Six Hundred Fifty Million Dollars** ($1,650,000,000.00 USD) despite the fact that our prices are significantly lower than the market.

Initial project funding shall be initiated by **the local or federal government** in a form of usage guarantee to the contractor's plants' services for minimum of 20 year or by an acceptance to purchase of future services at included MSW tipping fees.

"It is expected that such investment will promote and boost the local and regional economy that can reach multi billion dollars in exchange of goods and services in few years."

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3.2.Energy Production

Plant results using gasification processing depend on various factors, from the type of feedstock to the processing control system to the used turbines technology (must be verified through the FEED study).

However, we intend to utilize the use of GE Frame 7FH with power generation capacities of 320+ MWH if viable and confirmed during engineering phase.

3.3.Employment And Benefits to The U.S.

The facility will create a respectable number of stable full-time jobs. Positions will vary from management to engineering to technicians and operators. We estimate that the facility will create around 400 permanent positions to guarantee the successful and smooth operation during the various shifts. We shall provide efficient and suitably qualified and experienced personnel to perform the work as well as operate the completed facilities. Our Company will have complete control of its personnel engaged in execution of the project. We shall be arranging fully trained labors, technicians and engineers serving in our facility in order to submit the best performance. DuTemp's facilities shall be off limit to any and all outsiders that are not employees of this corporation. DuTemp is not proposing technology transfer and may choose or not local labor participations at its own discretions when such employment pose technology transfers.

Other Benefits:

- Bring jobs and other business via international manufactures to The **U.S.**
- Mexico has been in violation of NAFTA Treaty since have dumped the produced wastes by U.S. manufactures into rivers and buried illegally underground. This has created new liabilities for U.S. manufactured abroad since still responsible for produced wastes regardless. United States can easily forfeit the NAFTA due to violations by Mexican Government.
- Energize construction industry
- Convert Municipal Solid Waste (MSW), Bio hazardous, Bio-radioactive, Industrial waste, Dry/wet sludge cakes, Tires, Auto shredder residue (ASR), Industrial waste, asbestos, PCBs, electronic waste into electricity and bio fuels etc.
- Create jobs each 12000 MT plant directly creates 400 high paying jobs
- Has the ability to produce electricity at half the cost using any types of wastes with near zero pollution thus cheaper rates for electricity
- Make **The U.S.** a leader in green technology and a green energy role model
- Attract outside investment utilizing cutting edge environmentally friendly technology
- Attract business with cheaper energy costs. Only acceptable Solution for waste destruction of hazardous, bio hazardous and bio radioactive (up to level 5) in a cheaper and more efficient way without residual by US-EPA and EU.
- Clean up Landfills
- Eliminate methane gas from landfills and leaching of contaminates in water supply AFTER CLEANUP IS DONE.
- Produce bio fuels and electricity thru recycling MSW creating new markets
- Currently, Government grant and research funds for current and/or new hospital are utilized when they can comply and demonstrate proper means of disposal of Bio hazardous waste. This mandate and requirement shall be adopted and enforced for all WTO member countries in near future. With our plants in place in The U.S. Area, the hospital system would be ahead of the curve with such a requirement
- Generate carbon credits
- Generates CO2 Tax Incentives and Incomes
- Will generate Carbon Trade incentives

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Technology Benefits Of ATONN's Plasma Arc Waste Management

- Near zero emissions,
- No evaporation of inhibitors into the atmosphere usually associated with Cooling Tower Operations as there are no needs for cooling towers with this operation,
- No CO2 sequestration required as CO2 considered a feedstock for our reactors,
- Utilizing Plasma reactors vs. atmospheric Gasifier by other providers means: No Incineration,
- Contaminated soils and all other contaminants produced during the U.S. industrial revolution can be processed in our system to meet the "Cleanup Act" mandates designated by Federal Government through utilizing "Super Funds". Same principal would comply with mining industries' site contaminations.
- Low Maintenance- Life span of reactor is 50yr. Requires major revamp in 50 years
- Can produce Hydrogen and other components for markets when electricity production is not viable or in conflict with other power generators in the region,
- No landfilling is required,
- All finished products are marketable when cleaning up dumpsites/landfills,
- No CO2 emissions. A reactor produces @ 2 % CO2 of total processed carbon molecules which is captured and recycled back to reactor as feeder stock. No controversial CO2 sequestration.

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Economy Competitive Points List

Differentiator	Combustion	Plasma Arc Gasification
Economic impact	Low impact due to low investment and poor success rate. **Can constitute a Great loss to the country due to upcoming EPA and environment regulations**.	Great economic value due to size of investment, job creation, diseases risks elimination and health improvement.
Size of investment	USD 500 Million MAX	Could cost USD 1.65 Billion or more.
Fueling Costs	Requires import of Natural GAS and Diesel. Costs the Government substantial amounts of funds.	No fueling Costs. Plant is Self Powered
Power Production	Very low power production rate. Does not meet local consumption requirements.	Extremely high Production Volume. Guarantees self-sufficiency and may be exported to generate Revenue
Cost of production	Very high cost of production due to high operating costs and low production volume.	Costs are significantly lower than current known rates.
Employment	Low job creation. Usually less than 120 to cover all shifts.	High job creation project. Will create around 400 permanent positions.

Table 1 - Economy Competitive Points List

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4. Environmental Impacts and Benefits

Plasma Arc Gasification Systems and Renewable Energy Systems use third generation combustion technology known as pyrolytic gasification. This advanced and environmentally superior technology is described in the Technical Overview section of this Document.

Before detailing the environmental benefits related to emissions and discharges from pyrolytic gasification and renewable energy systems**,** ***we would like to direct the reader's attention to more significant environmental concerns*** that are very compelling health and ecological reasons why pyrolytic gasification and more specifically Plasma Arc Gasification proposed in this document should replace other forms of biomass / waste disposal and recycling (e.g. landfill-bioreactors, composting, etc.). Such reasons (including life-threatening health and ecological threats to mankind and the animal kingdom), are described in the Disease Control section of document.
Please refer to *"Plasma Arc Gasification Facts"* section for a more detailed and scientific description.

4.1. Environmental Benefit Details

Pyrolytic gasification and renewable energy systems' emissions and discharges are environmentally superior to many alternative forms of biomass / waste disposal and recycling (including landfill-bioreactors, composting, etc.), per the following:

- Biomass or organic waste dumped at a landfill immediately starts to decompose creating methane gas. This gas has been identified as a greenhouse gas and has an effect on the atmosphere approximately 24 to 50 times greater than carbon dioxide from combustion *(Ref. 1)*.
- In general, pyrolytic gasification and renewable energy systems untreated vent gases contain low pollution emission levels. On a comparative basis, 1 T/hr of biomass or waste processed shall have better exhaust emissions than a single 400 BHP diesel truck exhaust.

Our proposed Renewable Energy System eliminates the use of virgin fossil fuels traditionally used for energy production or electricity production. Furthermore, it will avoid the release of over 6.4 times of CO_2 equivalent greenhouse gas for every ton of dry biomass or waste processed rather than being land filled *(Ref. 1)*.

Subsequently, a Plasma Arc Gasification unit that processes 1 T/hr of dry biomass or waste will avoid approximately 85,000 T/y or 1,700,000 ton of CO2 equivalent greenhouse gas over a 30 year project life.

The proposed solution is exceptionally clean, relatively low cost and eligible for incentive premiums being introduced by governments world-wide.

The systems can ***simultaneously address the four key environmental concerns facing mankind***, namely fossil fuel consumption, biomass or waste disposal, atmospheric emissions and disease control. In addition, they can access the added economic benefit of carbon credits.

Ref 1: Sustainable Energy Development Authority of Australia, Australian Greenhouse Office, EDL, WCC. *Solid Waste Energy Recycling Facility - A Sustainable Waste Management Alternative.*

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5. Health and Social Impacts and Benefits

5.1. Disease Control

This document outlines the very compelling health, ecological and environmental reasons why combustion and more specifically pyrolytic gasification should replace other forms of biomass and waste disposal / recycling, particularly for municipal waste-biomass, quarantine matter and medical waste.

1. **Science Struggles with Disease Control:** Mankind and the animal kingdom are continually facing new and serious life threatening infectious diseases. Infectious disease experts predict the future will see ***a continuation of new and more aggressive pathogens or infectious diseases evolving and that medical science will struggle to keep apace with their control*** (as is the case now).

2. **The Current Era of Infectious Diseases:** Current serious infectious diseases include HIV/AIDS, Transmissible Degenerative Encephalopathy (TDE's, such as scrappy in sheep, chronic wasting disease in US deer, bovine spongiform encephalopathy or "mad cows disease" and the human variant Creutzfeldt-Jakob Disease), Ebola, etc.. Some of these diseases are transferred from contact with human or animal body fluids, whilst TDE's are also transferred by simple contact and/or consumption of infected animals or animal by-products.

3. **Disease Mapping & Control:** Due to the highly communicable nature (and as detailed herein, limited destruction methods) applicable to most above-mentioned serious infectious diseases (and predicted future more aggressive pathogens), there is worldwide emphasis on "mapping" of their contamination chains and then their subsequent control. Currently recognized contamination chains for biomass and wastes are:

    a. High Profile Contamination Chains: Contact and/or consumption of infected animals or infected animal by-products. Contact with infected matter at quarantine sources. Contact with infectious waste at medical (including veterinarian) sources.
    b. Low Profile Contamination Chains: Contact and/or consumption of infected animals or infected animal by-products, or quarantine matter, or medical wastes (including veterinarian); at landfill sites; usually by vermin (e.g. rodents, birds, etc.) whom enter the disease into, and subsequently cross-contaminate their food chain hierarchy. Also, by consumption of compost derived from contaminated organic municipal waste sources; again by vermin and again resulting in cross-contamination of their food chain hierarchy.

    Infectious disease experts recommend control of infectious diseases at each point in a contamination chain and only by methods that are proven to result in destruction. To comply with these recommendations, proven destruction methods for infectious diseases must be applied to biomass and waste contamination points of the cases identified above, namely: Municipal waste, Quarantine matter, Medical waste.

4. **Disease Control & Destruction:** Disease control alternatives for biomass and waste are:
    a. Treatment: However, many serious pathogens are resistant to temperature and disinfecting "treatment" processes. For example:
        i. TDE infected hamster brain tissue retained small amounts of infections after being heated at 360 deg. C for 1 hour (Brown *et al.*, 1990).
        ii. The pathogen causing prion diseases are extremely resistant to heat and chemicals. The usual disinfectants have hardly any effect at all. These pathogens are very difficult to decompose biologically - in soil they survive many years (Prionics *AG.*, 1999).
    b. Destruction: Combustion is the only method known to mankind that results in "destruction" of all pathogens or infectious diseases.

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i. Ref.: Brown, P., Liberski, P.P., Wolff, A. and Gadjusek, D.C. [1990]. *Journal of Infectious Diseases* 161:467-472 .
ii. Ref.: Prionics AG, University of Zurich, *http://prionics.ch/the_prion*

5. **Disease Control for Municipal Waste:** As substantiated above:
   a. ***MSW-Biomass (municipal solid waste-biomass) is a definite contamination point for serious infectious diseases*** (i.e. contact and/or consumption of diseased animals or diseased animal by-products, or quarantine matter, or medical waste at landfill sites, usually by vermin [e.g. rodents, birds, etc.], whom enter the disease into, and subsequently cross-contaminate their food chain hierarchy. Also, by consumption of compost derived from contaminated organic municipal waste sources; again by vermin and again resulting in cross-contamination of their food chain hierarchy).
   b. Many serious pathogens are resistant to temperature and disinfecting "treatment" processes. Combustion is the only method known to mankind that results in "destruction" of all pathogens or infectious diseases.

Subsequently, to control current serious infectious diseases (and predicted future more aggressive pathogens), Gasification is the only solution for treating MSW-Biomass. Landfill, landfill-bioreactors, composting, incinerators and conventional combustion treatment processes are not acceptable options.

6. **Disease Control for Quarantine Matter:** As substantiated above:
   a. Quarantine matter is a definite contamination point for serious infectious diseases (i.e. contact with infectious matter at quarantine sources, plus treated or untreated quarantine matter at landfill sites).
   b. Many serious pathogens are resistant to temperature and disinfecting "treatment" processes. Combustion is the only method known to mankind that results in "destruction" of all pathogens or infectious diseases.

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"Subsequently, to control current serious infectious diseases (and predicted future more aggressive pathogens), as detailed for Medical Waste below, treatment processes are not an acceptable option. Furthermore, the trend of the last decade to "treat" quarantine waste can be directly attributed to the current worldwide serious infectious disease's crisis."

7. **Disease Control for Medical Waste:**

   a. ***Medical waste is a definite contamination point for serious infectious diseases*** (i.e. contact with infectious waste at medical sources, plus treated or untreated medical waste at landfill sites).

   b. Many serious pathogens are resistant to temperature and disinfecting "treatment" processes. Combustion is the only method known to mankind that results in "destruction" of all pathogens or infectious diseases.

Subsequently, to control current serious infectious diseases (and predicted future more aggressive pathogens), Gasification is the only solution for treating Medical Waste. As further detailed below, treatment processes are not an acceptable option. Furthermore, the trend of the last decade to "treat" medical waste can also be directly attributed to the current worldwide serious infectious disease's crisis.

In fact, health authorities are now reversing the trend of the last decade, which has been steam sterilization, microwave or disinfecting treatment of medical waste, plus burying of both treated and

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untreated medical waste. This is evidenced by some hospitals already moving to use disposable equipment for tonsillectomies, appendectomies and, operations on the back of the eye and brain; because prions (which are associated with TDE's) are known to concentrate in these organs and it is recognized by these hospitals that they can survive temperature and disinfecting treatment processes.

Beyond the fact that steam sterilization, microwave or disinfecting treatment processes are not capable of destruction of all pathogens, the "treatment processes themselves" are very questionable. That is:

c. Firstly, the treatment processes rely upon other mediums to penetrate the waste (e.g. steam, chemicals, etc.) and there is the potential that this won't happen (as confirmed by the need to continually insert test vials into the waste).
d. Secondly, the treatment procedures rely upon operators to:
    i. Manually insert test vials into the waste prior to treatment
    ii. Manually remove and check test vials following treatment
    iii. Use self-assessment to determine whether the waste requires re-treatment.
e. With such high reliance upon operator self-regulation to follow procedures and operator self-assessment of test vials, there is a high potential that self-regulation and/or self-assessment may be compromised, either by the operator due to personal reasons and/or the hospital due to administrative or economic reasons.
f. Thirdly, the treatment processes venting mechanisms may transfer pathogens to atmosphere or groundwater.
g. Fourthly, shredding or granulation mechanisms commonly used as part of the treatment processes may transfer pathogens from infectious to non-infectious waste sources.
h. Furthermore, chemotherapy drugs and pathology specimens containing trace formaldehyde for example also can't be rendered non-hazardous by any of the treatment processes.

In summary, "treatment" processes provide no guarantee that pathogens are destroyed. Nor shall burying of either treated and untreated infectious matter or waste provide a guarantee that pathogens are destroyed. Plasma Arc Gasification is the only method known to mankind that results in "destruction" of all pathogens or infectious diseases.

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Health and Environment Competitive Points List

Differentiator	Combustion	Plasma Arc Gasification
Air Pollution	Old design. Releases Toxic Gases and Ashes in the Air.	Near Zero Emissions of gases.
Air Pollution Control	Attempts to reduce emissions. Cleans and Deodorizes gases before release in the air as best Option.	ELIMINATES Air pollution.
Fueling	Uses diesel, fossil fuel, which, itself produces toxic gases and hazardous waste. Can use imported natural gas.	SELF POWERED. No fuel, diesel or gases are needed.
Haz waste Handling	Does not operate at required temperatures to destroy hazardous material. Produces ashes (Hazardous). Residue can contain hazardous material that causes diseases.	Turns all waste, organic and non-organic matters into atoms and molecules (basic chemical structures).
Underground Water and Ground contamination	Creation of potential hazardous waste from the process needs to be land filled or buried, which potentially can contaminate the ground and underground water resources.	NO WASTES PRODUCED.
Diseases	**Gases and ashes released in the air constitute NUMBER ONE CAUSE OF CANCER AND INFECTIOUS DISEASES in the World.**	**Near Zero Emissions.**

Table 2 - Health and Environment Competitive Points List

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6. Technical Overview

6.1.DESCRIPTION OF PLASMA TECHNOLOGIES

Plasma technologies include the following:

- AC Plasma generation Systems – Through a very close working relationship with the Institute of Problems in Electro physics, Russian Academy of Sciences (IPE-RAS), S.A.A. brings the latest generation AC and DC Plasma Torches as well as a variety of other plasma generation methods.

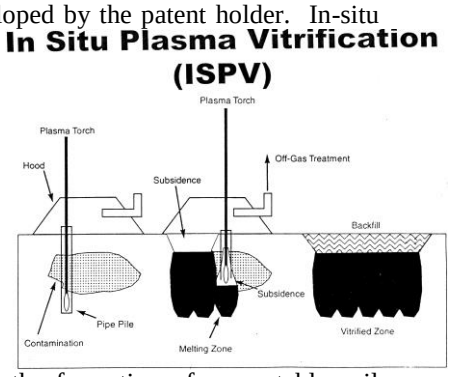
- "Table Top" Plasma Thermal Treatment and Destruction system IPE RAS has an ultra-small scale plasma thermal treatment and disposal system to provide small tests and demonstrations and for the terminal destruction of a wide range of hazardous and non-hazardous wastes (organic and in-organic) with a capacity of 10 to 40 kg/hr. These systems can be used for highly toxic materials where relatively small amounts are destroyed at any time.

Three-phase plasma generator up to 30 kW

Single-phase plasma generator up to 10 kW

"Table Top" plasma gasifier built by Georgia Tech P and the
10 KW and 30 KW plasma generators

- In-situ Plasma Arc Vitrification System – A technology developed by the patent holder. In-situ remediation of sites (including landfills) contaminated with hazardous and/or radioactive wastes. The technology has been successfully proven (and validated by the US Department of Energy) to completely (and in-situ) remediate highly contaminated sites, vitrifying the soil and the contaminants into a totally inert glass matrix (the most stable waste form – in fact a waste form utilized for the permanent immobilization of high-level nuclear wastes). This method offers unique cost and personnel safety advantages and can provide clients with a unique, cost effective and fast method to remediate contaminated sites. The in-situ process achieves a major reduction in volume of the materials processed and the formation of very stable soil structures for future construction at the site.



- Graphite electrode systems – This is a variation of the standard arc furnaces used in the steel and specialty metals industry for years whereby the system is converted to a true plasma arc system in lieu of being a conventional Joule heater. The advantage is in the ability to handle large volumes in a safe and very cost effective manner.

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- Plasma Gasifier Feed Systems – S.A.A. brings a number of proprietary feed system designs for plasma reactors where the feeder allows for the control introduction of materials into the reactor while maintaining control on the environment inside the reactor. One of these feeders allows for the homogeneous densification of waste and controlled feeding maintaining ideal operating reactor parameters.

7. INTRODUCTION TO PLASMA GASIFICATION

Gasification of carbonaceous materials has been widely used in commercial applications for many years in the production of fuels and chemicals. Gasification, particularly of waste materials (such as waste tires, Automobile Shredder Residue (ASR) or Municipal Solid Wastes (MSW)) has a number of important advantages, including:

- The ability to produce a consistent, high quality synthesis gas product that can be used for energy production or to provide critical feedstock for the manufacture of various products, including plastics and the ability to accommodate a wide variety of gaseous, liquid and solid feedstock.

- Gasification of conventional fuels, such as coal or oil, as well as low-value materials and wastes, such as petroleum coke, heavy refinery residuals, secondary oil-bearing refinery materials, halogenated hydrocarbon byproducts have also been successfully used in gasification applications.

- Gasification of these materials has many benefits when compared with conventional options such as combustion or disposal by incineration. The US Environmental Protection Agency (EPA) has recently enacted rules that specifically exclude the synthesis gas produced from gasification of hazardous wastes from being regulated as a hazardous waste. Thus the wide-ranging application of gasification of hazardous and non-hazardous wastes can greatly reduce the need to use fossil fuels for the production of energy and other precursor products for the manufacture of certain chemicals.

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7.1.Gasification

Gasification is a thermal chemical conversion process that maximizes the conversion of the carbonaceous fuel to a synthesis gas (syngas) containing primarily CO and H2, with lesser amounts of CO2, methane, N2 .and some polycyclic compounds in trace amounts. The chemical reactions take place in the presence of a reforming agent (i.e. steam, air or pure oxygen) in an oxygen "starved" atmosphere, in contrast to combustion wherein the reactions take place in an oxygen rich, excess air environment. In other words, the ratio of oxygen molecules to carbon molecules ideally is stoichiometrically balanced in the gasification reactor.

Pure pyrolysis can also be done in a plasma reactor, with different chemical results. The following chemical conversion formulas describe, in general, the process for ideal syngas generation:

$2H_2O + \text{energy} \rightarrow 2H_2 + O_2$
C (feedstock) + H20 (steam, or air or oxygen) + energy → CO + H2 (endothermic)
$C + CO_2 + \text{energy} \rightarrow 2CO$ (endothermic)
$C + 2H_2 \rightarrow CH_4 + \text{energy}$ (exothermic)

S.A.A. brings a number of technologies that utilize the principles of thermal plasma to generate an ultra-high temperature field of ionized gas (i.e. plasma) within the gasifier chamber. Plasma generating systems have at their core, the capacity to disassociate compounds into elemental atoms.
Once the atoms are freed to move independently, simple chemistry is applied to reassemble the atoms into usable, commercially viable products.

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The gasification process is distinctly different from combustion (incineration) in that it uses energy from the plasma to thermally convert organic waste from a solid (or liquid) to a gas through controlled pyrolysis or controlled gasification. The constant high operating temperature (above 1700ºC) ensures the destruction-thermal dissociation of all complex organic compounds, and the process control minimizes-controls minimize the possibility of reformation of complex pollutants. The escape of volatile metals and acid gases can be minimized to levels that meet the most stringent air emission standards. As the In some-thermal dissociation reaction is endothermic, in cases where the organic content of the waste stream is high, the pyrolysis product gas, composed mainly of hydrogen and carbon monoxide, can be used to safely recover much of the energy in the waste.

Concurrent with (or independent of) the controlled pyrolysis of organic materials, plasma gasification systems can melt inorganic materials (e.g. soil, metals-bearing wastes, and fly ash, metals, etc.), if present. These components, common in many waste streams, are melted and recovered as a glassy slag. The glass layer serves as a medium for chemically binding many metals in a non-leachable manner through Vitrification. This silicate glass slag can be re-used in commercial applications, including: concrete aggregate, manufacture of rock-wool insulation, roadbed construction and as a construction abrasive. Metals will separate into a heavy metal if the environment is sufficiently reducing. Waste streams that are predominantly metal can usually be processed to promote metal recovery. This is an important and unique benefit, particularly when processing, for example waste batteries, heavy metal sludge or Printed Circuit Boards, containing meaningful quantities of valuable metals, and even precious metals such as gold and palladium that can add significant value to such a project.

Key Differences between Gasification and Incineration

Subsystem	Incineration (Combustion)	Gasification
Combustion vs. Gasification	Designed to maximize the conversion of feedstock to CO2 and H2O Large quantities of excess air are required Highly oxidizing environment Operated at temperatures below the ash melting point; thus mineral matter is converted to fly ash (hazardous) and bottom ash (may be hazardous)	Designed to maximize the conversion of feedstock into CO and H2 Limited quantities of oxygen Reducing environment Operated at temperatures above ash melting point; mineral matter is converted to glassy slag
Gas Cleanup	Flue gas cleanup at atmospheric pressure Treated gas is discharged to atmosphere	Syngas clean-up at high temperatures Treated gas used for energy production on pre-cursors for chemical manufacturing
Residue and Ash Handling	Bottom and fly ash collected, treated (usually through stabilization operations that increase the disposal volume) and disposed as hazardous waste (mostly fly ash)	Slag is non-leachable, non-hazardous and suitable for a multitude of construction applications

Table 3 - Key Differences between Gasification and Incineration

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7.2.Emissions of SOx, NOx and Particulate Matter

For a given secondary material, emission levels of SOx and NOx, and particulate from gasification systems are orders of magnitude lower than for incineration systems. In an oxidative incineration environment, sulfur and nitrogen compounds in the feed are converted into SOx and NOx. In contrast, syngas cleanup systems for modern gasification systems can be designed to recover 95% to 99% of the sulfur in the feedstock as a high – purity sulfur byproduct. Likewise, Nitrogen in the feed is converted to diatomic nitrogen (N2) in the syngas. Any halogens in the feed will turn to acids that are easily scrubbed in conventional systems.

Once the syngas is combusted in an energy production plant (i.e. such as a boiler or gas turbine), the production of SOx and NOx is dramatically reduced. If the syngas is to be used as a feedstock in downstream chemical manufacturing processes, these compounds are not formed. Recent US Department of Energy (DOE) Data for re-powering coal-fired electric power plants with Integrated Gasification Combined Cycle (IGCC) technologies has shown that emissions of SOx, NOx and particulate are reduced by one or two orders of magnitude.

Please see Testimonials and US House Energy Committee Hearings"

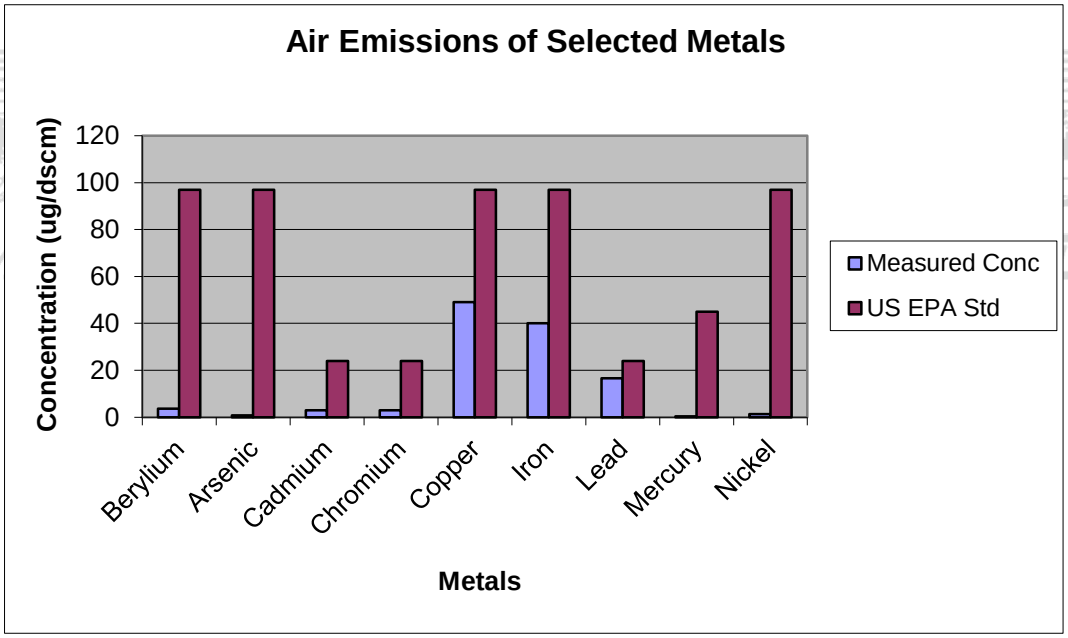

Figure 1 - Typical metal emission data from plasma gasification of hazardous wastes

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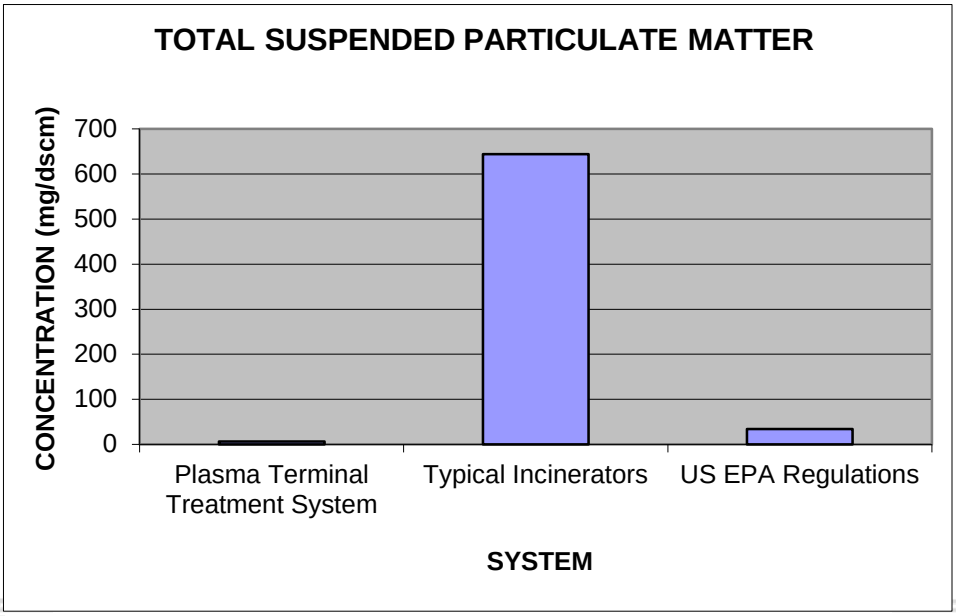

Figure 2 - Typical particulate emissions data measured from plasma gasification of hazardous wastes

7.3. Dioxins, Furans and other Organic Compounds

Typically, organic compound emissions of most concern from waste incineration systems have been Principal Organic Hazardous Constituent (POHC) in the waste feed and Products of Incomplete Combustion (PIC). POHC refers to the organic compounds present in waste feeds that must be destroyed at greater than 99.99% destruction efficiency (DRE) and in the case of dioxins and furans, greater than 99.9999% DRE, based on US EPA regulations for hazardous wastes. PIC's are compounds, such as semi-volatile organic compounds (SVOC's), polycyclic aromatic hydrocarbons (PAH's), VOC's and dioxin/furan compounds (PCDD's/PCDF's).

7.4. Why Plasma Gasification will NOT produce Dioxins and Furans

In a typical combustion (i.e. Incineration Process)، when processing materials that contain chlorine atoms, dioxins will typically form. Dioxin formation typically occurs if the temperatures produced by the combustion process do not exceed 250oC THROUGHOUT THE ENTIRE COMBUSTION CHAMBER.

However, when the chamber temperatures exceed the 250oC threshold, as will typically occur in a plasma gasifier, the chlorinated materials will dissociate itself of the Chlorine atoms and the Chlorine will preferentially combine with Hydrogen to form HCl (which is then removed in the gas treatment system and removed in the scrubber with NaOH to form a benign salt), or if lime is introduced into the gasifier, the Chlorine will combine with the Calcium and be trapped in the silicate slag.

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In order to form dioxins, ALL of the following five conditions MUST be present:

- Hydrocarbons
- Chlorine
- A "surface" (i.e. particulate matter)
- Copper (the most powerful catalyst), nickel or iron
- A temperature range between 250 C to 450 C

In order to prevent the formation of dioxins throughout ANY portion of the gasification system, the synthetic gas produced will be cleaned or filtered at temperatures exceeding 450 C. The filters will remove particulate matter (#3) (and therefore the binding "surfaces"). At the same time, the filters will remove metals that can act as catalysts (#4).

In summary, the ATONN design PREVENTS the formation of dioxins or furans throughout ANY portion of the gasification process by:

- Minimizing the presence of Chlorine in the syngas stream by the addition of lime into the reactor such that the Chlorine will combine with the Calcium and thus be trapped in the silicate slag.
- Any HCl in the gas stream will be removed by the removal of HCl in the scrubber through the addition of NaOH to form a benign salt.
- Removal of particulates in the gas stream through filtration

Results from measurements taken in conventional gasifiers confirm that, in general, VOC's such as benzene, toluene and xylene, when detected, were present in the parts per billion levels. SVOC's, including PAH's, were also detected in the syngas and/or turbine exhaust. SVOC's were typically present at extremely low levels on the order of parts per trillion.

Gasification tests using chlorinated feedstock have also been conducted to measure the DRE for organic compounds such as chlorobenzene and hexachlorobenzene. DRE's greater than 99.99% were demonstrated for both compounds.

Dioxin and Furan compounds (PCDD/PCDF's) are not expected to be present in the syngas from gasification systems for two major reasons:

(1) The ultra-high temperatures in the gasification process effectively destroy PCDD/PCDF compounds or precursors in the feed and

(2) The lack of oxygen in the reduced gas environment will preclude the formation of the free Chlorine from HCl, thus limiting the chlorination of any precursors in the syngas.

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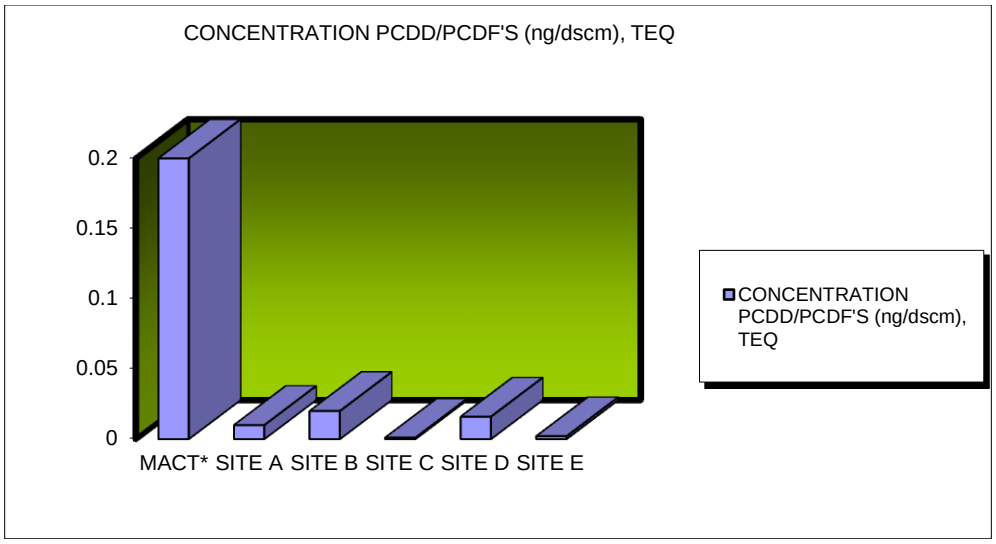

Figure 3 - Measurements of PCDD/PCDF compounds in gasification systems confirms these principles.

** MACT = Maximum Achievable Control Technology standards for hazardous waste incinerators in the US*

In all cases, the levels of PCDD/PCDF compounds were one or two orders of magnitude below the most stringent standard recently enacted for hazardous waste incinerators.

7.5. Trace Metals and Halides

US EPA data for hazardous waste incinerator systems indicate that metals emissions include antimony, arsenic, beryllium, cadmium, chromium, lead mercury nickel and selenium compounds. Acid halides (HCl, HF and HBr) may also be present depending on the halogen content of the feedstock.

Data from a variety of testing done on coal-fired gasification systems have been evaluated. Based on a compilation of this data, certain trace metals have the potential to be present in the clean syngas or turbine exhaust. These metals include Chloride, Fluoride, mercury, arsenic, cadmium, lead chromium, nickel and selenium. In most cases, the amount of these elements present in the syngas or combustion turbine exhaust represented less than 10% of the amount of input to the gasifier (based on coal). Elements such as Chloride and Fluoride are typically removed in the gas scrubbing and cooling operations and ultimately are removed by the process (i.e. scrubber) water streams; greater than 99% removal of HCl was measured during several EPA test programs. Semi-volatile metals, such as lead and mercury, will volatilize in the gasifier and re-condense on the fine particulate matter, which is removed from the syngas. In a plasma gasifier, the addition of lime to the gasifier vessel will promote the entrainment of some of the volatile metals and as much as 90% of the halogens (i.e. Chlorides and Fluorides), entrapping them as Calcium halides within the non-leachable glassy slag. Analysis of the glassy slag material from various gasification and plasma waste treatment projects (including Vitrification of fly ash from incinerators) consistently show that the slag to be non-hazardous according to RCRA definitions.

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ELEMENTS	COMPOSITION (% BY WT)
Silica	37.2
Alumina	19.5
CaO	19.5
Fe2O3	6.21
MgO	2.31
Na2O	3.87
K2O	1.31
ZnO	0.24
PbO	0.11
CuO	0.26
MnO	1.70
Cr2O3	0.26
NiO	0.32
CdO	<1
Specific Gravity	1.5 – 2
Volume Reduction	1.88 – 2.5

Table 4 - TYPICAL SLAG CHEMISTRY (MSW Incinerator Fly ash vitrified in a plasma reactor)

SPECIES	MSW FLY ASH FEED mg/l	MSW SLAG mg/l	HAZ WASTE RANGE Mg/l	INERT WASTE RANGE Mg/l
Arsenic	0.15	< 0.05	0.2 – 1.0	
Lead	4.81 *	< 0.05	0.4 – 2.0	Total less than 5
Cadmium	0.15*	< 0.05	0.1 – 0.5	
Chromium	0.64*	< 0.05	0.1 – 0.5	
Copper	0.11	< 0.05	2 – 10	
Nickel	< 0.05	< 0.05	0.4 – 2.0	
Mercury	<0.05	< 0.05	0.02 – 0.1	
Zinc	0.5	< 0.05	2 – 10	
Phenols	0.2	< 0.01	20 - 100	< 10

Table 5 - TYPICAL LEACHATE TEST (TCLP) RESULTS (Vitrified MSW fly ash)

** Boldface indicates values that exceed regulatory limits and therefore categorize the feedstock as a hazardous material*

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TYPICAL SYNGAS COMPOSITION

COMPONENT	CONTENT (VOL% UNLESS OTHERWISE STATED)
H2	32 – 35
CO	34 – 48
CO2	15 – 26
O2	NOT PRESENT
Ar	0.07 – 0.1
N2	0.18 – 5.8 (DEPENDING ON REFORMING MEDIUM USED MAY BE HIGHER)
NOx	NOT PRESENT
SO2	NOT PRESENT
SO3	NOT PRESENT
CH4	60 ppmv – 1930 ppmv
H2S	0 – 7590* ppmv (DEPENDING ON SULFUR CONTENT OF FEEDSTOCK) * gasification of coal or coal containing feedstock
COS	0 – 176 ppmv (DEPENDING ON SULFUR CONTENT OF FEEDSTOCK) * gasification of coal or coal containing feedstock
NH3	0 – 0.62 ppmv (after scrubbing and gas cooling)
THC	0 – 27 ppmv

Table 6 - Typical heating value of syngas = 300 – 350 BTU/SCF (11.2 MJ/Nm3 – 13 MJ/Nm3)

7.6. Use of Syngas in Electric Power Production

The use of low-BTU syngas in combined cycle electric power generating plants has achieved significant success, particularly in terms of significant cost reductions (particularly when the syngas is generated by the processing of waste materials, thus avoiding the cost of purchasing fuel), increased operating efficiency (many gasification /combined cycle projects have achieved ratings of 15% to 30% over natural gas operation) and improved emissions (e.g. lower NOx emissions than with natural gas).

Currently, commercial experience with the utilization of syngas in combined cycle installation total over 350,000 hours, clearly enough to establish that the basics of syngas utilization in combustion turbines for electric power generation in simple or combined cycle modes.

An average of 20% higher ratings is achieved when operating on low heating value gas (i.e. Syngas). Fourteen percent difference in flow at same firing temperature drives 28% more output (No Compression Power). However, such high levels of output can be limited by mechanical constraints.

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Output Increases			
Frame Size MW	**MW**		
	GT	CC	Syngas
6FA	90	107.1	126
7FA	200	262.5	280
9EC	215	259.3	300
9FA	300	390.8	420
7H		400	460
9H		480	550

Plasma gasification systems can produce syngas at a cost that is significantly lower than natural gas or even coal (delivered). As such, there are significant economic and environmental benefits of utilizing syngas generated by the gasification of carbonaceous waste materials, or coal for the production of electric power or feedstock for chemical manufacturing (i.e. plastics).

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Technical Competitive Points List

Differentiator	Combustion	Plasma Arc Gasification
International Regulations and standards	**DOES NOT MEET THE MINIMUM EPA REQUIREMENTS AND STANDARDS.** **BURNING WASTE WILL BE BANNED WORLDWIDE IN 2005**	**MEETS THE EPA REUIREMENTS AND STANDARDS 2005, 2010 AND 2020.**
Combustion vs. Gasification	Designed to maximize the conversion of feedstock to CO2 and H2O.	Designed to maximize the conversion of feedstock into CO and H2
Air Requirements	Large quantities of Air are required	Limited and controlled quantities of Oxygen are injected when needed
Oxidization	Highly Oxidizing environment.	Reducing Environment
Operating Temperature	Limited High Temperature 1370 C destroys high proportion of waste. Operated at temperature below ash melting point. Thus mineral matter is converted to fly ash **(hazardous)** and bottom ash **(may be hazardous)**	Extremely High Temperature 5000 C- 7000C destroy all wastes. Operated at temperatures above ash melting point. Mineral matter is converted into glassy slag.
Fueling	High consumption of fuel. It's outlets prices vary with the changes in fuel prices	No needed fuel to run the facility, self-powered
Type of Waste Processed	Destruction of most solid wastes except some hazardous, construction, clinical and classified nuclear wastes (Limited High Temp. cannot reach to handle it all)	Destruction of all kind of wastes including Hazardous, clinical, petro chemical and classified nuclear wastes (Extremely High Temp. eliminates all)
Gas Cleanup	Flue gas cleanup at atmospheric pressure Treated gas is discharged to atmosphere	Syngas clean-up at high temperatures. Treated gas used for energy production on pre-cursors for chemical manufacturing
Residue and Ash Handling	Bottom and fly ash collected, treated (usually through stabilization operations that increase the disposal volume) and disposed as hazardous waste (mostly fly ash)	Slag is non-leachable, non-hazardous and suitable for a multitude of construction applications
Residue	Up to 30 % Residue on average which leads into accumulating residuals Toxic and Hazardous wastes at the end of the year. The daily remaining residue can contain of high percentage of toxic and	0 % residue

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Differentiator	Combustion	Plasma Arc Gasification
	hazardous materials that is very harmful and dangerous.	
Reduction Efficiency	Limited reduction efficiency, 97% of input materials.	Maximum reduction efficiency, 100% of ALL Input materials
Gases and Emissions	Operates in Open Air mode. Toxic gases and Ashes are released in the air.	Closed and extremely controlled environment. Zero Emissions.
Toxic Gases	Dust content of flue gases could dangerously exceeds the international standards and causes pollution in surrounding atmosphere and contaminates area **Most of flue gases converted and deodorized then released in the air.**	No Dust, Toxic or flue gases
Waste Production	Produces waste including hazardous to be managed after process.	No waste production.
Monitoring	Monitoring system can give indications, though it is not built to control the exhaust gasses that are to leave the plant.	The monitoring system is built to monitor and control 24 hrs /day and 365 day /year.
Remote Monitoring and Control	None.	Plant monitored and can be operated remotely from 2 existing centers. US and Canada.
Power Production	Very poor production rate.	Very high production of power comparing to other technologies
Expansions	It cannot handle any expansion or increase in quantity of MSW with time.(Poor equipping)	State of the art design allows expansions any time

Table 7 - Technical Competitive Pints List

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8. Testimonials & References

Waste Minimization Projects Underway

Gasification Methods Convert Wastes Into Useable Fuel. Gasification converts carbon-containing materials, under high temperature and pressure, into synthetic gas. This gas is then used as a fuel to generate electricity or steam, or as a basic chemical building block for many uses in the petrochemical and refining industries. When used as a fuel, the synthetic gas, or "syngas", is cleaner than almost any fuel in use today and is comparable to natural gas. In the petroleum refining industry alone, up to seven to 10 million tons of hazardous byproducts currently managed under the Resource Conservation and Recovery Act (RCRA) could be converted in gasification systems into useable fuel.

As part of EPA's effort to promote flexible innovative ways to convert waste to energy while reducing the nation's reliance on fossil fuels, the Agency has proposed a regulatory change that will convert manufacturing wastes into a marketable fuel that supplements crude oil sources in electricity production, petroleum refining and chemical manufacturing. This regulatory change would exclude from hazardous waste regulations petroleum refining byproducts and possibly other industry byproducts that are used to make syngas that meets stringent purity standards.

Table 8 - EPA Comments on Gasification Process

Proposed Gasification Rule

March 25, 2002

The EPA is proposing revisions to the RCRA hazardous waste program to allow a conditional exclusion from the definition of solid waste. This exclusion would be for hazardous oil-bearing secondary materials generated by the petroleum refinery industry when these materials are processed in a gasification system to produce synthesis gas fuel and other non-fuel chemical by-products. We are proposing this exclusion to put the gasification of these hazardous oil-bearing secondary materials on the same regulatory footing (i.e., excluded) as other hazardous secondary materials returned to a petroleum refining process. If adopted, this proposal will establish a more consistent regulatory framework for this practice, potentially enhancing the use of this technology, as well as establishing conditions on the practice to assure the legitimacy of this fuel manufacturing activity.

Table 9 - Proposed Gasification Rule

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United States Environmental Protection Agency

Communications, Education, And Media Relations (1703)

Environmental News

FOR RELEASE: MONDAY, MARCH 25, 2002

EPA PROPOSES RECYCLED WASTE AS ENERGY SOURCE FOR GAS PRODUCTION AND POWER GENERATION

As part of an EPA initiative to promote flexible, innovative ways to recycle more wastes while reducing the nation's reliance on fossil fuels, the Agency has proposed an action signaling a shift in manufacturing from waste management to productive recycling and resource conservation. The proposal would conserve natural resources by supplementing crude oil sources in electricity production, petroleum refining and chemical manufacturing.

"Today's action is a step forward for the environment and energy self-sufficiency," said Marianne Lamont Horinko, EPA Assistant Administrator for Solid Waste and Emergency Response. "The Agency's objective is to increase recycling and energy recovery. This proposal encourages recycling of waste materials by lessening the regulatory burden on industry, while protecting public health and the environment. Today's announcement is the first in a series of Agency initiatives on this issue, with more to be announced later this spring."

Specifically, EPA is proposing to allow certain hazardous byproduct materials to be processed with gasification technology, in order to produce a clean, safe source of power generation. This promotes increased energy efficiency while reducing the volume of hazardous waste that would otherwise be treated and disposed of on land.

Gasification is a technology that puts coal and other carbon-containing materials under high temperature and pressure to convert them into synthetic gas. This gas is then used as a fuel to generate electricity or steam, or as a basic chemical building block for many uses in the petrochemical and refining industries. When used as a fuel, the synthetic gas, or "syngas"; is cleaner than almost any fuel in use today and is comparable to natural gas. In the petroleum refining

Industry alone, up to seven to 10 million tons of hazardous byproducts currently managed under the Resource Conservation and Recovery Act (RCRA) could be transferred to gasification systems.

EPA's proposal would exclude from hazardous waste regulations petroleum refining byproducts and possibly other industry byproducts provided certain conditions are met. These materials would be processed, along with fossil fuels such as coal, petroleum, coke, and possibly municipal solid waste and sewage sludge, to produce a synthetic gas. Processors would have to meet certain conditions to make sure the byproduct materials are handled carefully and that the syngas meets stringent purity standards.

Other related activities to be announced this spring include waste minimization strategies, additional energy recovery projects and a retail initiative targeted towards consumers.

Table 10 - EPA Press Release: EPA PROPOSES RECYCLED WASTE AS ENERGY SOURCE FOR GAS PRODUCTION AND POWER GENERATION

Zero-Emission Technologies and Eco-Cities:

An example of Zero-Emission technology is called the Gasification & Ash Melting System, which convert waste to resources. The system produces combustible gas from waste. The gas can be utilized for power generation or heat recovery. Furthermore, the system can synthesize basic chemical compounds such as ammonia or hydrogen from the gas, realizing a chemical recycling system from waste. It means that this system can utilize all the waste as raw materials for industry, realizing a typical approach to zero waste discharge, or the Zero-Emission.

Table 11 - Mayors' Asia Pacific Environmental Summit

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Developing Technologies Hold Promise for the Future. The U.S. Department of Energy is developing advanced technologies such as gasification-based systems for power production. A gasification-based process converts solid and liquid feedstock to synthesis gas that can be easily cleaned of pollutants. It also can convert potential pollutants to salable by-products such as sulfur, construction materials, and abrasives. Gasification enables production of electricity, steam, clean transportation fuels, chemicals, hydrogen, and natural gas substitutes. In addition, gasification systems will be amenable to future CO_2 separation and capture technologies.

Table 12 - Energy Information Administration, International Energy Outlook (IEO) 2002. Energy Information Administration, Annual Energy Outlook (AEO) 2002. (http://www.eia.doe.gov).

Extracts from testimonial of:

The House Committee on Energy and Commerce
W.J. "Billy" Tauzin, Chairman
Future Options for Generation of Electricity from Coal.

Subcommittee on Energy and Air Quality
June 24, 2003
2:00 PM
2322 Rayburn House Office Building

Testimonial of:

Deputy Assistant Secretary for Coal and Power Systems
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC, 20585

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How Have Gasification Devices Been Used in the Past?

Gasification devices have a long history of use in the United States for the production of fuels. The use of gasification processes to produce useable quantities of fuel began in the mid 1800's when manufactured gas plants converted coal into hydrogen gas and methane to power city street lamps. Following the widespread use of electricity to power city lights, the operation of manufactured gas plants largely ended. Use of gasification systems to produce fuel from coal or other organic sources increased briefly during the years surrounding and during World War II as the international community experienced a shortage of fuels derived from oil.

Following the end of World War II, the use of gasification declined rapidly as more effective techniques to produce fuels from crude oil were developed and crude oil was once again plentiful. In the 1970's, gasification technologies were resurrected to deal with fuel shortages. During this time, the United States Department of Energy (DOE) financed research in gasification technologies that resulted in commercial ventures designed to use the technology to produce higher value fuels from low value coal. Over the last 10 to 15 years, private industry and the DOE have continued their investigation of gasification as a clean coal energy alternative, and have developed better methods to extract fuel value from organic containing materials, as well as developing more efficient turbines to utilize the clean burning fuel.

In recent years, the oil refining and chemical manufacturing industries have configured gasification systems to produce base chemical products and fuels. Presently, gasification systems operate around the world in a number of different configurations. In the United States, gasification systems have been designed to gasify coal, municipal solid waste, tires, petroleum coke, biomass, and oil-bearing hazardous secondary materials into synthesis gas for the production of electricity or use as a feedstock to produce more complex chemical products. Data on the use of gasification to process hazardous waste is limited. Information that does exist, has largely been confined to configurations where the systems produce specialty chemical intermediates from virgin materials, or where the devices produce a fuel from historically waste-like materials that can be burned for energy recovery (e.g., gasification of petroleum refinery secondary materials).

B. How Do Gasification Systems Operate?

In general, gasification systems are designed to react carbon containing materials and steam at high temperatures under partial oxidation conditions to produce a synthesis gas fuel composed mainly of carbon monoxide and hydrogen. However, all gasification systems do not operate in exactly the same manner. Gasification systems can be designed to operate at high or low pressures, reducing conditions, using dry or wet feed systems, but they are all operated in a manner that limits the complete oxidation of hydrogen and carbon monoxide to water and carbon dioxide. Some gasification systems derive a portion of the energy--in the form of heat--from the partial oxidation of the materials being fed to the system.

When the feed materials are partially oxidized, heat is given off. The heat helps sustain the process by promoting the disassociation of other molecular species in the reactor freeing the molecular species for limited oxidation. In gasification systems, this process promotes the formation of hydrogen and carbon monoxide species which are the base compounds in synthesis gas fuel. Using organic materials as both fuel and raw material for the gasification process is one of the reasons the system operates with increased efficiency when compared to traditional power plants that use coal or petroleum coke as their fuel.

Gasification systems generally include two basic components. The first is the high temperature reactor or gasifier and the second is a gas cleanup or polishing system used to remove various contaminants from the raw (un-polished) synthesis gas fuel. The two systems work in conjunction to produce a high purity synthesis gas that can be used directly as a fuel for power production, or used to produce chemicals or fuels in other manufacturing processes.

Operators of gasification systems monitor and control the operation to ensure that it is producing a high quality synthesis gas. They monitor and limit parameters such as the BTU value, sulfur content, chloride content, and ash content of the materials fed to the reactor (gasifier). They also continuously monitor and regulate the

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amount of oxygen fed to the reactor, the temperature of the reactor, and the composition of the raw synthesis gas produced by the reactor. In the synthesis gas cleanup stage, operators monitor and regulate various other parameters that maintain the removal efficiency of the cleanup system. The result of these parameter specifications and attendant monitoring is production of a synthesis gas that meets the desired specifications.
Gasification systems, similar to many of the more traditional fuel production units found at petroleum refineries, are expensive, highly engineered systems that must be carefully operated to produce marketable fuels and co-products in a cost-effective manner.

Both traditional petroleum refining processes (e.g., distillation, catalytic cracking, fractionation, thermal cracking, etc.) and gasification systems operate under conditions in which the feed, temperature, and pressure are closely controlled to optimize the production of marketable fuels or fuel components. Owners/Operators of both gasification systems and traditional refinery process units must analyze and characterize the feed materials, in addition to controlling the operation of the unit. Operational control of the gasification system is necessary to optimize the conversion processes occurring in the reaction chamber and to regulate the performance of the gas polishing systems.

C. How Do Gasification Systems Remove Contaminants From Raw Synthesis Gas?

In a gasification system, the gas cleanup or polishing component will be configured and monitored to operate with varying degrees of performance. The operation of the gas cleanup component is determined by the composition of the raw synthesis gas and the product specifications for the fuel and chemicals generated. Generally, the systems operate with sufficient effectiveness to produce a synthesis gas that contains low contaminant levels of sulfur, nitrogen, ash, and metals. The systems used to remove contaminants are generally the same types of systems used in other industrial settings to produce commercial grade chemical compounds or to remove unwanted contaminants from gaseous effluent streams. These systems have a history of use in industrial settings with the parameters that control their operation being well understood.

As we explained earlier, the synthesis gas product from gasification is not released directly to the atmosphere. Gasification systems are generally designed to be closed to the environment. In gasification systems, the raw synthesis gas exits the reactor at a temperature between 1800 and 3000 degrees Fahrenheit (depending on the design and operating characteristics of the device). Generally, after exiting the reactor, heat value from the gas is extracted in systems designed to produce steam and electricity.

The raw synthesis gas is then typically processed in a series of systems designed to remove entrained particulate matter, acid gases (such as hydrochloric acid), and other inorganic compounds. The gas cleanup systems typically include filters or scrubbers for the removal of entrained particles and absorbers for the removal/recovery of sulfur and chlorine. The solids recovered in the filters or scrubbers are frequently put back into the gasification system. The polishing systems that remove the unwanted contaminants from the raw synthesis gas also concentrate these materials to form chemical by-products. The reduced sulfur species are recovered as elemental sulfur, or in some cases, converted to a sulfuric acid by-product. The typical sulfur removal and recovery process used to clean the raw synthesis gas (to yield a high purity fuel) are the same commercially available methods used in other industrial applications such as oil refining and natural gas recovery.

Sulfur recoveries of 95% to 99% can typically be achieved using these systems. These systems do include process vents, but the synthesis gas is not released through these vents. After the gas is polished, it is sent for turbine combustion to produce electricity and steam or to produce other chemical products.

Metal species found in the materials fed to the gasification system are controlled both in the reactor phase, and in the cleanup systems used by the device. The low volatility metals are captured in the slag emitted from the reactor, with the higher volatility metals being captured in the cleanup systems, or in the particulate removal systems and acid gas scrubbers. These captured metals can be put back into the reactor or be removed from the system and disposed. Control of metal compounds in gasification systems is discussed more in a later section of today's proposal.

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Ultimately, the extent to which contaminant removal systems polish the raw synthesis gas is governed by the fuel specifications for the systems that use the synthesis gas and/or the environmental regulations that apply to those systems. For example, use of synthesis gas in combustion gas turbines can require fairly low levels of alkalis and total entrained particles, thus the gas cleanup system would be tailored for this type of contaminant removal. The turbine system may also have fairly low sulfur oxide(s) emissions standards applicable to the turbine stack, so the synthesis gas will also have to be cleaned to a level to meet the emission standard. Therefore, the ability of gasification systems to extract useful chemical by-products from hazardous oil-bearing secondary materials is based on the extent the gas must be polished before it is released for its intended commercial application.

How Do Gasification Systems Differ From Hazardous Waste Treatment Units?

In most cases, gasification systems resemble fuel manufacturing devices more than they resemble RCRA treatment devices. Information submitted to us in response to the July 1998 NODA suggests that the design, operation, and operational characteristics of certain gasification systems are significantly different from those of conventional RCRA treatment devices. This is because gasification systems are not designed and operated to treat waste.

Gasification systems manufacture synthesis gas fuel by re-forming the organic compounds that exist in oil-bearing hazardous secondary materials through unique conversion processes that involve thermal disassociation and partial oxidation. The synthesized fuel is primarily composed of hydrogen and carbon monoxide. Gasification systems can also be configured to produce other gaseous or solid compounds for purposes other than as a fuel.

The reformation or conversion processes occurring within gasification systems are continuously monitored and controlled to enhance conversion efficiency. As such, they require feedstock materials to adhere to certain specifications prior to introduction into the system. Feedstock materials must be analyzed to determine BTU value, sulfur concentrations, chlorine concentration, and ash content. The analytical information on the feed material is needed in order to control the processes that convert the organic components of the feedstock material into valuable products (including synthesis gas fuel).

Gasification processes likewise limit and control oxygen levels to ensure the process reactions convert organic material to the synthesis gas product, and to prevent the complete (or unwanted) oxidation of the gaseous compounds that constitute synthesis gas. In contrast to gasification systems, thermal waste treatment devices (such as incinerators and certain industrial furnaces) process materials through ``complete oxidation processes'' to reduce the volume and toxicity of the waste materials. When referring to ``complete oxidation processes'' that occur in thermal treatment devices, what we mean is that the oxidation of specific compounds in the waste material is not controlled to any extent other than that what is needed to fully oxidize and destroy the waste materials.

Gasification systems also differ significantly from thermal waste treatment devices in terms of releases to the environment. As explained more fully below, gasification systems are not designed to and ordinarily do not release gases directly to the environment. Gasification systems are generally designed to be closed to the environment. The gases evolved in the partial oxidation or reactor phase are processed in polishing systems following the reactor that strip the gas of sulfur, chlorine, and particulate matter.
These polishing systems recover some of these materials to form additional products such as elemental sulfur, sulfuric acid, or hydrochloric acid.

The markets for these non-fuel by-products were not evaluated for this proposal, but many of the by-products do have marketable value. Non-gaseous by-products that are used in a production process to produce other products are not regulated by this proposal and are generally excluded from regulation under 40 CFR 261.2(e)(1)(i). In some systems, the stripped contaminants are fed back to the gasification reactor.

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Following the polishing processes, the synthesis gas can be used in a number of ways:

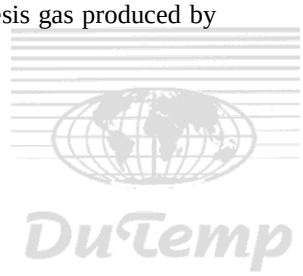
8. Immediately as a fuel in a combustion turbine;
9. as a chemical intermediate in a chemical manufacturing process; or
10. Stored for product use later.

In contrast, thermal treatment devices (e.g., incinerators and industrial furnaces) are designed to release combustion off-gases to the environment as a consequence of normal operation. The resultant gases, which are primarily carbon dioxide and water, are rarely used in a manner similar to that of the gasification system.

However, we note that certain types of industrial furnaces are designed to treat hazardous waste and extract sulfur compounds or halogen acids from the effluent gas stream prior to release to the atmosphere. These systems are generally operated to release the gases directly to the atmosphere after the desired compounds are extracted from the combustion off-gas.

Gasification system means an enclosed thermal device and associated gas cleaning system or systems that does not meet the definition of an incinerator or industrial furnace (found at Secs. 260.10), and that:

(2) Limits oxygen concentrations in the enclosed thermal device to prevent the full oxidization of thermally disassociated gaseous compounds;
(3) Utilizes a gas cleanup system or systems designed to remove contaminants from the partially oxidized gas that do not contribute to its fuel value;
(4) Slags inorganic feed materials at temperatures above 2000; deg. F;
(5) Produces a synthesis gas; and
(6) Is equipped with monitoring devices that ensure the quality of the synthesis gas produced by the gasification system.



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Plasma Installations

There are only a limited number of actual plasma installations that are not directly related to the steel industry. The most important are:

International:

France:

- Bordeaux: Ash Vitrification at the Bordeaux MSW Incinerator plant
- Electricite de France: Asbestos destruction – 2 ea. 55 gal drums at a time.

Switzerland:

- Muttenz / MGC-Plasma AG (Plasmox) hazardous waste destruction.
- Zwilag / MGC-Plasma AG (Plasmarc) Radioactive waste

Germany:

- Munster / Plasmox - Chemical warfare agents destruction.

Italy:

- Milano / Plasma arc Unit operated for about 9 months with ASR. Unit dismantled in 1998 due to site problems.

Korea:

- Seoul / Jinro Plasma: Demo unit never used as main company Jinro Steel was one of the earliest bankrupsies in Korea
- Taejon / KAERI (Korea Atomic Energy Research Institute) / Hanjung / MeltTran (USA) Radwaste destruction unit

Japan:

- Westinghouse/Hitachi: Pilot plant and 200 tons/day plant. Rely on plasma torch assisted cupula. Uses about 10% by wt of coke.
- Several ash Vitrification plants (small units)

Australia:

- There is a local company that has installed some units for testing and for the destruction of chlorinated hydrocarbons – mainly PCB.

South Africa:

- MINTEK: recovers metals and manufactures ferroallys.

Russia:

- IPE-RAS: Has several test reactors on site and has built medical waste plant for LLNL.

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Taiwan:

- PEAT facility for liquid solvents and PCB destruction. Converted plant from the SUI USCS system. Uses Russian AC torch.
- Taipei: C&S Small plasma system Uses Russian AC torch.

U.S.

Department of Defense:

- PEPS I – 500 kW stationary unit built for U.S. Army CERL. Unit was permitted for tests in Virginia. Unit currently at GaTech (GTRI) facility in Atlanta. (Dobbins AFB).
- PEPS II – 500 kW mobile unit built for U.S. Army CERL. Unit being moved to Lockheed Martin plant in Marietta, GA (Dobbins AFB). Operation will be supervised by GTRI
- MSE – Mobile plasma unit – 500 kW
- MSE – Pit 9 radwaste remediation with Lockheed Martin (Retech)
- MSE – PODS unit / ARDEC – Hawthorne Ammo Depot, NV. Ordnance destruction.
- Norfolk, VA – PAHWTS – NRL with Retech unit. Used PACT 8 Unit built and not installed. Being given away by NRL.
- NRL – PAWDS – on board aircraft carrier plasma arc shipboard waste destruction system. Prototype built by Pyrogenesis in Canada.
- USAF – GTRI supplied test unit at Tindell AFB. Using Russian AC torch.
- Strategic Asbestos Stockpile destruction: 750 kW unit was used to destroy stockpiled asbestos. Plant was decommissioned after completion of work.
- Aberdeen Proving Grounds: Chem demil dunnage destruction. Test was a failure due to improper system operation and wrong design for chem. de-mil.
- PET: This Company has build a chem. de-mil unit tested by the US Army at the EPA labs in Raleigh, NC. (They generated the data used by others to show chem. de-mil destruction rates). May be building a hazwaste facility in either Maine or Canada.

Others:

- USCS : Contraband destruction unit ; mainly marijuana, cocaine and Freon. Unit built and successfully tested. Project dropped. Unit converted to liquid PCB contaminated solvent destruction and installed in Kaohsiung, Taiwan.
- ITE. This company has several units installed. One with ATG for radwaste has been idled as ATG bankrupted. ITE has a 5 ton/day unit operating in Hawaii for medical waste and has sold a unit to Japan. Units rely on dual power supplies.

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Typical Plan to Advance and Complete Plasma Gasification Projects

The plan should be phased with key decision milestones. Steps should include:

Phase 1 - Develop a Detailed Conceptual Plan.
The plan will consist of an Economic Feasibility Study and Site Selection Study that will include

- Marketing Analysis and Evaluation
- Supply Logistics and Transportation Study
- Configuration Evaluation
- Site Selection Study
- Feasibility-Study Level Project Cost Analysis
- Environmental Assessment
- Preliminary Refinery Organization and Operating Programs Plan and Strategy
- Define Management Structure to Implement the Construction Project

This phase will probably be divided in to several sub-phases such as initial scoping to validate this proposal then detailed proposal development to proceed with phase 2.
Decision Deliverable is the Economic Feasibility of Project, Alternatives and Other Business Issues

Phase 2 - Develop Funding/Financing Commitment based on Project Cost Analysis
Decision Deliverable is funding to continue project development.

Phase 3 - Develop Engineering Design Basis for Bidding to Target Engineering/Construction Companies.
Decision Deliverable is developing design parameters and developing the bid package. The detailed Design Basis Memorandum (DBM) will be the core information with which to bid the engineering and construction.

Phase 4a - Develop Detailed Engineering Design Basis.
Decision Deliverable is a detailed engineering package developed by the engineering contractor for construction.

Phase 4b - Develop Detailed Plasma Gasification Plant Organization Start up and Operational Plan

- Management Team Development
- Start up and Commissioning Team Development
- Operating Maintenance Staff Team Development and Training
- Support Engineering and Administrative Team Development and Training
- Supply, Coordination, Marketing and Business Team Development and Training
- Computerized Engineering, Operations and Administrative Tool Selection, Installation and Training

Decision Deliverable is a complete operating organization plan with the necessary training and advanced tools to create a world-class pacesetter, efficient refinery.

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Phase 5 - Bid the Construction, Start-up and Commissioning of the project

Phase 6 - Operate the Plasma Gasification Plant

Phases 1, 3 and 4b scopes are expanded in the attached.

Phase 1 - Develop a Detailed Conceptual Plan.

The plan will consist of an Economic Feasibility Study and Site Selection Study that will include:

Marketing Analysis and Evaluation for both the material to be gasified and the selection and uses of gas and other by-products.

Market Analysis:

- Overall Market Trends and Opportunities
- Competitors in the Market for raw material and end products
- Possible Markets
- Identify Target Market Customers and any special relationships that currently exist
- Price forecasting
- Assessments future competitive posture of plasma plant and system

Supply Logistics and Transportation Study

- Transportation and Receiving Analysis
- Waste product storage issues.
- Waste storage layouts and reactor feeding issues
- Alternatives, Advantages/Disadvantages

Finish product selection for market

- Syngas
- Electricity
- MLiquid Fuels
- Hydrogen
- Rock Wool
- Aggregate
- Other
- Alternatives, Advantages/Disadvantages
- Middle Distillates

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Configuration Evaluation

- Evaluation of processing options
- Evaluation of energy mass balances for different end products.
- Alternative processing schemes to meet specific raw material, product specification, product slate, or investment objectives.
- Validate the plant size as proposed.
- Review options of staged construction in smaller increments based on market opportunities.
- Develop strategic and capital expenditure and working capital plans.
- Summarize alternatives studied
- Major equipment studies
- Preliminary layout studies
- Feed and product yield studies

Site Selection Study

- Address special issues such as environmental, port facilities, market opportunities, labour supply, materials supplies, flooding potential, water and utilities availability, access to ports, practical access for large shipping activities to determine fitness of site and effects on neighbourhood.
- Define Advantages and Disadvantages
- Tax advantages and special tax benefits

Feasibility-Study Level Project Cost Analysis and Budget Development

- Develop a Feasibility Study level Budget based on proposed configuration
- Develop Preliminary project schedule

Environmental Assessment and Issues Development:

- Environmental impact studies
- Air Issues
- Water Issues
- Wet Lands Issues
- Fresh Water availability and quality
- Other special and restrictive environmental guidelines
- Special interest, advocacy group and political issues
- Other Good Neighbors issues

Preliminary Organization and Operating Programs Plan and Strategy

- Define Management Structure to implement the Construction Project
- Project Development Organizational Issues
- Resources
- Project Development Management and Status
- Investor Management Participation - contribution of management and consultants to development of project from concept to operations.
- Company Management Team Development
- Venture Partners
- Consultants
- Major Engineering and constructions firms
- Preliminary Plant Organization Plan - First Pass Organization and functionality including pace setter manning definitions and matrix management functions
- Define Special programs to achieve maximum operating productivity.
- Energy Conservation Planning
- Mechanical Reliability Planning including Risk Based Assessments

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- Advanced Computer Controls
- Maintenance Management Programs
- Business Analysis and Product Coordination

Phase 3 - Develop Engineering Design Basis for Bidding to Interested Engineering/Construction Companies

Design Basis Development

- Develop Processing Concept Plan
- Profit Margin Analysis and Economics
- Detailed environmental Plan and Considerations
- Develop Detailed Project Data as a design basis
- Feedstock's, end-products
- Utilities, catalysts, chemicals consumables
- Operating reliability and flexibility
- Handling and storage facilities
- Delivery and shipping logistics
- Spare equipment and parts
- Maintenance and operations strategies
- Safety requirements
- Economics for evaluation and alternatives
- Energy conservation and cost criteria
- Equipment design philosophy
- Philosophy for isolation and decontamination
- Block and Bypass philosophy
- Environmental requirements and considerations
- Electrical instrumentation and design.
- Computer control philosophy
- Philosophy for buildings, shelters and enclosures
- Communication requirements
- Property protection and industrial hygiene
- Equipment spacing and plant layout

Define Special Programs

1. Energy Conservation Planning
2. Mechanical Reliability Planning including Risk Based Assessments
3. Environmental Assessments

Present and Future Product Quality Issues and Anticipated Changes in Specifications

Phase 4b - Develop Detailed Organization Start up and Operational Plan
For Transition from Construction through Start up to Operations
The following lists a number (but not all) critical functions/activities to accomplish.

Management Team Development

- Develop Operations/Maintenance Organization Plans
- Overall Management Team
- Plant Manager and Senior Managers
-

Construction, Start up and Commissioning Team Development

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- Develop internal staff or contract to company or individuals
- Project Executive role
- Engineering Manager and staff
- Construction Manager and staff
- QA/QC
- Commissioning Team
- Start up Team
- Operations Management Structure
- Build transitional Start up team
- Start up Executive role
- Operations Staff hiring and training.
- Maintenance and Operations Training
- Process Safety Management Team and Process Safety Program Development
- Operating Practices and Procedure writing team
- Maintenance Staff, hiring and training

Construction

- Develop Construction Project Execution Plan (PEP)
- Project resources (technical support, operations personnel, vendors)
- Project organization/organization interfaces
- Unusual project features (new technology, revamp, specialized equipment or materials)
- Timing of estimate preparation, project approval
- Preliminary contract strategy (lump sum vs. cost plus)
- Engineering strategy (in-house/local engineering/outside engineering with particular know-how)
- Purchasing strategy (in-house/by outside engineering/lead time)
- Field construction (construction packages, shop vs. field fabrication, labour relations)
- Develop Detailed Engineering - develop strategy to engineer and design, fabrication and construct plasma facility. Determine correct resources for project.
- Functions
- Project Planning and controls
- Detailed Process, Civil and Mechanical Engineering Design and Procurement
- Shop and Offsite Fabrication
- Construction
- Quality Control

Contracting Choices

- Firm types
- Negotiated Bid
- Constructability Reviews,
- Operability Reviews
- Claim Evaluation & Preparation, Litigation Support/Expert Testimony
- Estimating & Bidding Practices

Pre Startup/Startup/Commissioning

- Develop start up and commissioning Plan
- Pre-Start up Audits for Start up Status Prior to Commissioning of Major New Facilities.
- Turnover Sequence
- Pre-Commissioning Equipment Protection,
- Commissioning Procedures,
- Construction/Commissioning Interface
- Punch Listing

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- Commissioning/Start up Planning & Scheduling
- Commissioning Quality Assurance
- Start up Progress Evaluation
- Simulated Operations
- Total Systems Readiness Review
- Start-up and Operating Procedure Writing
- Productivity Evaluations

Other Staff Functions with Critical Assignments

Operations Staff Team Development and Training
Maintenance Staff Team Development and Training

- **Routine and Turnaround Planning & Scheduling,**
- Turnaround Procurement/Materials Management,
- Maintenance Writing Project Execution Plans,
- Turnaround and Construction Management, Budgeting Cost Estimating, and Control,
- Turnaround Manual Development,
- Claims Management,
- Claims, Assistance, Claims Prevention/Avoidance/Mitigation,
- Waste Loss Related Maintenance and Training Procedures,

Engineering Support and Administrative Team Development and Training
Process Engineering/ Operations Contact Engineering

- HAZOP
- Management of Change

Mechanical Technical Contact Engineering

Facilities and Project Engineering

- Proposal and Bid Review Preparation, Bid Review, Selection and Contract Award
- Contract Administration
- Post Project Audits
- Resourcing Reviews

Process Computer Technical Support Engineering
Environmental Engineering Team

- Environmental Regulation and Compliance Support
- Legal and environmental technical specialists.
- Negotiations with federal, state, and local environmental authorities regarding compliance issues.

Supply, Coordination, Marketing and Business Support Team Development and Training

- Business Analysis and Supply/Product Yields
- Economic Analysis and Coordination

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Administrative Support

- Finance and Accounting
- Public Relations
- Employee/Human Resources Relations
- Offices Services
- Medical Services
- Waste Loss Control and Identification/Custody Transfer

Traffic and Shipping
Purchasing and Stores

- Contracting Manuals,
- Contracting Planning
- Bidder Prequalification & Invitation for Proposals

Mechanical Reliability

1. Equipment Inspection and Machinery Reliability
2. Reliability Management Implementation,
3. Maintenance Program Development using Reliability-Centered Maintenance (RCM),
4. Root Cause Failure Analysis (RCFA) Training and Support,
5. Predictive Maintenance Program Development & Implementation,
6. Reliability Modeling,
7. Reliability Program Development & Implementation,
8. Training on Reliability Technology,

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Health, Safety and Human Resources

1. Health Monitoring Programs
2. Hazard Awareness Education
3. Permitting Control Systems
4. Safety Facilities,
5. Benefits Programs Development
6. Safety Evaluations and Audits
7. Access controls & perimeter security (Internal and external security)

Computerized Engineering, Operations and Administrative Tool Selection, Installation and Training

- Computer model for automated plant operation and closed loop feedback for process control.
- System for detailed daily scheduling of plant operations
- Linear programming application to optimize product blending
- System for tracking, reporting and projecting compliance with EPA regulations
- Laboratory information management system specifically modified for plasma or chemical production sites to predict process output with changing feedstock's

1. Project Control and Information management Systems,
2. Turnaround and Construction Database Development/Management,
   - Portable Data Collectors & Integrated Data Base Software for Managing Operator Rounds,
   - Computerized Maintenance Management System (CMMS) Strategy and Implementation,
   - Training Records Systems

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