

REPORT

FACTORS INFLUENCING SPSA'S WTE SYSTEM



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Executive Summary

HDR Engineering, Inc. has been requested to provide an opinion regarding factors which could influence the economic viability of SPSA's WTE system. The key factors to be addressed include environmental regulatory impacts, major equipment repairs and replacements, energy market factors, and new technology impacts. The intent is to provide an opinion on the "macro" factors that may come into play in the foreseeable future based on HDR's experience, general knowledge of the age and condition of equipment at SPSA and of comparable facilities. These factors include environmental regulations, plant equipment, facility infrastructure, energy markets, and new disposal technologies.

Environmental Regulations

The WTE industry has completed major upgrades and modifications of existing facilities in response to the Federal Clean Air Act Provisions. These requirements have required "Maximum Available Control Technology" application to existing large WTE facilities, including SPSA's Steam Plant. The impact of these regulations was severe, requiring major modifications and retrofits. With continued emphasis on global warming, ozone depletion, fine particulates, smog and haze, mercury emissions, etc., there remains a fair amount of long term uncertainty as to whether additional control mechanisms may be required. We foresee a relatively stable scenario regarding additional regulatory burdens on the WTE industry over the next five years. Beyond the next five years, we could foresee the potential for the next round of "maximum achievable" ratcheting down of some air emissions concentrating on nitrogen oxides (NO_x) and fine particulate matter controls.

Steam Plant and RDF Plant Equipment

Aging of equipment and systems is a problem that many of the earlier vintage (1980 to 1990) WTE facilities have to deal with. Good maintenance programs and sound operating practices can extend the overall life of a WTE system indefinitely. However, this requires a continuing program to upgrade and replace systems and equipment that is worn out, and no longer capable of providing reliable service. The following systems represent the key elements of the WTE facility (RDF Plant and Steam Power Plant) that may require repair/replacement in the mid-term due to obsolescence and normal wear and tear:

- Power Plant Electrical Systems
- Rotating Equipment
- Refuse Cranes
- Turbine Generators

- Boiler Tubes
- RDF Processing Equipment
- Ash Management System
- Cooling Tower

Additionally, the facility infrastructure, such as roads, building roofs, tipping floor surfaces and building exteriors require general maintenance and upkeep.

In terms of a general overview, SPSA's existing capital budget program appears to address the major requirements adequately.

Energy Markets

As everyone certainly knows, energy prices have risen considerably over the past year. Oil prices have rocketed to the mid \$40 per barrel range, however, it is anticipated that the long term trend would be to stabilize in the mid to upper \$30 per barrel range. The same situation prevails for natural gas, with increased demand for this "cleaner" fuel, along with higher costs for drilling ever deeper wells, and additional environmental controls on exploration activities. Coal is likely to continue to increase in price, although with less volatility than either gas or oil, as older supply contracts expire and newer contracts reflect the elasticity associated with increased costs of oil or gas competition. In short, all of the long term projections for energy pricing are on an upward trend worldwide.

There is a direct correlation between energy raw material pricing (coal, oil and gas) and electricity pricing, leading to the conclusion that electricity wholesale and retail pricing is also likely to rise. As with other forms of energy, efficiency increases, as well as conservation will help temper price increases. The cost of electricity will also be further escalated by environmental control requirements, particularly applicable to coal fired power generation, which provides over 50% of our national electrical supply.

SPSA has already made the investment in environmental controls at the power plant. However, the electric utility industry is still making those investments, and will continue to do so over the next several years. Electricity pricing should escalate over the next several years, reflecting the combined impacts of higher fuel costs, and increased environmental controls. This should result in an overall benefit to SPSA as an exporter of electrical energy.

SPSA should also continue to explore opportunities to increase revenues for excess energy available at the power plant (beyond that required to meet Navy contract steam requirements). The potential exists for higher value than that currently received on the wholesale electricity marketplace for steam or chilled water sales, or for premium pricing for electricity derived from renewable sources.

New Disposal Technologies

Although there has been intensive research and development in new disposal technologies in the recent past, the use of conventional mass burn WTE combustion with energy recovery remains the dominant technology. While several emerging technologies offer promise of lower overall emissions, none are considered commercially proven, and they currently are more costly than the conventional alternatives. The most promising is waste gasification, which is described briefly in the report to follow.

Worldwide, the use of RDF processes continues to lag those of mass burn combustion, with virtually no new RDF construction planned. The result is likely to be less vendor development of improvements and replacements owing to the low market share for the RDF preparation and combustion technologies.

Introduction

HDR Engineering, Inc. has been requested to provide an opinion regarding factors which could influence the economic viability of the WTE system. The key factors to be addressed include environmental regulatory impacts, major equipment repairs and replacements, energy market factors, and new technology impacts. It is not the intent to provide a review or analyses of SPSA's budget projections on a detailed level, or to perform inspections of equipment, systems or facilities in order to provide this opinion. Rather, based on HDR's experience, general knowledge of the age and condition of equipment at SPSA and of comparable facilities, to render an opinion on the "macro" factors that may come into play in the foreseeable future.

Environmental Regulations

In a general sense, the WTE industry has completed, circa 2000, major upgrades and modifications of existing facilities in response to the Federal Clean Air Act Provisions. These requirements have required "Maximum Available Control Technology" application to existing large WTE facilities, including SPSA's Steam Plant. The impact of these regulations was severe, requiring the Facility to retrofit scrubbers, baghouses, and continuous emissions monitoring systems. In addition, in order to address carbon monoxide emissions requirements, the Facility also upgraded and substantially modified fuel feed systems and combustion controls.

Given the on-going worldwide and national concerns regarding global warming, ozone depletion, fine particulates, smog and haze, mercury emissions, etc., there remains a fair amount of long term uncertainty as to whether additional control mechanisms may be required. For WTE facilities, a stable period of 5 years or so (i.e., until the 2010 time frame) is expected, given the major impacts from environmental retrofits completed at great expense about 5 years ago, and the political and economic climate associated with the recent presidential elections. After that time frame, we could foresee the potential for the next round of "maximum achievable" ratcheting down of some air emissions. Recognizing that no one can foresee the future with certainty, our best estimate is that the following impacts may be logical:

1. Oxides of Nitrogen (NO_x). NO_x emissions derive from the release of fuel bound nitrogen, along with thermal effects, during the combustion process. NO_x in the atmosphere is considered to be a greenhouse gas, and contributor to global warming. It is also associated with smog formation. Existing NO_x requirements are routinely being met at SPSA without special control mechanisms. For planning purposes, we would expect that SPSA will have to implement a Selective Noncatalytic Control System (SNCR) circa 2010. By that time, other, perhaps more cost effective technologies may be available. SNCR control technology involves the injection of an ammonia based reagent into the furnace to convert nitrous oxides to elemental nitrogen and water.

Typical implementation costs are on the order of \$1million, with on-going costs of less than \$1 per ton of waste processed for reagents.

2. Fine Particulate Controls may also be part of the next round of environmental ratcheting down. Sometimes referred to as “PM10” which is an acronym for particulate matter less than 10 microns in diameter, PM10 is best controlled currently by baghouses, a technology already employed at SPSA. For planning purposes, we would foresee potential tightening of particulate limits resulting in the need to use more sophisticated fabric filter materials than is currently the case. This would represent more of a slightly increased operating expense than a major capital project.

Steam Plant and RDF Plant Equipment

Aging of equipment and systems is a problem that many of the earlier vintage (1980 to 1990) WTE facilities have to deal with. It is axiomatic that wear, tear, corrosion, and other environmental and operating factors take a tremendous toll on power plant equipment, and WTE systems in particular. Given good maintenance programs, and sound operating practices, the overall life of a WTE system can be extended indefinitely. However, this requires a continuing program to upgrade and replace systems and equipment that is worn out, and no longer capable of providing reliable service. The best example of this is the nation’s coal fired power plant fleet. The combination of conservative design, good operating and maintenance practices, and timely equipment renewal has enabled many facilities to far surpass their original design life, generally 30 years. It is not uncommon for utility coal fired power plants build in the 1950 and 1960’s to still be on line today, providing reliable power to the grid. Along the way, several rounds of equipment replacement and upgrades have taken place to enable this to be the case.

The discussion that follows is broken down into various systems that make up the key elements of the WTE facility (collectively the RDF plant and the Steam Power Plant).

1. Power Plant Electrical Systems. The electrical systems in the power plant are comprised of a complex system of major feeders (buses), and equipment that distribute power to pumps, fans, conveyors, refuse cranes, lights, HVAC systems, instrumentation and controls, etc. The electrical systems themselves consist of metal buswork, copper cables, motor control centers, switchgear, transformers, protective relays and controls, etc. Most of this equipment is robust, and suitable for long life. However, a portion of the equipment is subject to obsolescence, primarily the ability to obtain spare parts and replacements from the original equipment manufacturers and third party suppliers that service the industry. Many of the original manufacturer’s (OEM’s) no longer support the equipment they once sold. In other cases, the OEM’s may have gone out of business, or been absorbed by mergers, etc. These factors, along with advances in technology, materials and especially electronics over the past 20-30 years, renders an increasing amount of

electrical equipment obsolete. Over the course of the next 10 years or so, these factors may lead to the need to replace relays and controls, motor controllers, and many types of instrumentation and control systems and monitoring systems used throughout the plant. In general, these replacements can be programmed ahead of time, and investments spread out over several years to minimize financial impacts. A conservative guess would be to budget \$200,000 per year in electrical and instrumentation and control system replacements going forward.

2. Rotating Equipment. Within the broad category of rotating equipment are the dozens of motor driven components at the Facility. Electrical motors used in a power plant environment are typically in service around the clock for extended periods of time. As a very general rule, the life span of equipment that is not in a special environment, which includes nearly all of the outdoor and indoor motors at the facility, can be expect to fail and require replacement or extensive refurbishment within a 6 to 10 year life span. Long term budget projections should reflect this on-going expense.
3. Refuse Cranes. The refuse cranes at the steam plant are subjected to a dusty, dirty environment within the refuse pit environment, along with impact loads, and normal wear and tear. Eventually, the crane trolleys will require replacement in order to continue to be serviceable. Although the plant currently maintains this equipment, and replaces components as needed, there will likely come a time when this is no longer practical. Accordingly, we would recommend that an escrow fund leading to eventual replacement of the crane systems (trolleys, grapples, cables and festoons, rails, controls) be contemplated in the 2010 time frame.
4. Turbine Generators. The heart of the power production facility, the turbine-generators, is a very robust design which is capable of many years of reliable service. Eventually, there are two generic aspects of turbines that will likely require major modifications. In the high pressure end of the turbine, the rotating blades and stationary diaphragms become subject to cracking, fatigue, or are generally “roughed up” to the point that the efficiency of the machine is impaired. The low pressure end of the machines suffer similar concerns, with the added contribution of water erosion as the saturated steam water droplets impinge on blades and diaphragms. We would expect the cumulative effects of these and other factors to require major refurbishments some time around 20 plus years of operation, which is only a few years hence. It would be prudent to budget for major repairs at the major inspection intervals henceforth. Major repairs would be expected to cost approximately 2 to 3 times the normal major inspection costs.
5. Water Treatment Equipment. A major component of the water treatment equipment used for purifying boiler water is the mixed bed demineralizers.

They will eventually require replacement, estimated at or near the 20 year mark. Replacement costs should be budgeted accordingly.

6. **Boiler Tubes.** The boiler tubes are especially vulnerable to high wear, given the aggressive chemistry and high temperatures present in some parts of the boilers. The state of the art in boiler tube protection for such areas is inconel overlay, an expensive, but effective material overlaid onto the fire side surface of the tubes. SPSA has applied this technology in the past to selected areas of the furnaces, generating banks, and superheater areas. The tube life of such protected areas has been 2 to 3 times the life expectancy of unprotected tubes. However, the protection of inconel will eventually require renewal, with an expectation that all areas originally overlaid with “field applied” inconel will wear out over the next 5 years or so. An organized program to regularly measure tube wastage rates, and plan for replacement on a rotating boiler basis is recommended. It appears as if this area is being addressed in the plant budgeting process annually.
7. **RDF Plant Equipment.** The RDF plant processing equipment is a very demanding environment with extensive wear and tear on all of the moving parts. This includes the trommels, conveyors, shredders, magnets, and dust removal equipment. It appears that all of this equipment is being maintained regularly, rebuilt and/or upgraded as needed.
8. **RDF Plant Control Systems.** The RDF plant controls are primarily Programmable Logic Controller (PLC) based controls, with a mimic/control panel operator interface. The equipment and software is 1980’s vintage, and will likely suffer obsolescence in the next few years. The plant budgets identify a line item for this replacement, which seems reasonable and necessary.
9. **Ash Management System.** Conceptual plans have been developed for the incorporation of an ash management building. This would assist in load-out operations and provide added containment and control.
10. **Cooling Tower.** The Steam Plant has the ability to generate up to 60 MW, but is limited by cooling capacity to a maximum of 52 MW. A recent performance study result indicated that the addition of a new cooling tower cell is required to improve power generation.

Steam Plant and RDF Plant Infrastructure

Throughout the remaining the remaining life and use of the facilities, there are several areas of general maintenance and upkeep that should continually evaluated on an annual basis, and included in the general operating budget. These include roadway maintenance and paving, roof repair/replacement and siding replacement.

Consideration should also be given to power washing/cleaning the exterior of the entire RDF Facility. The appearance of this facility is certainly degraded, and the process would identify any repairs or resurfacing required for life extension.

In addition to the above, replacement of the RDF tipping floor should be capitalized over the next five years, for installation in 2010.

Energy Markets

As everyone who puts gas in a car has surely noted, energy prices are up considerably over the past year. The major long term trend is for oil prices to fall somewhat from their current levels in the mid \$40 per barrel range, and stabilize in the mid to high \$30 range in the short term. Increased worldwide demand (with significant increases in India and China), coupled with higher development costs for new sources appear to make this a long term trend. In a general sense, the same situation prevails for natural gas, with increased demand for this “cleaner” fuel, along with higher costs for drilling ever deeper wells, and additional environmental controls. And finally, coal, our most abundant fuel source, is likely to continue to increase in price, although with less volatility than either gas or oil, as older supply contracts expire and newer contracts reflect the elasticity associated with increased costs of oil or gas competition. In short, all of the long term projections for energy pricing are on an upward trend worldwide. The US is expected to import ever increasing quantities of oil to meet domestic demand in the face of declining production and reserves.

As in the past, increasing prices will be somewhat tempered by slowing demand, to the extent that conservation takes hold. Projections are for sales of “hybrid” gas/electric vehicles to increase dramatically over the next few years, for example. However, barring even larger price increases than we have seen in the recent past, we do not expect that either additional conservation, or higher efficiency vehicles and appliances will be sufficient to reverse the upward trends of pricing. The simple fact is we have increasing demand, and decreasing supply, with the result of higher prices a foregone conclusion.

There is a direct correlation between energy raw material pricing (coal, oil and gas) and electricity pricing, leading to the conclusion that electricity wholesale and retail pricing is also likely to rise. As with other forms of energy, efficiency increases, as well as conservation will help temper price increases, but not eliminate them, again barring catastrophic events. The cost of electricity will also be further escalated by environmental control requirements, particularly applicable to coal fired power generation, which remains the fuel source for over 50% of our domestic electricity production. The costs associated with environmental controls for mercury, sulfur, and NO_x reductions will be factored in to overall electricity pricing. Another wild card is CO₂ and carbon reduction associated with global warming concerns, which will either reduce the mix of coal fired generation (and increase that from competing sources, especially natural gas, and to a lesser extent renewables), or further increase the costs of electricity from coal.

It is of some comfort to SPSA that the investment in environmental controls at the power plant has already been made, and is being amortized. The coal fired power industry is still making those investments, and will continue to do so over the next several years as new rules kick in on the state level (i.e., North and South Carolina), or on the federal level (i.e., the Clear Skies initiative). In any case, a slow, but real increase in electricity pricing over the next several years is expected to take place. This can be of ultimate benefit to SPSA as an exporter of electrical energy.

There is a significant amount of interest within the WTE industry regarding the granting of some form of credit or subsidy for electricity generated from renewable sources, which includes solar, wind, biomass and landfill gas, and MSW combustion. Indeed, many electric utilities offer premium retail pricing for “green power” derived from renewable sources. Unfortunately, there is no consensus regarding the treatment of MSW as renewable, and this is the subject of intense opposition from various environmental groups and political interests, who basically oppose any incentives for MSW combustion. The controversy surrounding this issue makes it no better than an even chance, in our opinion, that meaningful subsidy for WTE will be forthcoming.

New Disposal Technologies

Over the past few years, a relatively new technology has evolved into a promising alternative for waste minimization and disposal. This technology is characterized as waste gasification. The technology is based primarily on three core processes: preprocessing, gasification, and energy generation.

MSW may be mechanically separated to recover steel, aluminum, and plastics for recycling. This material is sometimes autoclaved as a means of sterilization prior to processing. A homogeneous feedstock is produced from the residual organic matter and undergoes further processing to remove glass and grit.

However, gasification of MSW does not require separation of recyclable materials, though the operation efficiency will not be as great due to the less homogenous nature of unsorted MSW. The process involves first a degasification and compaction of the MSW, which results in a charcoal-like product. This is then passed into a high temperature reactor with controlled exposure to oxygen. At the high temperatures involved, part of the MSW simply vaporizes into gas, which is collected and processed to produce a synthesis gas, part is melted into its metallic components, and part falls out as mineral slag. The basis of this process is environmentally sound and considered an alternative to waste combustion or other forms of incineration. The only combustion involved in this process is combustion of the natural gas required to heat the high temperature reactor to the proper temperatures for pyrolytic reaction to take place.

Some by-products produced by this method include synthesis gas for direct energy production or as feedstock for production of chemical products such as hydrogen,

hydrocarbons, ammonia, and alcohols; pure water for internal plant requirements; mineral substances for use in the construction industry; metals; mixed salt for the production of caustic soda; zinc concentrate for the recovery of zinc and lead; and sulphur for the production of sulphuric acid. These by-products will necessarily vary in proportion due to the varying nature of the MSW feedstock.

Some 20 percent of the waste stream can be recovered for recycling and reuse, while 70 percent is converted into renewable energy and potentially other uses. A maximum of 10 percent will require landfill disposal at this stage; however, some technology vendors claim zero percent disposal requirements.

Technical Feasibility

At least two international companies have developed high-temperature processes based on gasification/pyrolytic conversion of waste to energy. While this is an interesting concept, no commercial facilities exist in the United States; however, there are several facilities in Europe and the Far East. These facilities do not have long-standing operating track records, with the longest being approximately two years. This fact is a concern when evaluating a long-term solution for waste disposal.

All of these types of technologies involve energy intensive processes, which obviously impact the overall operating costs for the facility. Additionally, the capital investment required for development on this type of facility is higher than traditional waste-to-energy combustion options, making the energy sales agreement critical to the overall feasibility of this technology.

Summary

Environmental regulations impacting the waste-to-energy industry have resulted in significant facility modifications and monetary impacts. It is anticipated that future legislation will concentrate on controlling nitrogen oxides and fine particulate matter. To carry WTE through the next decade and beyond, continued investment in the following elements may be required:

- Power Plant Electrical Systems
- Rotating Equipment
- Refuse Cranes
- Turbine Generators
- Boiler Tubes
- RDF Processing Equipment
- Ash Management System
- Cooling Tower

The trend for the cost of domestic electricity is on the rise. This is direct result of a decrease in supply and an increase in demand, and further escalation due to

environmental requirements. It may be advantageous for SPSA to evaluate improving electricity generating capability and search for potential hosts to impact overall facility revenues. New disposal technology is emerging, however, the feasibility for implementation can be prohibitive without significant energy sales agreements.