Abstract

This paper provides an overview of the City of Tampa's 1,000-TPD, four-unit McKay Bay Facility which began operations as an incinerator in 1967; was upgraded to a waste-to-energy (WTE) facility (using waste heat boilers) in 1985; and then again retrofitted during a 33-month design, procurement, and construction period, from 1999 to 2001. As the selected project developer for this recent retrofit, Wheelabrator McKay Bay, Inc. (WMBI) chose to design new chute-to-stack units within the space constraints of the existing refuse feed chutes, ground floor slab and bottom ash conveyors. This paper identifies key plant statistics and describes the project scope, schedule, controls, and safety issues. Results of acceptance testing, including air emissions, are reviewed and compared against contractual and permit requirements. The unique challenges faced by the operations staff during the retrofit are discussed in detail. Several examples of "lessons learned" regarding design and operations are given.

History

In 1965, after a long and increasingly difficult history of small landfill operation, the City of Tampa built an incinerator at McKay Bay to provide for waste reduction. The incinerator, operated by City of Tampa staff, was closed in 1979 at the request of USEPA due to air emission violations. Waste disposal was then handled via contracts with Hillsborough County in permitted landfills.

In 1979, the State of Florida mandated that the 19 urbanized counties investigate the feasibility of resource recovery; recovering energy and/or materials from solid waste. After studying the many alternatives available, the City of Tampa ultimately chose to retrofit the existing incinerator for energy recovery with improved air emission controls. After a competitive process, the City chose Waste Management Energy Systems to accomplish the retrofit and operate the rebuilt plant for a 20-year period. This first facility retrofit commenced operating in 1985. Tampa Electric Company (TECO) was and is the energy market for the power produced via a 20-year contract with a possible mutually agreeable extension to the year 2022.

The 1992 Clean Air Act amendments and new knowledge regarding air emissions made it clear that the plant would need an upgrading sooner than the contract end point. Anticipating a significant cost for any change in disposal alternatives, as well as a costly shutdown and retrofit, the City authorized an engineering study to analyze the long-term costs of
possible alternatives which included: closing and demolishing the existing facility and landfilling; developing a new greenfield plant; and retrofitting the existing plant to meet the standards. For reasons of lower estimated lifetime costs, existing plant siting and retrofit permitting considerations, it was decided to retrofit the existing McKay Bay Facility at its nominal capacity of 1,000 TPD.

The City then initiated a survey of available technologies and vendors. After confirming industry interest in the project, a request for proposals was prepared with the cooperation and input of identified qualified firms.

A project library was established which included all contracts, design drawings from the Bechtel Corporation (1985 retrofit design engineer), and all pertinent correspondence regarding permits. The library was then made available during the time that proposals were prepared and clarifications issued to the approved vendors of record - Wheelabrator McKay Bay, Inc. (WMBI), Ogden Power Systems, and Lurgi gmbh of Germany.

Three contracts with one vendor were actually contemplated: the retrofit construction contract which would parallel in time the interim operations agreement, and the long-term operations and maintenance contract for the 20-year term after acceptance of the completed facility. Technical proposals were received and evaluated for compliance and technical conformance. An open period of questions and answers then took place to clarify technical, performance, and contract issues. All documents associated with these exchanges were issued to all participating vendors and made publicly available. After final approval and confirmation of any required changes, priced submittals were requested.

Evaluation and ranking of proposals were based on total net present value which was calculated to be $290.95 million; $301.10 million; and $348.94 million with capital costs for the retrofit at $87.65 million, $105.75 million, and $127.44 million by Wheelabrator, Ogden, and Lurgi respectively. The selected vendor was Wheelabrator McKay Bay, Incorporated (WMBI) with the low total cost proposal. The process to authorize construction was begun immediately.

Prior to the award, the City negotiated a Force Majeure agreement with TECO to permit the performance requirements to be set aside while interruptions in generation of electricity occurred. This resulted in a loss of revenue associated with payment by TECO to the City of Tampa for avoided cost for generating and operating capacity valued at approximately $250,000 per month for the estimated term of the outage. The Force Majeure outage was declared at the time the shut down and isolation occurred with the first half of the plant scheduled for demolition and wasn't cured until passage of acceptance testing at the end of the specified construction period.

Scope of Work and Project Schedule

The main components of the McKay Bay Retrofit Project were: 1) demolition and subsequent erection of four 250 TPD boiler/APC trains (see Figure 1 for a section through boiler and grate (feed chute through the spray dryer absorber or SDA)); 2) construction of an ash processing system with ferrous recovery and associated Ash Management Building; 3) major modifications to the existing tipping floor and refuse pit/charging floor areas; and 4) refurbishment of the Administration Building. Notice to proceed was issued to WMBI on April 1, 1999. Design, procurement, construction, startup, and testing occurred over the next 33 months. The facility was accepted by the City of Tampa on December 31, 2001.

The strategy for the reconstruction of the McKay Bay plant included keeping two of the four process trains "on line" while construction work was being performed on the other two units. The facility construction was done in three stages:

Stage 1 - April 1, 1999 to July 14, 1999. Perform all mechanical and electrical work to isolate existing boiler/APC trains and perform inspections and upgrades to the existing 23 MW T/G set and cooling tower.

Stage 2 - July 15, 1999 to November 5, 2000. Demolish Units 3 and 4 and construct two new process trains along with a new ash processing system and Ash Management Building; build a new concrete stack with four flues; upgrade the tipping floor area (new walls, roof, floor slab, and fire sprinkler system), and refuse pit/charging floor areas (concrete repairs and refuse crane upgrades).

At the end of Stage 2, a Demonstration Test was conducted on the new Units 3 and 4 prior to further project construction work. New federal air permit regulations required the new unit to be "on line" and the remaining two units be shut down by November 13, 2000. All components of the Stage 2 work were completed and testing performed within the scheduled timeframe.
Stage 3 - November 6, 2000 to December 31, 2001. Demolish Units 1 and 2 and construct two new process trains; complete repairs to the refuse pit/charging floor areas and refurbish the Administration Building; construct a Maintenance/Warehouse Building; and complete site paving, utilities, irrigation system, and landscaping.

Toward the end of Stage 3, a comprehensive Acceptance Test was performed on all four units. WMBI's Acceptance Test Report (along with the facility) was accepted by the City on December 31, 2001.

Project Controls and Safety

A retrofit project of this magnitude and lengthy implementation schedule involved many participants. In addition to the design and procurement firms and field construction manager and subcontractors, coordination with the facility operations staff was a key component to successfully complete the retrofit. The fact that the plant was processing refuse while construction was taking place in all areas of the site was a unique situation not encountered during standard waste-to-energy facility construction.
Control of the facility design, procurement, and construction was done via a detailed schedule using Primavera software. The schedule identified all of the key tasks to be performed from the Notice to Proceed through Facility Acceptance. Early and late start/finish dates, task durations, and total float were established for all work items. The master project schedule, updated monthly, contained 17 major milestone dates and included over 1,500 tasks. Monthly progress reports were developed by WMBI and issued to the City and their consultants. Also, monthly progress meetings were held on site, providing updates on project execution as well as allowing for discussion and resolution of both technical and contractual issues.

During project implementation, site safety was always the highest priority. The construction project management firm, Whiting-Turner, conducted weekly safety orientation meetings. All construction workers (over 1,600 personnel) were required to attend a meeting prior to working at the site. There were no lost-time accidents in over 100,000 construction mandays worked throughout the retrofit project.

**Acceptance Testing**

The Acceptance Test, performed for all four units over a 3-week period, required satisfying the following criteria:

1. **Reliability:** During a 14-day period, process refuse of at least 12,600 tons with no processing downtime caused by the furnace grate or heat recovery system. (At the City’s sole discretion, the City could accept up to 8 hours of total downtime, provided the throughput capacity was achieved during the test period.)

2. **Throughput Test Capacity:** During a 7-day period, process refuse of at least 7,000 tons total and 1,600 tons per combustion line.

3. **Net Electricity Generation:** Generate a net electrical output of at least 390 KWH/ton.

4. **Minimum Steam Production (or Evaporation Rate):** Produce at least 2.40 pounds of steam per pound of processible waste processed per combustion line. Steam at the turbine inlet to meet the conditions of 700 degrees F and 600 psig.

5. **Residue Quality:** Have a maximum unburned carbon content of 4.0% by dry weight as adjusted for the carbon injection system.

6. **Ferrous Recovery Efficiency:** Recover at least 80% of ferrous greater than 1 inch in diameter.

7. **Air Emissions:** Operate in full compliance with the requirements of the facility air permit, except for the fugitive emissions requirements.

8. **Wastewater Effluent:** Operate in full compliance with the requirements of the facility wastewater discharge permit.

Acceptance testing of the McKay Bay Facility occurred between 00 hours on October 11, 2001 and 2400 hours on October 31, 2001. During the 7-day throughput capacity test and 14-day reliability test, refuse feed to the four boilers was measured by the refuse crane load cells and recorded and summarized in the distributed control system (DCS) daily reports. The reference HHV of the processible waste was specified as 4,800 BTU/lb. Verification of the actual HHV of the processed waste, as well as the evaporation rate, was calculated for each boiler using boiler as a calorimeter (BAC) test methods.

Table 1 lists each test, the test standards, and the test results.

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<thead>
<tr>
<th>Test</th>
<th>Guarantee</th>
<th>Actual</th>
</tr>
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<tbody>
<tr>
<td>1. Reliability (2 Weeks)</td>
<td>12,600 Tons</td>
<td>14,057 Tons</td>
</tr>
<tr>
<td>2. Throughput Capacity (1 Week)</td>
<td>7,000 Tons Total 1,600 Tons Each Unit</td>
<td>7,247 Tons Total/1,812 Tons Each Unit</td>
</tr>
<tr>
<td>3. Net Electricity Generation</td>
<td>390 KWH/Ton</td>
<td>442 KWH/Ton</td>
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Table 1 - McKay Bay Acceptance Test Summary (con't.)

<table>
<thead>
<tr>
<th>Test</th>
<th>Guarantee</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Evaporation Rate</td>
<td>Min. 2.4 lb. Steam/ lb. Processible Waste</td>
<td>2.87 lb. Steam/ lb. Processible Waste</td>
</tr>
<tr>
<td>5. Residue Quality</td>
<td>Max. 4%</td>
<td>1.95%</td>
</tr>
<tr>
<td>6. Ferrous Recovery</td>
<td>Min. 80%</td>
<td>83.7%</td>
</tr>
<tr>
<td>7. Air Emissions</td>
<td>Full Compliance with Air Permit</td>
<td>Full Compliance</td>
</tr>
<tr>
<td>8. Wastewater Effluent</td>
<td>Full Compliance with Wastewater Discharge Permit</td>
<td>Full Compliance</td>
</tr>
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Some Lessons Learned During the Retrofit

In addition to the inherent difficulties associated with a major facility retrofit while in operations, other aspects of this project resulted in additional difficulties and costs throughout project implementation. Some key issues were:

1. Compliance with Project Documents
2. Unexpected Field Conditions
3. Design Enhancements

Compliance with Project Documents - The vast number of project documents and required level of specific detail led to a number of design omissions and revisions. WMBI was required to comply with all aspects of the Retrofit Agreement, the RFP, WMBI's proposal and subsequent clarifications, environmental permits, and in some cases, permit applications. For example, the Solid Waste Permit Application to the Florida DEP included details on a glass-lined wastewater storage tank and a special liner system for the sedimentation basin. These items were not included in the initial proposal, and design revisions were required to comply with these standards.

Unexpected Field Conditions - When the roof and walls were removed from the tipping floor (constructed in 1985), roof purlins, wall girts, and sprinkler piping were seriously deteriorated and required total replacement with galvanized structural steel members and piping. This change was necessary to ensure that these items would be functional throughout the 20-year operations contract (commenced on January 1, 2002).

Design Enhancements - There were several cases wherein WMBI elected to make modifications to the project during the detailed design phase. An example of this involves the revisions to the existing charging hoppers to allow smooth refuse feed from the hoppers, down through the feed chutes, and onto the grate ram feeder. The original design and revised design are shown in Figure 2.

On the left is the original design with an offset in the feed chute. This original design allowed use of the existing charging hopper location (both vertically and horizontally) with the proposed boiler/ash loadout configuration. By cutting out concrete and reconfiguring the feed chute (shown on the right), a true vertical orientation for feeding refuse was implemented, thus eliminating the potential for chute pluggage.

Operational Safety Considerations

The McKay Bay Retrofit Project posed a unique set of challenges for the operations staff. Safety was and continues to be the first priority. Operating staff meetings, held every morning, begin with safety compliance issues under the direction of the Environmental, Health and Safety Director. As of January, 2002, there were no lost-time accidents over a 2-1/2 year period. This was a major accomplishment in view of all the factors involved in this retrofit project. Certainly, it proves that safety can become automatic and systematic in the culture of the workplace. Constantly communicating the fact that safety is the first priority each and every day with every worker results in it becoming the norm.
Old vs. New Plant Operations

The facility's staff has been a fairly steady one without much turnover for many years. Much of the staff has been working at McKay Bay since the first retrofit in 1985. At that time, a furnace with rotary kiln and an attached waste heat recovery boiler with associated electrostatic precipitator for particulate removal were the makeup of the four lines. The control system was electro-pneumatic. During day-to-day operations, if opacity was within permit guidelines, i.e. below 15%, all was well, and the "turn and burn" philosophy would move forward.

The second retrofit project required meeting stringent new parameters that were part of the facility's air permit. The electrostatic precipitators were replaced by SDA's and fabric filters (FF's). Also, attached to the combustion trains were a selective non-catalytic reduction (SNCR) system for NOx removal and a powdered activated carbon (PAC) system for mercury control. These APC systems are monitored by a Bailey DCS as part of controlling all plant functions.

The challenge before the operating group was to learn and employ the new equipment to meet all permit obligations and operate the facility in a safe, environmentally compliant, and efficient manner.

Operators are now responsible for maintaining strict parameters for carbon monoxide, sulfur dioxide, nitrous oxide, outlet temperatures, and opacity. Air emission limits, in some cases due to contract requirements, were more stringent than the Clean Air Act Title V Permit and required the facility to meet New Source Performance Standards. An example of this being nitrous oxide, by permit being 180 ppm, but by contract being 150 ppm.

The cultural changes in managing day-to-day tasks with the retrofitted facility were significant and posed a training task second to none. No longer could we feed fuel in the "turn and burn" mentality and know that as long as opacity was within limits, everything was OK. Not only were we training a staff in the operation of new air pollution control equipment, but also new boilers and combustion systems with a computerized control system.

Key personnel within the group were assigned to rework the facility operating manuals and to interface directly with the construction group and vendors during the project. As the facility manuals were reworked, they were distributed to Operations Shift Supervisors and Control Room Operators who were required to take another A.S.M.E. site-specific examination for QRO certification, as the facility technology would be new. This was accomplished in November, 2001.
Vigilance with which the personnel operate the new units is critical. Because of the small size, 250 TPD, these units are very sensitive to changes in fuel moisture from grapple to grapple. After a long training period, the ability to operate these units watching fuel feed, grate speed, air profiles, and bed depths while maintaining steam setpoints and compliance parameters has become part of the culture of this operating group.

Operating the Ash Management System

The residue ash transfer system at McKay Bay was designed as an enclosed materials handling system that conveys bottom ash and flyash to an Ash Management Building. Bottom ash is collected on a vibrating conveyor. APC flyash is conveyed to a pugmill wherein water is added for conditioning and then discharged onto the vibrating conveyor where it mixes with the bottom ash. Large ferrous objects are removed by a "grizzly scalper". The combined ash stream is then conveyed along a belt with a walkway and enclosure up to the Ash Management Building. The incline of the belt conveyor is 13°, its length being 225 ft with a vertical rise of approximately 25 ft. The outfall at the head end of this conveyor is on an upper deck located in the Ash Management Building. The material drops off the belt where a spreader feeder sends the material under a drum magnet, wherein smaller ferrous material is removed. The ferrous coming off the drum magnet is deposited onto the ferrous pile. The remaining material drops down to a vibrating finger screen where the ferrous 1 in. or greater is captured. The ash residue that passes through the finger decks drops onto the belt conveyor where it mixes with the rest of the ash. The outfall of this conveyor is the ash load-out area within the Ash Management Building. The ferrous is trucked to a contracted metals recycler. The ash residue is trucked to the Hillsborough County Landfill, where it is used for daily cover. The City of Tampa is reviewing non-ferrous recovery for potential future installation.

Design Modifications in the Ash Handling System

The vibrating pan conveyors that move bottom ash that is expelled from the boiler ram ash expellers, were designed with a hood arrangement covering the conveyors. WMBI is currently in the process of a design modification to improve the atmosphere under these hoods. The buildup of heat and gases within this confined area has led to its being unacceptable for worker access unless a complete shutdown and air purge of the atmosphere under the hood takes place. The process modification will consist of a PVC pipe hung from the frame with a fresh air makeup damper valve and various intake ports positioned along the line run. A fan will exhaust collected gas to an existing wet scrubber located in the facility ash conditioning building.

Boiler Maintenance

The boilers at McKay Bay were designed in a five-pass arrangement with waterwalls in the first three passes, a primary superheater in the fourth pass, and secondary superheaters and economizers in the fifth pass. The furnace waterwall area was tiled 2/3 of the boiler sidewalls height with a patented Wheelabrator furnace tile and Inconel 625 overlay above the tile line in the furnace and on the first and second pass walls and roof.

WMBI has initiated a study in regards to fireside corrosion with these boilers. Besides installed soot blowers and rappers, on-line and off-line percussion blasting has been utilized to clear tube bank gas passes. This has been working well with units 3 and 4, as both units have 18 months of run time. U.T. profiles on tube surfaces have shown undetectable or negligible deterioration.

An added benefit with utilizing percussion blasting as a cleaning method is the ability to run the dry materials through the ash system. With traditional water washes, the cleanup is substantial in manhours and equipment. The cost, when cleanup time has been accounted for, has shown that there is an immediate economical benefit to this form of cleaning.

Summary

The timeframe for contractor selection, design, procurement, construction, startup, and testing of the 1,000 TPD McKay Bay Waste-to-Energy Facility has been lengthy, but in the year 2002, the facility commenced a 20-year operating phase. The level of difficulties experienced by all parties associated with the project during design, construction, and operation of the retrofit has been significant. However, this facility is successfully processing trash and generating electricity for the City of Tampa.