TECHNICAL AND REGULATORY CHALLENGES OF ACID GAS SCRUBBER RETROFITS

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ABSTRACT

In early 1991, a major retrofit of the 1500 TPD trash-to-energy facility in Saugus, Massachusetts was completed. In addition to an overall upgrade of the plant, the modifications included the addition of spray dryer/absorbers, baghouses, induced draft fans and a new stack. The project was designed to meet new stringent air pollution emission limits and was constructed to keep the change-over outage to less than three weeks. This paper reviews the major aspects of the project that made the Saugus RESCO facility the first major plant to be modified for acid gas control equipment.

INTRODUCTION

The evolution of modern trash-to-energy facilities in the United States really began with the passage of the Clean Air Act Amendments in 1970. The combination of available technology from Europe and the forced closings of aging incinerators paved the way for a high tech solution to solid waste disposal. Unlike old municipal incinerators, these new facilities incorporated enclosed storage bunkers for odor control, waterwall boilers for heat recovery and power generation and electrostatic precipitators for particulate control. The new plants were heralded and welcomed as an environmental solution to solve local solid waste disposal problems.

For local North Shore communities in Massachusetts, the constructions of Wheelabrator's Saugus RESCO facility meant a beginning to the end of odors, frequent fires and other nuisances associated with the old Saugus dump. It also meant long term stability of the cost of solid waste disposal. Hence, the initial firing of the boilers in 1975 marked the beginning of a long and successful relationship between these communities and the country's first private trash-to-energy project.

In the next 15 years, many things changed that would lead to a complete upgrade of the Saugus facility. Changes in people's awareness of the environment, the enactment of new laws and regulations and advancements in air pollution control technology resulted in the Saugus facility being modified to meet very stringent air emission limits in 1991, and while engineers are most interested in specific technical details, they must also be aware of the social, political and regulatory issues that can determine the design requirements for the retrofit of a trash-to-energy facility.

In 1987, there were nine major trash-to-energy facilities in operation or under construction in Massachusetts. However, when the Commonwealth of Massachusetts Solid Waste Act (Chapter 584) was signed into law on December 17, 1987, it contained certain language which applied only to the Saugus facility:

> "Resource recovery facilities and other solid waste incinerators operating prior to January first, nineteen hundred and seventy-seven shall, no later than July first, nineteen hundred and eighty-nine operate with acid gas scrubbers or such other technology providing

equal or greater protection to the public health and environment, as determined by the department."

On the surface, this new law seemed to simply require that scrubbers be added to the RESCO boilers within 18 months. In reality, this new law re-opened all of the regulatory approvals guiding the facility design and operation. Due to the nature of the repermitting process, the Massachusetts DEP ultimately more than doubled the original compliance schedule. So even though contractors were anticipating immediate release to begin design and construction of the new equipment, everything was put on hold. As shown on the schedule in Fig. 1, the state and local approval process took more than 2 years before the final Building Permit was granted on January 19, 1990. In addition to a multitude of design and operating conditions that were added during the approval process, the following major factors further complicated the challenge of the Saugus retrofit:

Since the plant was providing inexpensive, uninterrupted solid waste disposal service for 19 surrounding communities, the retrofit plan had to minimize the downtime of each boiler to avoid creating a solid waste disposal problem. Also, since the communities would have to accept future higher disposal fees to pay for the state mandated changes, it was essential to minimize the retrofit project costs.

The property line for the facility ran right behind the existing stack, leaving no room to add the new equipment. Further, subsequent to the 1987 change in law this adjacent property was designated as an "Area of Critical Environmental Concern" by the Massachusetts Department of Environmental Affairs. This designation prohibited any development or construction on this site.

In addition to establishing an extensive new set of air emission limits and continuous emission monitoring requirements as shown in Table 2, the Massachusetts DEP issued a complete new set of ash disposal guidelines which greatly impacted the ash handling and disposal practices at the facility.

PLANT DESCRIPTION

The Saugus RESCO facility is located off Route 107 on the Saugus River. The original plant site occupied 14 acres and was bordered by industrially zoned parcels, the highway and the old landfill. The plant consists of two mass-fired boilers each with burning capabilities of 750 tons per day (TPD) (680 tonnes/day) and maximum steam generating capacities of 185,000 lb/hr (83,900 kg/h) at 650 psig (45 Bar) and 835°F (446°C). The furnaces are of a balanced draft design with a normal heat input rate of 280 mm Btu/hr (70.5 mm Cal/h).

Besides the conventional steam turbine plant with its once-through brackish water cooling system, other features of the plant included an open trash receiving area, an enclosed concrete refuse storage pit, and overhead bridge cranes. The original pollution control equipment consisted of a two-field electrostatic precipitator (ESP) for each boiler. From the ESPs, flue gases were then combined and discharged to the atmosphere from a single-flue 178 ft (54 m) stack. Prior to the retrofit project, the RESCO ash handling system had undergone several modifications, but basically grate riddlings and bottom ash from the grates collected in a water-filled quench tank/drag conveyor and then was conveyed to the ash load-out area where rotary screens and magnetic separators removed ferrous metals for recycling. The fly ash from the boiler and ESP hoppers was combined with the bottom ash prior to the ferrous metal separation process.

REQUIRED MODIFICATIONS AND PERMIT CHANGES

The obvious impact of the regulatory changes was that the use of an acid gas removal technology was specified. However, a number of related retrofit design features were also required. The required changes included:

(a) Addition of a fabric filter to replace the ESPs in order to meet a new particulate limit of 0.015 gr/dscf.

(b) Continuous emissions monitoring systems (CEMS) for opacity, sulfur dioxide (SO_2), nitrogen oxide (NO_x), carbon monoxide (CO), and oxygen (O_2).

(c) Complete enclosure of the trash receiving area and ash handling and loadout area.

(d) An ash truck wash down station.

(e) Auxiliary fuel burners for the boilers to maintain minimum flue gas temperatures during start-up.

(f) A Good Engineering Practice (GEP) 286 ft (87 m) stack.

(g) A new fly ash collection, conveying and conditioning system.

Besides the new air permit for the RESCO facility, other permits or agency submittals listed in Table 1 were necessary for the project. Some of these review boards, such as the local Zoning Approval and Site Assignment, only met weekly or monthly. Hence, these approvals took many months to obtain. Table 2 shows the impacts of the regulatory changes on air emissions

TABLE 1 SAUGUS RESCO RETROFIT PROJECTS, AGENCY REVIEWS AND PERMITS

FAA Stack Approval - Application submitted April 1, 1988
PSD Conditional and Final Approval
Coastal Zone Management Consistency Certificate
Army Corps of Engineers
Water Quality (MA DEP)
Site Assignment (Saugus Board of Health)
MEPA Review
Conservation Commission Review
Zoning Approval
Fuel Oil Storage Tank Permit
Saugus Planning Board
Massachusetts DEP Approval of Contaminated Soil Removal
Saugus Building Permits - Issued January 19, 1990

limits and the extent of before and after continuous stack monitoring.

PROJECT SCHEDULE

The Scrubber/Fabric Filter Retrofit Project Schedule as shown in Fig. 1 has actual durations for the various activities. It shows both units going into operation with the new pollution control equipment well before the state's compliance date.

In developing the retrofit project schedule, the need to avoid an extended total plant shutdown was recognized. In fact, any facility downtime had to be minimized, yet in order to make the compliance date, the project had to be done on a "fast-track" basis.

PROJECT DESIGN AND CONSTRUCTION APPROACH

Given that the RESCO facility had to stay on-line, it was necessary to literally design and construct the new plant additions around the operating units. As discussed, the greatest impact of the project was on the "back end" of the plant where the pollution control equipment was being installed and where there was extensive demolition occurring. However, on the south and west sides of the plant, the receiving and ash load-out areas were totally enclosed to reduce the fugitive dust and noise and on the east side a new warehouse was built. Figures 2 and 3 show plant layouts before and after the retrofit.

The philosophy was adopted to first construct as much as possible of the new pollution control systems

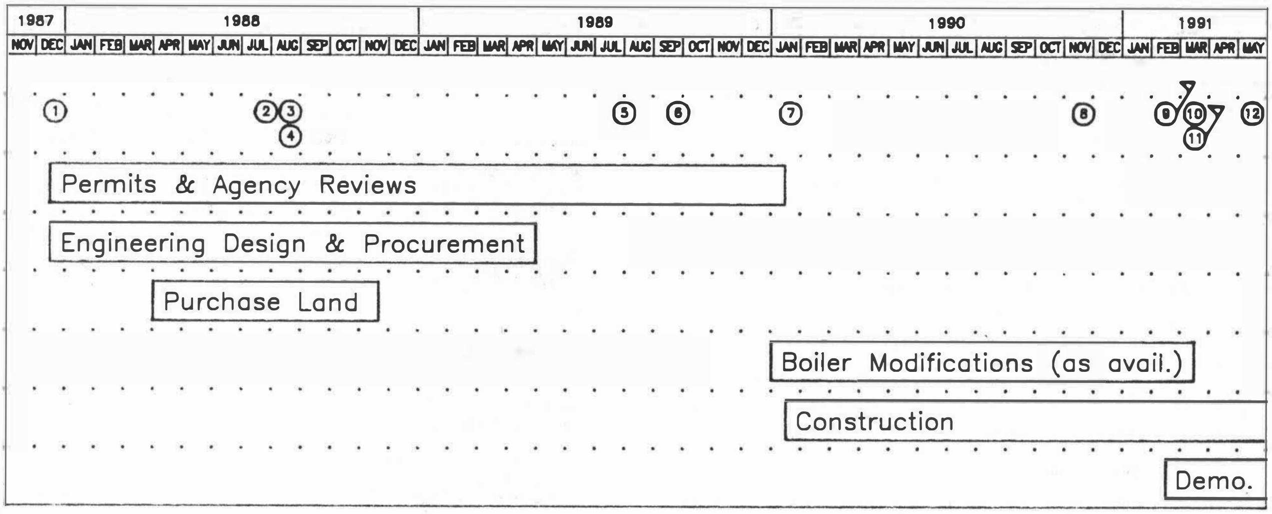
TABLE 2 SAUGUS RESCO FACILITY AIR EMISSION LIMITS

	Original Permit	Post-Retrofit Permit	Preliminary Stack Test Results
Particulates			
gr/dscf @ 12% CO_2	0.05 *	0.015 *	0.0018
(mg/dscm @ 12 % CO_2)	(114.4)	(34.3)	(4.1)
SO_2			
lb/mm BTU	NA	0.21 *	0.079
(mg/dscm @ 7% O_2)		(232)	(0.085)
NO_x			
lb/mm BTU	NA	0.84 *	0.41
(mg/dscm @ 7% O_2)		(927)	(452)
CO			
lb/mm BTU	NA	0.147 *	0.054
(mg/dscm @ 7% O_2)		(162)	(60)
HCl			
PPMV @ 12% CO_2	NA	50	37
(mg/dscm @ 12% CO_2)		(76)	(56)
Hf			
lb/mm BTU	NA	0.008	ND
(mg/dscm @ 7% O_2)		(9.3)	
H_2SO_4 (Mist)			
lb/mm BTU	NA	0.0406	0.025
(mg/dscm @ 7% O_2)		(44.7)	(27.5)
Hg			
lb/mm BTU	NA	0.003	3.08 E-04
(mg/dscm @ 7% O_2)		(3.3)	(0.32)
Pb			
lb/mm BTU	NA	0.001	ND
(mg/dscm @ 7% O_2)		(1.3)	
Be			
lb/mm BTU	NA	7.0 E-07	1.09 E-07
(mg/dscm @ 7% O_2)		(7.7 E-04)	(1.2 E-04)
VOC			
lb/mm BTU	NA	0.022	ND
(mg/dscm @ 7% O_2)		(24)	

* Notes requirement of continuous emission monitoring

and equipment and then make the tie-ins to the existing boilers during relatively short unit outages. Most interconnections to existing systems were identified early in the design phase and whenever possible these were accomplished during normal scheduled unit outages. Using this method, only a minimum number of tie-ins were necessary during a "cold iron", or total plant shutdown condition. Only two cold iron outages of three day lengths were necessary during the start-up phase of construction. The work planned for these days consisted of high voltage electrical connections, control systems changes, fire protection system cut-ins and instrument air system connections.

The fact that the boilers had to stay on-line as much as possible during the retrofit considerably complicated everyday plant operations as well as the construction program. Some of the special procedures included employing a full time traffic control specialist to monitor tipping floor activities during demolition and rebuilding of the enclosure. Also, many areas required that con-



Key Milestones:

1. Chapter 584 becomes law
2. FAA permit
3. PSD conditional permit
4. Ash management guidlines issued
5. Original compliance date
6. Site assignment
7. Building permit
8. "Cold Iron" outages
9. Unit #2 commercial
10. "Cold Iron" outages
11. Unit #1 commercial
12. DEP compliance date

FIG. 1 REFUSE ENERGY SYSTEMS COMPANY SCRUBBER/FABRIC FILTER RETROFIT PROJECT

struction activities take place at night and on weekends in order to keep the plant on-line.

To help with the fast track schedule it was decided to duplicate the scrubber equipment supplied at Wheelabrator's Bridgeport, Connecticut plant. Since RUST Engineering was the original designer of both the Saugus and Bridgeport facilities, its staff was intimately familiar with both plants and it had the capability to expeditiously design and procure retrofit systems and equipment as required by the compliance schedule. The 2-year-old Wheelabrator-owned Bridgeport RESCO plant was selected as the design basis for the retrofit because it is new, with similarly sized boilers and its design had evolved from generations of Wheelabrator plants. Thus, it reflects a state-of-the-art approach to trash-to-energy and related pollution controls. Where possible, the duplicate retrofit design included the same equipment suppliers in order to minimize redesign time and avoid installation and operating uncertainties.

RETROFIT PROBLEMS AND SOLUTIONS

Besides the impossible compliance schedule required in the original legislation, another major problem, that was not initially evident, was the lack of adequate real estate. The original site did not have space for plant expansion to the north where the scrubber and fabric filter would be located. To provide for the back end expansion and for the major construction program, the purchase of an additional 13 acres of abutting land had to be negotiated. Only about 3 acres were actually needed for new structures; however, the remainder was necessary for construction laydown and trailers and some provided a boundary buffer zone for the marshlands.

Our attempts to streamline the construction schedule did not always work as ideally as planned. Prior to the mobilization of construction forces, a number of modifications to plant systems were subcontracted out to be done during normal scheduled unit outages. This was done to minimize downtime at more critical periods of the retrofit project. Since the General Contractor, RUST, was not on site at this time, the work was not included in their scope. In some cases this proved to be cumbersome, since RUST had overall responsibility for the project, yet a number of vital activities necessary for the start-up were not within their direct control. These included boiler modifications, burner work,

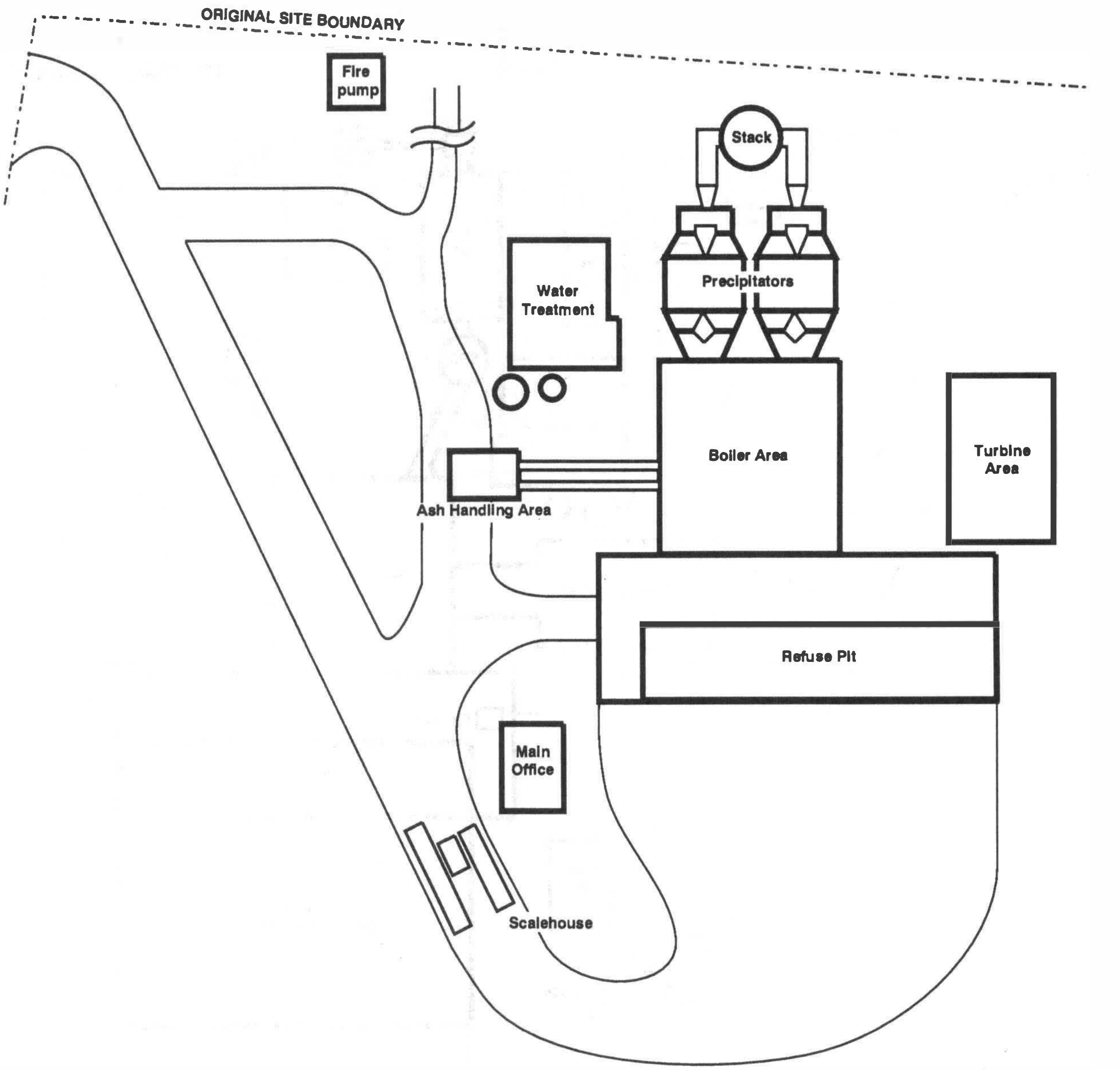


FIG. 2 SAUGUS RESCO PLANT BEFORE RETROFIT

office building construction and some demolition and site work. Specific problems arose with the storage of equipment on site and its maintenance after installation before it was actually "turned-over" to plant operations at the completion of the project. To avoid this, Wheelabrator recommends that the General Contractor be responsible for all subcontracts, even the "early" work that potentially could impact the schedule of the project.

Other steps taken to expedite the retrofit proved to be well justified, for example the duplication of a plant design and use of the same equipment suppliers. Due to our operating experience, there are individuals within the organization who have more extensive backgrounds in trouble shooting equipment problems than the equipment suppliers themselves. During startup we had occasion to use this expertise on the new distributed control system and lime slurry pumps. Conversely, because an improved lime slaker design was selected for this project, there were installation/interference problems as well as start-up problems with this equipment.

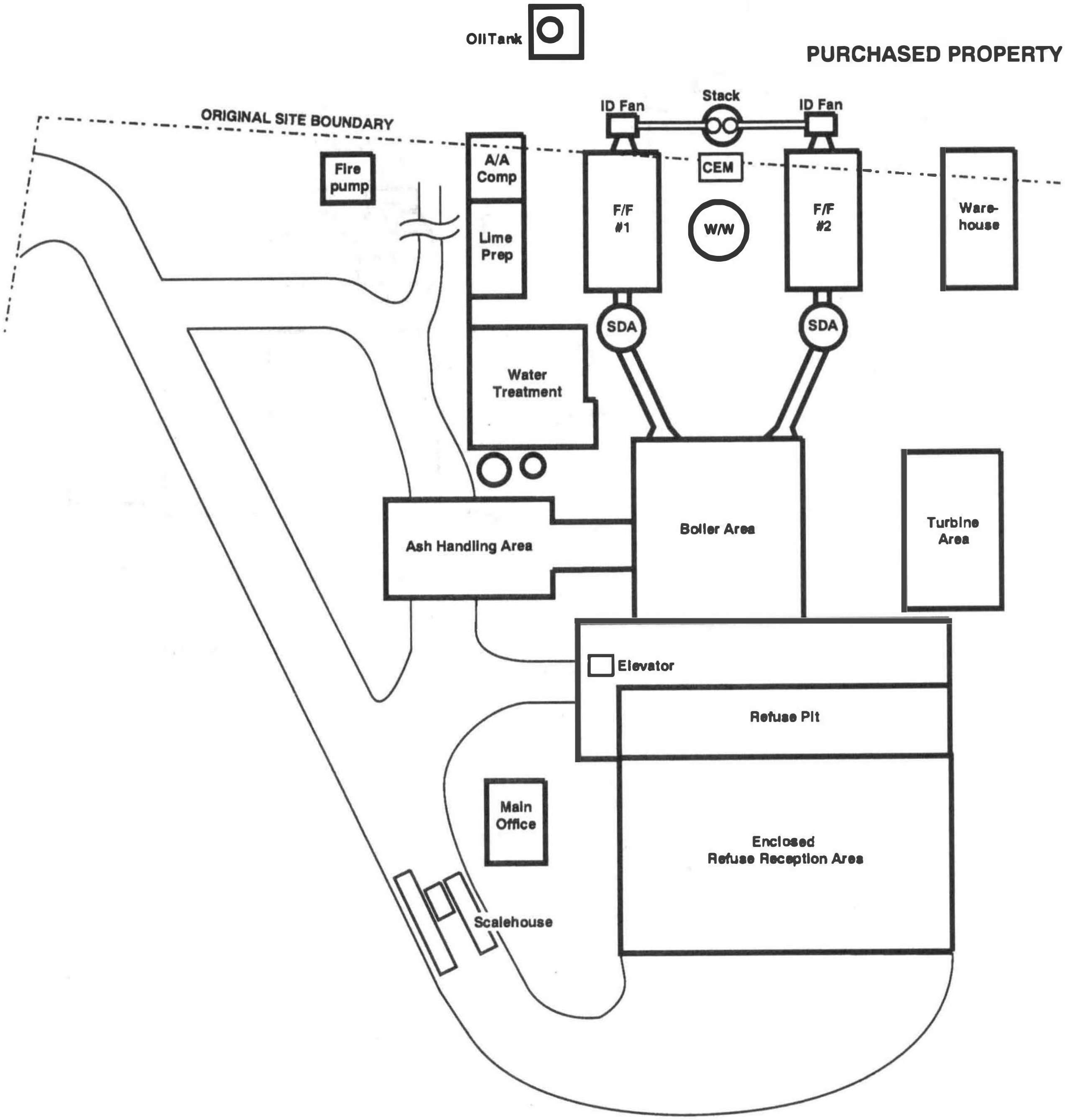


FIG. 3 SAUGUS RESCO PLANT AFTER RETROFIT

Perhaps the least anticipated problem was the difficulty posed for a fully operational facility to do "business as usual" while undertaking such an extensive construction program. The plant staff was expected to review designs, train on new systems and observe and accommodate construction, all while carrying out their normal responsibilities. On the other hand, construction at an operating facility is also difficult. Contractor activities are often interrupted by operational requirements particularly with moving underground utilities and often key plant personnel on shiftwork are unavailable for coordination with construction.

To minimize operations/construction interface problems, Wheelabrator concluded that it is very beneficial to assign at least one individual from the plant to the project team. Initially, this person would coordinate the plant's design review and it would not be too time consuming, but as construction progresses, the individual would need to be relieved of operational responsibilities and be dedicated to system acceptance and turnovers. This person's knowledge of the plant greatly facilitates the transition and can help avoid costly changes during and after construction.

Once construction was complete, the actual startup and acceptance of the new systems by plant personnel went very smoothly. This went much quicker than a grass roots facility, since the operations team was simply "adopting" a few new systems added to a plant they fully understood. The stack emissions testing was successfully completed in August, 1991 and the facility has been operating in full compliance with the new permit conditions since that time.

CONCLUSION

The end of the year passage of the Massachusetts Solid Waste Act in 1987 required the straightforward addition of acid gas scrubbers to the Saugus facility. This modification was envisioned by many to be an inexpensive addition to an older facility that could be completed within 18 months. Actually, this new law required more than a dozen federal, state and local permits and approvals that resulted in a $66 million facility modification finally completed in March 1991. Engineers and regulators evaluating the impacts of adding acid gas control equipment to existing facilities must recognize that the scope of work can be many times more complex and expensive than that envisioned by the simple addition of scrubber equipment.