Journal of Hazardous Materials, 22 (1989) 221-232
Elsevier Science Publishers B.V., Amsterdam — Printed in The Netherlands

REVIEW OF DESIGN AND OPERATIONAL CONCEPTS FOR THE DUPONT REGIONAL INCINERATOR SABINE RIVER WORKS, ORANGE, TEXAS*

PAUL D. LORIMER
E.I. DuPont de Nemours, Sabine River Works, Orange, Texas 77630 (U.S.A.)

Summary

DuPont is presently constructing a large (140 M Btu/h or 147 GJ/h), state of the art, Regional RCRA Incinerator at the Sabine River Works located at Orange, Texas to service six Gulf Coast plants in Texas and Louisiana. This activity is one step in implementing the corporate environmental policy "to minimize waste generation to the extent that is technically and economically feasible and to handle all waste in an environmentally sound manner. Treatment or disposal will be, whenever practicable, on site or at another DuPont facility."

Fundamentals for good incinerator performance are: clearly defined project objectives; in-depth understanding of the regulations; knowledge of the wastes to be burned; application of the best technology available; assignment of experienced personnel to all phases of the project; selection of a knowledgeable design contractor; purchase of high quality equipment; thorough check-out of the installation; attention to details; attention to fugitive emission control; containment of all spills; timely detection of any leaks; experienced operators and mechanics; high quality training; and a thorough review of all safety and environmental aspects.

Responsible waste management is vital to the health of our industrial community and to the protection of the community and our environment from harmful exposure to the products of our industrial operations. A general understanding of some of the specifics of the Incinerator Project and a feel for some of the more important operating considerations are addressed in this document.

Introduction

DuPont has been in the incineration business for many years with numerous units in operation at a number of plants. Most of these units are small specialized incinerators designed to handle a specific waste. We do have a rotary-kiln type unit at our Pontchartrain Plant in Louisiana that is 15 years old and 1/3 of the size of the unit presently under construction.

Waste Management activity within DuPont is driven by the following policy: "It is DuPont policy to minimize the generation of waste to the extent that is technically and economically feasible, and to handle all waste in an environ-

*Presented at the First Annual GCHSRC Symposium on Hazardous Waste Incineration: Current Practices and Future Directions, Lamar University, Beaumont, TX, February 23-24, 1989.

0304-3894/89/$03.50

mentally sound manner. Treatment or disposal will be on site whenever practicable or at other DuPont sites with suitable waste management facilities as a first choice if it becomes necessary to send waste off-site." The Regional Incinerator is one logical step in meeting the internalization facet of the corporate policy.

Efforts to define the need for a regional facility began as early as late 1984 with a comprehensive survey of all waste generated by DuPont's plants. This survey showed that even with waste minimization programs, more incineration capacity was needed by 1990. With the results of this data base, a large rotary kiln facility appeared to be the most logical selection. We found on visits to Europe that the Europeans had established a significant lead in the area of designing and operating large scale units. This influenced our decision in selecting as a full service design contractor, Ford, Bacon And Davis, located in Salt Lake City, UT. This firm is a totally owned subsidiary of Deutsche Babcock, Anlagen, of Krefeld, West Germany. This connection gave us access to the latest European technology as well as a full service design contractor that has been very active in the U.S. in the area of RCRA and TSCA Incinerator design, construction, and operation.

Incinerator project

Management

In June of 1986, the present author was assigned as Project Team Leader to direct the efforts within DuPont to design, permit and build an Incinerator at Orange, Texas. This Incinerator was to incorporate the latest technology available and would be designed to service specifically six DuPont plants located along the Gulf Coast. These plants are shown in Fig. 1.

These six plants produce a wide variety of products. Mostly plastics, elas-

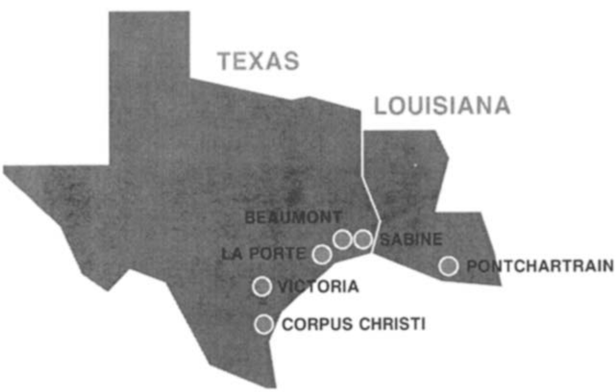

Fig. 1. DuPont Gulf Coast regional plants.

PROJECT OBJECTIVES

- Gulf Coast Mfg. Serv. To Manage Operation
- Accomodate DuPont Waste Only
- Strong Safety, Health, and Environmental Emphasis
- No PCB's, Asbestos, Or Radioactive Materials
- Ample Storage And Flexibility
- Analytical Capabilities
- Feed A Variety Of Materials
- Wide Mixture Of Containers
- Capable Of Handling Chlorides
- Meet RCRA And All Other Applicable Standards
- Fully Operational By May, 1990

Fig. 2. Project objectives.

tomers, synthetic fiber intermediates, basic chemicals and agricultural products. There is a distance of almost 600 miles between them from Corpus Christi to Pontchartrain along the Gulf.

Important factors considered in the site selection included minimization of waste transportation, location on an environmentally acceptable site with adequate support facilities, and the potential for direct pipeline feed to the unit.

DuPont has regionalized a number of service functions along the Gulf Coast into a Regional Manufacturing Organization. Assigning the business management function of the Regional Incinerator to this group was a logical continuance of this regional program. Project Objectives were then generated that defined the type of facility and the operational concepts for the new unit. An abbreviated list of these objectives is shown in Fig. 2.

The fundamentals of the operation of any industrial unit are determined by first establishing clearly defined objectives. Once a clearly defined set of objectives has been established, the work can proceed to design, permit, construct and operate a facility to meet these objectives. It is the balance of effort to meet these objectives through the application of sound design and engineering that becomes the work of the project team.

Design and operation

Figure 3 lists several design and operational concepts that have been incorporated into the Sabine Incinerator.

Incinerator Technology has changed rapidly over the past few years. The modern RCRA Incinerator of today reflects high technology and a complexity previously found only in chemical processing units. Figure 4 shows the general arrangement of the new DuPont Incinerator.

This is an elevation and plan view of the DuPont Incinerator presently under construction. This unit incorporates the latest technology in the area of waste feed and flexibility and has a modern multistage gas-cleaning train. There

DESIGN AND OPERATIONAL CONCEPTS

- Technology
- Project Status
- Baghouse And Quench Tower
- Scrubbing Train
- Container Standardization
- Waste Receipt And Control
- Fugitive Emissions
- Operating Hazards
- Protective Clothing
- Experienced Operators And Mechanics
- Specialized Training
- Miscellaneous
- Community Awareness

Fig. 3. Design and operational concepts.

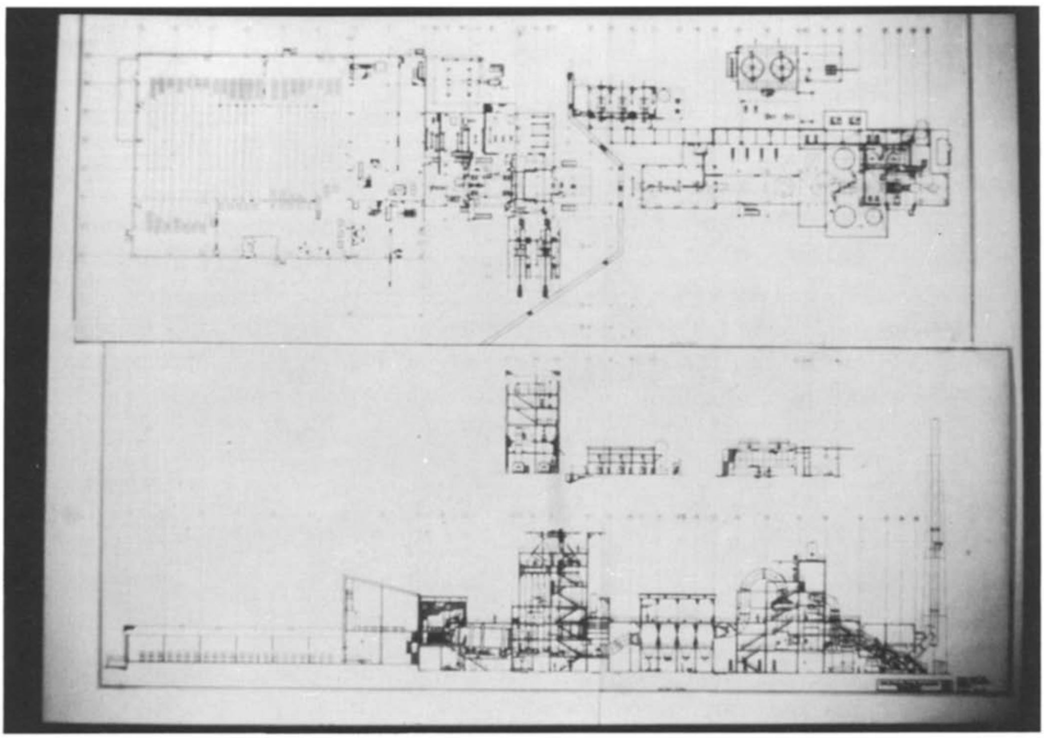

Fig. 4. Elevation and plan view of the DuPont 140-MBtu/h incinerator.

are many configurations of Incinerators that still achieve the end goal as specified in the regulations. This unit is the arrangement that best matches the project objectives agreed to for this particular unit.

The shear size of the new units is impressive. The main train is some 500 feet long and equipment reaches up to 100 feet in the air. The combination of rotary kiln and afterburner system is one of the most popular designs used in the modern Incinerator. This arrangement offers a high degree of flexibility as far as acceptable feeds and at the same time is capable of demonstrating better than four 9's destruction of the various wastes in the feed. Almost all new Incinerators constructed in recent times, directed at handling a variety of solid and liquid waste, are of this particular design.

The actual status of construction is shown in Figs. 5–7.

The first figure, Fig. 5, shows the kiln, afterburner, quench tower and baghouse in their present state of construction (February 1989).

The next figure, Fig. 6, starts at the baghouse and shows the high energy scrubber/demister and I.D. fan. Other equipment in this block will include the saturator, condensers, and stack. On the ground level are the scrubbing brine neutralization vessels.

Figure 7 shows the tank farm and waste receiving areas. Note that much of this area is roofed to minimize rainwater collection.

The simple flow sheet shown in Fig. 8 gives some idea of the entire Incinerator and gas cleaning train.

One unique feature of this Incinerator is the gas cleaning train. Specifically, a baghouse and quench tower combination. Baghouses have been in common use in the power industry for some time; however, their application to the Incinerator field is limited. The present author knows of no other application in an operational unit. Figure 9 shows a schematic of a quench tower/baghouse arrangement.

This configuration was selected for several reasons. The two primary being: 1) to avoid the generation of a RCRA waste water stream in the Incinerator area and; 2) to improve the particulate removal capability.

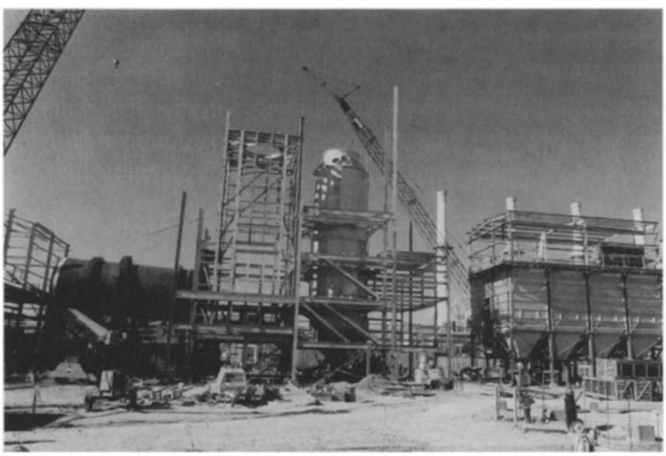

Fig. 5. Construction state of kiln, afterburner, quench tower and baghouse section (February 1989).

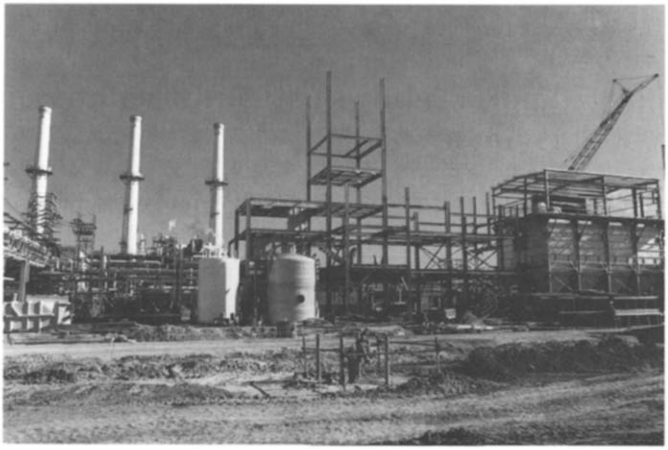

Fig. 6. Construction state of high energy scrubber/demister and I.D. fan section (February 1989, saturator, condensers and stack are not shown but yet to be incorporated).

Fig. 7. Construction state of tank farm and waste receiving areas (February 1989).

The baghouse alone could not function without first cooling the hot gases to 400 °F (220 °C) in the quench tower system before entering the baghouse. The quench system is very sophisticated to insure that the inlet temperature to the baghouse is closely controlled to prevent destruction of the bags.

A purge stream from the gas scrubbing system is used in the quench tower to cool the combustion gas from 2400 °F to 400 °F (1300 °C to 220 °C). This tower also serves as a spray dryer for separating the neutralization salts and scrubbing products from the purge stream. The dry powder generated is then removed in the baghouse. Thus the quench tower serves the dual purpose of a spray dryer and the first stage in the scrubbing and gas cleaning system.

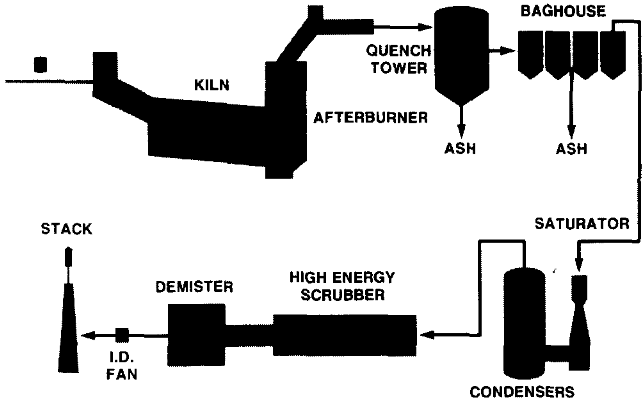

Fig. 8. Simplified incinerator train schematic.

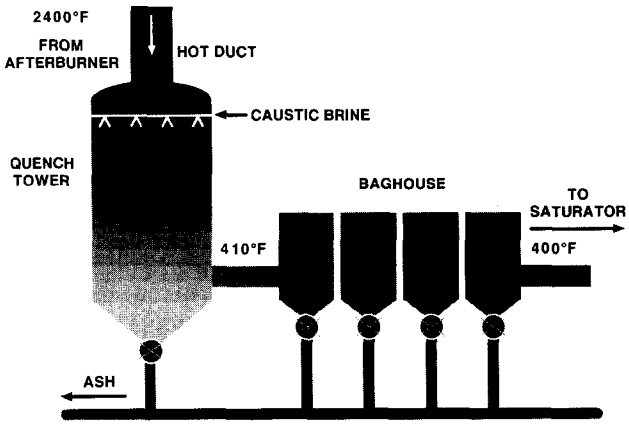

Fig. 9. Quench tower and baghouse schematic.

In the baghouse, the particulates are separated on the surface of the bags while forming a cake. The baghouse then not only serves to remove particulates but also serves as another chemical reaction step for gas cleaning as the gas passes through the sodium hydroxide cake collected on the outside of the bags.

Downstream of the baghouse, the gas is cooled in the saturator from 400 to 180 °F (220–80 °C) in a brick lined unit by spraying caustic water into the gas stream.

This unit is followed by a parallel condenser step and a high energy scrubber and separator upstream of the induced draft fan ahead of the stack.

Waste handling

Being able to handle a wide variety of waste containers is an important design consideration for an Incinerator. To insure good flexibility in this area, we have designed to handle wastes in the formats shown below in Fig. 10.

WASTE CONTAINER STANDARDIZATION

- Lever Packs 15 - 85 Gallon
  (Limited To 400# And/Or 2.5MM BTU)
- Tank Trucks
- Bulk Containers "Tote Bins" 550 Gallons
- 500 Gallon Portable Tanks
- Vacuum Trucks
- Steel Drums - (Limited Acceptance)
- Cartons 2' X 2' X 4' Limited To 400#

Fig. 10. Waste container standardization (7 items).

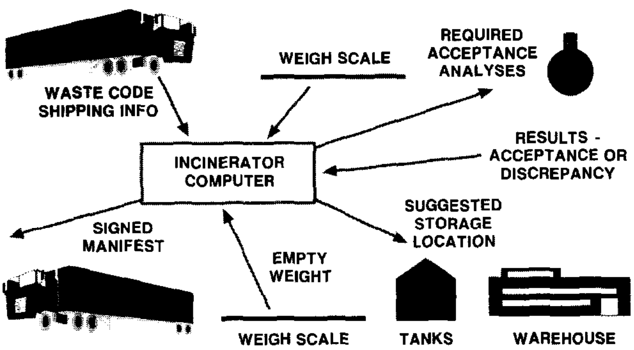

Fig. 11. Computer assisted waste receipt and acceptance system.

Seven categories of waste packaging will be accepted for feeding to the Incinerator and we are capable of feeding seven different streams simultaneously to the kiln front wall providing a high level of operating flexibility.

The containers of waste received will each be identified with a bar coded label like that used in the grocery stores. This system will be used to maintain inventory control. At the time these containers are prepared for feeding, this bar code is read back into the computer system and into the feed control system to insure incinerator permit limits on Btu, chlorine content, ash content, etc. are not exceeded. This also serves to close the accounting loop that insures that a given waste shipment has in truth been fed to the Incinerator for destruction.

When wastes are received, the necessary sampling and testing must be completed to insure that the wastes meet the specifications listed on the manifest and are identified correctly by the waste codes.

We have built into our operating system a correlation between the waste code listed on the manifest and the MSDS sheets). (Material Safety Data Sheets) This system will work as shown in Fig. 11.

With this computer assisted waste receipt and acceptance system, the operator enters the waste code from the manifest into the computer. He receives

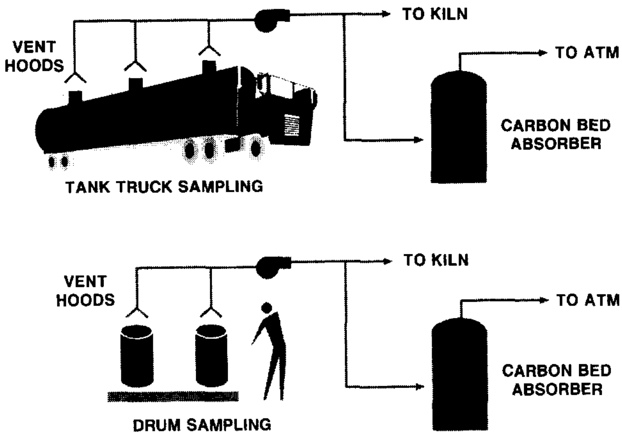

Fig. 12. Tank truck and drum sampling systems.

back a copy of the correct safety equipment requirements and information defining the type and quantity of sample and the correct analysis to define the fingerprint test to be run on each received shipment. This also insures the material meets the manifest and waste code specification. The shipment is weighed in and the sample taken for analysis in the Incinerator Laboratory. The results determine acceptance of the shipment and a recommended storage tank destination. Compatibility tests of the material in the storage tank and the material to be transferred into it are run. If no indication of incompatibility is observed, the material is transferred to the tank and the truck weighed out of the plant with its signed manifest (see Fig. 12).

All sampling areas are provided with fume collecting systems to insure protection of the environment and the operator from exposure. As shown on this slide, these gas collecting systems discharge to the combustion air fans feeding the kiln during periods of kiln operation and to carbon bed absorbers during periods when the kiln is not in operation.

One potential operational hazard that must be protected against by thorough inspections of all containerized waste can be best illustrated with the help of Fig. 13.

This figure shows the arrangement of the kiln and afterburner chamber and the solids feed chute. Sampling of containerized waste is critical. It is very important that no container be fed that contains a significant quantity of high-Btu free liquid. Only solids should be fed in any containerized feed.

Feeding such a container down the feed chute into the kiln could result in a rapid heat release and a pressure rise inside the system. A rapid pressure rise carries with it the potential for equipment damage, personnel exposure, and pollution of the environment.

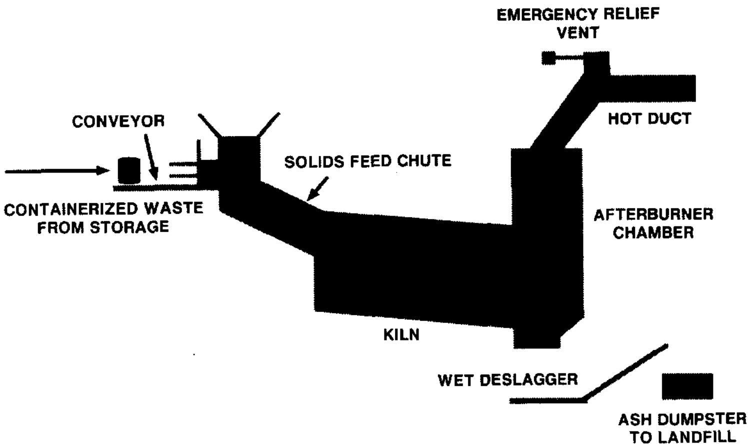

Fig. 13. Containerized feed to the kiln.

Additional design and operational concepts

Clothing and laundry facilities are provided for the operators to ensure that no contaminated clothing leaves the facility.

Specialized protective equipment will be available for use as necessary. In addition, a special clean room is available for operators to enter on one side and leave any contaminated clothing before using shower facilities, and leaving the clean room on the opposite side after donning clean clothing.

The importance of experience and training should not and has not been overlooked in the operational plan for this new facility. Only experienced personnel will be assigned, so that the highest level of performance can be insured. The jobs vacated by these experienced people will be filled by entry level people in less critical operations. Operator training facilities and instructors have been provided to insure all regulated training is accomplished in addition to that normally required on a DuPont site.

A number of miscellaneous innovations and design concepts were incorporated. These include roofing over specified areas that contain listed waste to minimize rainwater contamination; placement of tanks on dunnage to permit inspection for potential leaks in their bottoms; coating of floors with a special plastic coating to prevent attack and migration of wastes through to the ground below; installation of s/s water stops in all floor joints to further insure full retention should a spill occur.

More than 500 operating data points will be monitored from a central control room by means of a distributive control system. Operations will be controlled by 95 controllers to ensure that the unit is operated within both the Permit levels and those specified by DuPont.

Visual information will be provided to the operators through 10 field mounted

TV camera systems, including monitoring of the internals of the kiln and all unloading, sampling and waste handling operations.

Exposure records for operators and medical surveillance will be a routine part of the operational plan.

All building sumps will be monitored for organic vapors on a continuous basis.

Nitrogen padded storage tanks will vent to the kiln when it is in operation. When the kiln is out of service, these vents will all pass through a carbon bed filter system. A fully automated interlock system is provided that will meet the legislated requirements, and that will provide the system with a safety protection level that meets Dupont's stringent safety standards.

Parallel to the design activity, we have conducted a safety design review called a "Process Safety Review". This review is carried out throughout the project design and installation to investigate the potential for safety or environmental problems. If any problem is identified, the unit design is modified to eliminate the problem and/or modifications to the interlock safety system are made to address all identified concerns. These reviews are made using outside consultants and all levels of experienced personnel. We believe that these reviews are as important as the basic engineering design and that every effort must be made to insure that nothing is overlooked.

Speaking of overlooking things, an often overlooked function is a Community Awareness Program. Our program was initiated prior to formally notifying the agencies of our intention to construct a RCRA facility on the Orange site. We have continued this program throughout the design and construction phase and will maintain this activity indefinitely.

Responsible environmental activity should always include the communication of information to the community concerning what type of facility is being installed and to what degree their protection is being made a part of its design, installation and operation. It is important to work with the local officials, media, plant personnel and other responsible groups to keep them informed as to the progress of the project and to insure that they understand what is being done and how they can assist and input into the project.

After spending a number of years in the environmental arena, the present author believes that one message has become more and more clear. That message is that responsible waste management is vital to the health of our industrial community and to the protection of the community and our environment from harmful exposure to the (by-) products of our industrial operations.

In summary, we would like to share what we believe to be some basic fundamentals for good Incinerator design and operation.

Good incinerator practice

Figure 14 outlines fundamentals that will garantee good incinerator performance.

FUNDAMENTALS FOR GOOD INCINERATOR PERFORMANCE

- Clearly Defined Project Objectives
- Indepth Understanding Of The Regulations
- Knowledge Of The Wastes To Be Burned
- Application Of The Best Technology Available
- Assignment Of Experienced Personnel To All Phases Of The Project
- Selection Of A Knowledgable Design Contractor
- Purchase Of High Quality Equipment
- Thorough Check Out Of The Installation
- Attention To Details
- Attention To Fugitive Emission Control
- Containment Of All Spills
- Timely Detection Of Any Leaks
- Experienced Operators And Mechanics
- High Quality Training
- Thorough Review Of All Safety And Environmental Aspects

Fig. 14. Good Incinerator Performance Fundamentals.

I do not suggest that these fundamentals should be all inclusive; however, I do submit that violation of these fundamentals will jeopardize the successful construction and proper operation of an incineration facility. We in the business of waste destruction must provide well designed and well constructed facilities and we must operate them in a responsible and proactive manner.

Acknowledgement

I wish to thank DuPont Company for the opportunity to share this information about its activities in this area to the scientific audience and would be happy to answer any queries the reader may have.