On-Site Incineration at the
Bayou Bonfouca Superfund Site
Slidell, Louisiana

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<table>
<tr><td>Site Name:
Bayou Bonfouca Superfund Site</td><td rowspan="2">Contaminants:
Polynuclear aromatic hydrocarbons: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, ideno(1,2,3-cd)-pyrene, chrysene, and creosote</td><td>Period of Operation:
November 1993 - July 1995</td></tr>
<tr><td>Location:
Slidell, Louisiana</td><td>Cleanup Type:
Remedial action</td></tr>
<tr><td>Vendor:
IT Corporation
312 Directors Drive
Knoxville, TN 37923
(423) 690-3211</td><td rowspan="2">Technology:
• Sediment transported through a feed system that included dewatering and mixing
• Incineration system consisting of rotary kiln and secondary combustion chamber (SCC)
• SCC operated between 1,600 °F and 1,800 °F
• Exhaust gases from SCC directed through gas cleaning system
• Residual ash was landfilled, and an engineered cap was placed over residual ash and surface soil</td><td>Cleanup Authority:
CERCLA and State: Louisiana
• Phase I ROD signed August 1985
• Phase II ROD signed March 1987
• Fund-lead
• ESD Signed February 1990</td></tr>
<tr><td>SIC Code:
2491 (Wood Preserving)</td><td>Point of Contact:
Mark Hansen
U.S. EPA Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202
(214) 665-7548</td></tr>
<tr><td>Waste Source:
Bayou sediments - creosote waste</td><td colspan="2" rowspan="2">Type/Quantity of Media Treated:
Sediment (169,000 cubic yards)
Contaminated material from waste piles (10,000 cubic yards)</td></tr>
<tr><td>Purpose/Significance of Application:
Underestimated volume of contaminated soil by a factor of three, prompting EPA to reevaluate remedial plans. Completed 18 months ahead of schedule</td></tr>
<tr><td colspan="3">Regulatory Requirements/Cleanup Goals:
Destruction and Removal Efficiency (DRE) of 99.99% for all constituents of concern as required by Resource Conservation and Recovery Act (RCRA) incinerator regulations at 40 CFR part 264, subpart O</td></tr>
<tr><td colspan="3">Results:
Monitoring and trial burn data indicate that all DRE and emission standards have been met</td></tr>
</table>

Incineration at the Bayou Bonfouca Superfund Site
Slidell, Louisiana

(Continued)

Description:
Between 1892 and 1970, the Bayou Bonfouca site operated as a former creosote works facility. During this period, numerous creosote releases occurred. In 1970, a fire at the plant released large amounts of creosote into the environment. Sediments in Bayou Bonfouca, an adjacent navigable waterway, were heavily contaminated with creosote (PAHs).

In August 1985, a Phase I Record of Decision (ROD) was signed, specifying excavation and off-site landfilling of creosote waste piles. In March 1987, a Phase II ROD was signed. The remedial actions for the Phase II ROD included the excavation and on-site incineration of sediment and the contents of surface waste piles with placement of an engineered cap over residual ash and surface soils. During 1988, a detailed design investigation showed that the volume of contaminated sediment was underestimated by a factor of three. The volume increase resulted in a cost increase and prompted EPA to issue an Explanation of Significant Difference (ESD) in February 1990.

The selected incineration system consisted of a feed system, a rotary kiln, a secondary combustion chamber (SCC) and a gas cleaning system. Sediment was dewatered and then mixed before being fed to the incinerator. During its operation, the incinerator processed approximately 250,000 tons (169,000 cubic yards) of contaminated sediments and waste pile material. Treatment performance and emissions data collected during this application indicated that all performance standards and emissions requirements were met.

The actual cost for remediation using the incineration system was approximately $110,000,000.

EXECUTIVE SUMMARY

This report presents cost and performance data for the application of on-site incineration at the Bayou Bonfouca Superfund site in Slidell, Louisiana. A rotary kiln incinerator was operated from November 1993 through July 1995 as part of a remedial action. Contaminants of concern at the site included specific polynuclear aromatic hydrocarbons (PAHs).

The Bayou Bonfouca site was a former creosote works facility that operated from 1892 until its closure in 1970. During this period, numerous creosote releases occurred. In 1970, a fire at the plant released large amounts of creosote into the environment. Sediment at the Bayou Bonfouca site was contaminated with PAHs.

In August 1985, a Phase I Record of Decision (ROD) was signed, specifying excavation and off-site landfilling of creosote waste piles. In March 1987, a Phase II ROD was signed. The remedial actions for the Phase II ROD included the excavation and on-site incineration of sediment and the contents of surface waste piles with placement of an engineered cap over residual ash and surface soils

The material specified for excavation and incineration included approximately 165,000 cubic yards of bayou sediments contaminated with PAHs in excess of 1,300 mg/kg and 10,000 cubic yards of contaminated material from waste piles. The ROD also specified incinerator requirements that included a destruction and removal efficiency (DRE) of 99.99% for each contaminant of concern.

During 1988, a detailed design investigation showed that the volume of contaminated sediment was underestimated by a factor of three. The volume increase resulted in a cost increase and prompted EPA to issue an Explanation of Significant Difference (ESD) in February 1990.

The ESD divided the Phase II ROD remedial action into two operable units: a groundwater and a source control operable unit. On-site incineration was a component of the response for the source control operable unit.

The selected incineration system consisted of a feed system, a rotary kiln, a secondary combustion chamber (SCC) and a gas cleaning system. Sediment was dewatered and then mixed before being fed to the incinerator.

A countercurrent kiln lined with castable refractory brick was used at the Bayou Bonfouca site. The resulting ash was discharged from the kiln and quenched outside of the kiln, while exhaust gases were channeled to the SCC. The SCC provided additional combustion of organics in the exhaust gas which was subsequently quenched with water.

The gas cleaning system consisted of a quench system, a combustion gas conditioner, a Hydro Sonic® scrubber, and a vane separator. Particulate matter and acid gasses were removed throughout the gas cleaning system.

During its operation, the incinerator processed approximately 250,000 tons (over 170,000 cubic yards) of contaminated sediments. Treatment performance and emissions data collected during this application indicated that all performance standards and emissions requirements were met.

The actual cost for remediation using the incineration system was approximately $110,000,000.

SITE INFORMATION

Identifying Information

Bayou Bonfouca Superfund Site
Slidell, Louisiana

CERCLIS # LAD980745632

Phase II ROD Date: March 31, 1987

Treatment Application

Type of action: Remedial (on-site incineration)

Period of operation: November 1993 - July 1995

Quantity of material treated: approximately 250,000 tons of contaminated sediments

Background

Historical Activity that Generated Contamination at the Site: Creosote plant that treated pilings for use in railway construction

Corresponding SIC Code: 2491 (Wood Preserving)

Waste Management Practice That Contributed to Contamination: Improper waste storage and disposal practices

Site History:

- The Bayou Bonfouca Superfund site is characterized by standing water and saturated surface soil.
- The northern section of the site is heavily wooded and the remainder of the site is bordered by a drainage ditch, a creek, and the Bayou Bonfouca.
- The site operated as a creosote works facility from 1892 until it was closed as the result of a fire in 1970. During this period, numerous creosote releases occurred, contaminating the area with PAHs [4]. The fire in 1970 released large amounts of creosote into the environment.
- In 1976, the Coast Guard investigated the Bayou Bonfouca waterway. The creosote in the bayou sediments was so concentrated that Coast Guard divers received second-degree chemical burns and found that the bayou was biologically sterile. The initial investigation was supplemented in 1978 by a study conducted by EPA, the Coast Guard, and the National Oceanic and Atmospheric Administration. The Remedial Investigation (RI) and Feasibility Studies (FS) were completed in 1987.
- In 1988, design investigations showed that the volume of waste was approximately three times the amount previously estimated. This resulted in a dramatic increase in cost. These two factors led EPA to divide the remedial action into two operable units, allowing remediation of the groundwater operable unit to continue while further investigating the source control operable unit. At the same time, EPA conducted a Value-Engineering (V-E) study to ensure that the remedy selected was still the most appropriate.
- Incineration operations began in November 1993 when a trial burn was conducted. Incineration was completed July 1995, 18 months ahead of schedule.
- Approximately 250,000 tons of contaminated sediment were incinerated between November 1993 and July 1995.
- Remedial actions were funded by EPA through the Superfund program and by the state of Louisiana.

SITE INFORMATION (CONT.)

Background (Cont.)

Regulatory Context:

- In September 1983, the Bayou Bonfouca site was placed on the National Priorities List (NPL).
- A ROD for Phase I was signed in August 1985, specifying excavation and off-site landfilling of creosote waste piles and contaminated on-site soil; and the disposal of contaminated water by deep-well injection at an approved Resource Conservation and Recovery Act (RCRA) facility.
- A ROD for Phase II was signed in March 1987, specifying excavation and on-site incineration of sediment from the Bayou Bonfouca.
- EPA issued an ESD in February 1990, as a result of the discovery of more waste than estimated by the RI/FS and the subsequent increase in cost. The ESD upheld the decision to use on-site incineration, but divided the Phase II remedial action into two operable units: groundwater and source control.
- The DREs were set in accordance with RCRA incinerator regulations in 40 CFR part 264, subpart O, §264.343.
- Site activities were conducted under the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986, and the National Contingency Plan, 40 CFR 300 [1].

Remedy Selection: On-site rotary kiln incineration was selected as the remedy for contaminated sediment at the Bayou Bonfouca Superfund site based on the site investigation, feasibility study, Health Assessment, Technical Assistance Memoranda for Development of Record of Decision, and Reports on Public Hearings.

Timeline

Table 1. Timeline [2]

Date	Activity
1892-1970	The facility on the Bayou Bonfouca site produced creosote
1976	Coast Guard investigated Bayou Bonfouca waterway
September 1983	Site was placed on the NPL
August 1985	Record of Decision for Phase I signed
1987	Remedial Investigation/Feasibility Study completed
March 31, 1987	Record of Decision for Phase II signed
1988	Design investigations revealed volume of waste material was three times previous estimates.
February 1990	ESD divided the remedial action into two operable units
November 1993	Trial burn performed
November 1993-July 1995	Rotary kiln incinerator operated

SITE INFORMATION (CONT.)

Site Logistics/Contacts

Site Management: EPA-Lead

Oversight: Louisiana Department of Environmental Quality (LDEQ)

Remedial Project Manager:
Mark Hansen
U.S. EPA Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202
(214) 665-7548

State Contact:
Duane Wilson
Louisiana Department of Environmental Quality
Inactive and Abandoned Sites Division
7290 Bluebonnet Drive
Baton Rouge, LA 70810
(504) 765-0463

Treatment System Vendor:
IT Corporation
312 Directors Drive
Knoxville, TN 37923
(423) 690-3211

MATRIX DESCRIPTION

Matrix Identification

Type of Matrix Processed Through the Treatment System: The primary feed for the incinerator was dewatered bayou sediment. Small amounts of creosote generated from groundwater treatment at the site and contaminated soil also were incinerated.

Contaminant Characterization

Primary Contaminant Group: Polynuclear aromatic hydrocarbons (PAHs)

- The contaminants of greatest concern were benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)-fluoranthene, indeno(1,2,3-cd)-pyrene, and chrysene.
- The maximum concentration of PAHs detected at the site was 13,450 mg/kg.

Matrix Characteristics Affecting Treatment Cost or Performance

Table 2 presents the matrix characteristics that most significantly affected cost or performance at the site and their measured values.

MATRIX DESCRIPTION (CONT.)

Table 2. Matrix Characteristics

Parameter	Bayou Sediments			Creosote Waste Piles		
	Maximum Value	Minimum Value	Average Value	Maximum Value	Minimum Value	Average Value
Moisture (%)	77	17	52	NA	NA	NA
Ash (%)	81.0	3.6	40	NA	NA	NA
Total Chloride (%)	0.29	0.02	0.07	1.42	0.02	0.17
Sulfur (%)	1.24	0.04	0.25	0.79	0.04	0.24
Carbon (%)	60.5	0.3	9.2	96.3	3.17	45
Oxygen (%)	25.2	0.3	6.8	19.78	0.55	7.6
Hydrogen (%)	8.14	0.01	2.4	4.56	0.64	2.4
Nitrogen (%)	1.61	0.02	0.42	1.43	0.10	0.64

Note: NA - Not Available

TREATMENT SYSTEM DESCRIPTION

Primary Treatment Technology

Rotary kiln incineration, including:

- Rotary kiln; and
- Secondary combustion chamber.

Supplemental Treatment Technology

Pre-Treatment (solids): Dewatering and mixing

Post-Treatment (air):

- Quench system;
- Combustion Gas Conditioner;
- Hydro Sonic® Scrubber; and
- Vane Separator.

Post-Treatment (water): Oil water separator and carbon adsorption

System Description and Operation

- The rotary kiln incineration system used at the Bayou Bonfouca site consisted of two chambers (the kiln itself and a secondary combustion chamber) and a gas cleaning system consisting of a quench system, a combustion gas conditioner, a Hydro Sonic® scrubber, and a vane separator.
- Turbidity curtains, silt curtains, and absorbent booms were placed along the bayou prior to dredging. The curtains were manufactured from synthetic materials which allowed the passage of water but prevented the flow of soil particles.
- Sediments were pumped through an 18-inch pipeline from the bayou into a water retention basin. Sediment was then moved to a feed preparation building where it was dewatered in a filter press. The filter cakes were mixed to create a homogeneous matrix. Prepared solid waste was transferred to mass flow feeders by front-end loaders. The waste was then moved by a transfer conveyor to a slinger belt conveyor, which fed the waste into the kiln. The transfer conveyor and slinger belt conveyor were completely enclosed and under negative pressure.
- The countercurrent rotary kiln had a length of 75 feet, with an inside diameter of 12 feet and a volume of 8,475 cubic feet. The kiln was a carbon steel chamber lined with 9 inches of super-duty castable refractory and was operated in an oxidative mode.
- Hot ash from the kiln was discharged to an ash pan conveyor and then

TREATMENT SYSTEM DESCRIPTION (CONT.)

transferred to the ash cooler where the ash was quenched.

- A slag removal system was installed in case slagging occurred. The system consisted of a slag quench chamber, a slag roller crusher, and a dewatering slag removal screw. According to site personnel, slagging was not a problem.

- Flue gases from the kiln were routed to the SCC for additional combustion of volatilized contaminants. The SCC operated between 1,600°F and 1,800°F, with an average oxygen content of 4 to 8 percent. The inside diameter of the SCC was 10 feet, 6 inches, and the minimum off-gas retention time was 2 seconds.

- The exhaust gases from the SCC were directed through a gas cleaning system. First, the gases were channeled through the quench system to cool the off-gases and remove particulates and acid gas. Flue gas from the quench system then flowed into the gas conditioner, where additional particulate and acid gas were removed.

- Gas leaving the gas conditioner entered a Hydro-Sonic® scrubber where caustic solution was sprayed into the gas stream.

- The gas stream entered the vane separator, where the spray solution from the scrubber was removed.

- The incinerator system was equipped with an emergency relief vent system to treat off-gases from the kiln during emergency shutdowns. The Environmentally Safe Temporary Emergency Relief System® (ESTER®) received electricity from a battery-powered uninterruptable power source, so the off-gases were treated even during power outages. The ESTER system consisted of a natural gas ring burner, two continuous gas pilots, and two natural draft air dampers. The system was designed to be a complete stand-alone combustion system in emergency shutdown situations [5].

- Combustion gases were drawn through the kiln system and gas cleaning system by an induced draft fan, resulting in a constant negative pressure throughout the system. Gases were exhausted through a 100-foot stack.

- Residual ash was required to meet a goal of 10 mg/kg PAH or less before land disposal. Residual ash was landfilled on-site, and an engineered cap was placed over residual ash and surface soils.

- Water from the sediment was treated by sand-bed filters, with oil/water separation and carbon adsorption. The treated water was discharged into the bayou.

Table 3. Summary of Operating Parameters

Parameter	Value
Residence Time (Solids)	30 - 40 minutes
System Throughput	25 tons/hr
Kiln Temperature	1,200°F

TREATMENT SYSTEM PERFORMANCE

Cleanup Goals/Standards

The cleanup goals and standards were specified in the Phase II ROD.

- The sediment cleanup level was 1,300 mg/kg of PAHs.
- Residual on-site soils containing greater than 100 mg/kg PAHs and less than 1,000 mg/kg were collected and landfilled on-site. Soils less than 100 mg/kg were left in place and those greater than 1,000 mg/kg were incinerated. All ash had to be less than 10 mg/kg PAHs before on-site landfilling.
- The required DRE was 99.99% for each contaminant of concern.
- The ESD re-evaluated the cleanup levels presented in the ROD. The levels represented a lifetime increased cancer risk of less than 1×10^{-4} which conformed to the acceptable health risk criteria contained in the National Contingency Plan.

Treatment Performance and Compliance

- The trial burn conducted at the Bayou Bonfouca site was designed to operate the incineration system at conditions that reflected worst-case destruction and removal of all constituents of concern.
- Anthracene, naphthalene, and toluene were selected as the POHCs for the Bayou Bonfouca site. The reported DRE for each POHC are included in Table 4.
- The incinerator operated within the operating limits established during the trial burn, signifying that all performance requirements were met. Table 5 presents the AWFCO limits during the operation of the incinerator. Information regarding the frequency of AWFCOs was not available. AWFCOs occurred occasionally throughout the project primarily due to electrical power interruptions from the regional electric power provider, CLECO. Table 6 presents values for operating parameters measured during the trial burn and subsequent operations.

Table 4. Average Destruction and Removal Efficiencies from Compliance Testing

Contaminant	Average Contaminant Feed Rate in Soil (lb/hr)	Average Contaminant Rate Stack Gas Emissions (lb/hr)	Average Contaminant Rate in Residual (lb/hr)	DRE (%)
Toluene	23.36	8.7E-5	0.0004	>99.9996
Naphthalene	83.09	2.18E-3	0.0068	>99.997
Anthracene	79.87	1.99E-3	<0.0804	>99.998

TREATMENT SYSTEM PERFORMANCE (CONT.)

Table 5. Automatic Waste Feed Cutoffs [2]

Parameter	Cutoff Limit
Maximum kiln feed rate, 15-minute rolling average	29.05 tph
Maximum instantaneous kiln pressure	-0.02 in w.c.
Minimum kiln off-gas temperature, 1-hour rolling average	1,088°F
Minimum kiln off-gas temperature, instantaneous	1,088°F
Minimum SCC off-gas temperature, 10-minute rolling average	1,689°F
Minimum SCC off-gas temperature, instantaneous	1,689°F
ESTER® pilot out	400°F
Maximum quench outlet gas temperature	220°F
Minimum GCS differential pressure, 10-minute rolling average	21.2 in w.c.
Maximum stack gas flow, 10-minute rolling average	45,580 acfm
Maximum stack CO, 1-hour rolling average corrected to 7% O_2	100 ppm
Maximum stack gas CO, instantaneous corrected to 7% O_2	500 ppm
Maximum stack gas THC, 1-hour rolling average as propane, corrected to 7% O_2	20 ppm
Minimum stack gas O_2 , 1-minute rolling average	3 % dry volume

Table 6. Operating Parameters [2]

Parameter	Actual Value*	Trial Burn Value
Minimum kiln off-gas temperature, instantaneous	1,094°F	1053°F
Kiln Pressure, 15-minute rolling average	NA	-1.49 in w.c.
Minimum SCC off-gas temperature, instantaneous	1,689°F	1626°F
Maximum stack gas flow, 10-minute rolling average	45,580 acfm	45,050 acfm
Maximum kiln feed rate, 15-minute rolling average	29.05 tph	30.79 tph
Minimum scrubber change in pressure, 10-minute rolling average	21.2	24.15 in w.c.
Minimum Hydro-1 Recycle flow rate	396	396 gpm
Maximum stack gas CO, 60-minute rolling average, corrected to 7% oxygen	100	2 ppm
Maximum stack gas THC, 60-minute rolling average, corrected to 7% oxygen	20	15 ppm
Stack gas CO_2	NA	9.78% dry volume
Stack gas O_2 , 1-minute rolling average	NA	10.31% dry volume
HCl Emissions	NA	0.036 lb/hr
Particulate Matter Concentration	NA	0.0059 gr/dscf

*Anticipated values from the trial burn report.

Performance Data Completeness

- Data are available for concentrations of contaminants in the incinerator residue. These data were collected at the end of four separate runs during the trial burn.

TREATMENT SYSTEM PERFORMANCE (CONT.)

Performance Data Quality

- The Quality Assurance/Quality Control (QA/QC) program used throughout the remedial action met the EPA and the state of Louisiana requirements.

TREATMENT SYSTEM COST

Procurement Process

- The prime contractor was a joint venture, IT Corporation (68%) and O.H. Materials, Incorporated (32%).

Cost Data

- The estimated total cost for operating the incinerator at the site was $110,000,000, with a cost of $72,000,000 for thermal treatment. A total of 179,000 tons of sediment and waste pile material were incinerated. This corresponds to a total unit cost of $440 per ton, and a unit cost for thermal treatment of $288 per ton.

Table 7. Costs

WBS Number			Description	Cost
331	01	01	Mobilization of construction equipment and facilities	$21 million
331	01	02	Mobilization of personnel	$0.5 million
331	01	03	Submittals/implementation plans	$2.0 million
331	02	03	Air monitoring and sampling	$4 million
331	02	05	Sampling surface and groundwater	$0.8 million
331	02	06	Sampling soil and sediment	$0.5 million
331	02	09	Laboratory chemical analysis	$2.5 million
331	03	03	Earthwork (i.e., excavating, stockpiling)	$20 million
			Miscellaneous	$3 million
			Total Capital Costs	$54 million
			Annual Operating and Maintenance Cost	$18 million/yr
			Total Operation and Maintenance Costs	$30 million

Cost Data Quality

- Cost data was provided by IT Corporation.

OBSERVATIONS AND LESSONS LEARNED

Cost Observations and Lessons Learned

- EPA chose an innovative approach to pay for the incineration by paying on the dry-weight basis of the ash instead of on the weight of the feed material. This helped to prevent the incineration of unnecessary moisture by placing the responsibility on the contractor to optimize the process train.
- After incineration of the waste at Bayou Bonfouca was completed, the incineration system was used to incinerate waste from Southern Shipbuilding, a site less than two miles away. According to site personnel, reusing the system at Bayou Bonfouca instead of building a new one at Southern Shipbuilding saved at least $20 million.

Other Observations and Lessons Learned

- Approximately 96% of the AWFCOs were due to momentary power glitches partially attributable an old system of power lines. These were not true power outages, but the sensitive equipment would register the glitch as a break in power, resulting in an AWFCO.
- The Bayou Bonfouca site had some problems with power outages that occurred during storms. To prevent this from being a problem, wastes were not fed to the unit during storms.
- A stack/ID fan silencing system allowed 24-hour operation without disturbing local residents.

Public Involvement

- A Community Involvement Plan was developed April 1984 and revised in August 1985. Twenty open houses and workshops were held for the public between 1985 and 1996. Several fact sheets were mailed to the 318 citizens on the mailing list.
- A high level of interest existed in the community according to site personnel. Nearby residents were generally supportive of EPA's efforts because they wanted the source of contamination to be addressed.

REFERENCES

1. Superfund Record of Decision Operable Unit 1, Bayou Bonfouca, Slidell, Louisiana, August 1985.
2. Superfund Record of Decision Operable Unit 2, Bayou Bonfouca, Slidell, Louisiana, March 1987.
3. Explanation of Significant Differences, Bayou Bonfouca, Slidell, Louisiana, February 1990.
4. Public Health Assessment Addendum, Bayou Bonfouca, Slidell, Louisiana, December 1993.
5. Bayou Bonfouca Trial Burn Report, IT Corporation, January 1994.
6. EPA Region VI Superfund Homepage, Internet,(http://www.epa.gov./earth1r6/6sf/b-bonfou.pdf) March 24, 1997.
7. Personal communication with Kevin Smith, IT Corporation, April 3, 1997.
8. Personal communication with Mark Hansen, USEPA, Region 6, June 1997.