American
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STEP
Strategies for Today's
Environmental Partnership

TEMPORARY TREATMENT OPTIONS FOR PETROLEUM DISTRIBUTION TERMINAL WASTEWATERS

REGULATORY AND SCIENTIFIC AFFAIRS
PUBLICATION NUMBER 4688
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American Petroleum Institute

STEP Strategies for Today's Environmental Partnership

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Temporary Treatment Options for Petroleum Distribution Terminal Wastewaters

Regulatory and Scientific Affairs

API PUBLICATION NUMBER 4688

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American Petroleum Institute

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PREFACE

The American Petroleum Institute's (API's) Health and Environmental Sciences Department, through its Water Technology Task Force (Task Force), has been conducting a multi-year research program to identify and evaluate practical and environmentally sound technologies for wastewater treatment at petroleum facilities. The Task Force has also been sponsoring research to assist petroleum facilities and government agencies in improving regulations and attaining compliance. The results of this program are intended to provide both industry and regulatory agencies with the requisite technical information for making informed decisions on appropriate wastewater treatment alternatives for individual petroleum marketing and distribution facilities.

The Task Force has sponsored and published a significant number of research reports in prior years. A listing of some key published reports is provided below. The goal of this study was to identify options for the temporary treatment of wastewaters at marketing distribution terminals. Contaminated waters from distribution terminals can be generated intermittently, such as hydrostatic test waters or tank bottom waters, frequently in small volumes that can be stored. In many cases, these waters can be returned to refineries or other oil recyclers for oil recovery and reuse. The water portion of this material is treated at the receiving site. In other cases, it may be economical to install permanent facilities to treat the waters or to pretreat them for discharge and final treatment in POTWs (publicly owned treatment works, such as sewage treatment plants).

The trend toward highly automated distribution terminals, requiring minimal on-site staff, makes attractive temporary or mobile treatment facilities managed by contractors. Moreover, temporary treatment is often the preferred option for handling wastewater from the growing number of groundwater remediation projects at petroleum facilities. This report assists facility personnel in selecting appropriate temporary treatment technologies, competent contractors, and effective implementation options at petroleum product distribution and pipeline terminals. The information may also be applicable to other petroleum facilities that have a need for temporary treatment of wastewaters.

This report covers typical contaminated waters at terminals, permitting issues, treatment technology selection processes, contractor selection, oversight, and case studies.

The Task Force greatly acknowledges and appreciates the fine work performed by ENSR, Acton, Massachusetts, in preparing this document.

Studies Sponsored by the Water Technology Task Force

Publ. 4665 - Analysis and Reduction of Toxicity in Biologically Treated Petroleum Product Terminal Tank Bottoms Water, April 1998.

Publ. 4664 - Mixing Zone Modeling and Dilution Analysis for Water-Quality-Based NPDES Permit Limits, April 1998.

Publ. 1612 - Guidance Document for Discharging of Petroleum Distribution Terminal Effluents to Publicly Owned Treatment Works, November 1996.

Publ. 4602 - Minimization, Handling, Treatment, and Disposal of Petroleum Product Terminal Wastewaters, September 1994.

Publ. 4606 - Source Control and Treatment of Contaminants Found in Petroleum Product Terminal Tank Bottoms, August 1994.

Publ. 4582 - Comparative Evaluation of Biological Treatment of Petroleum Product Terminal Wastewater by the Sequencing Batch Reactor Process and the Rotating Biological Contactor Process, June 1993.

Publ. 4581 - Evaluation of Technologies for the Treatment of Petroleum Product Marketing Terminal Wastewater, June 1993.

ABSTRACT

This document provides terminal operators and engineers with an evaluation process for selecting temporary systems for treatment of wastewater generated at petroleum distribution terminals. Some of the variables that must be considered include the characteristics of the wastewater, the permitting process, and contractor experience. The four steps in the process are:

- problem definition
- technology selection
- contractor selection
- implementation

In problem identification, the operator/engineer collects information on the wastewater and terminal site, as well as 1) the constraints of the site, such as location, size and access to utilities, and 2) the applicable permits (e.g., RCRA, NPDES, and air). Once the problem is defined, the next step is to evaluate and select the appropriate treatment technology. This is done by first identifying the contaminants, based on the wastewater characteristics and site/permit limitations defined earlier. In selecting an appropriate treatment technology, the terminal operator/engineer uses information on available temporary treatment technologies, including their efficiencies in treating specific contaminants, and their capital and operating costs. Once the treatment technology is chosen, the terminal operator/engineer selects a competent contractor, taking into account such considerations as contractor experience, level of service, warranties, and cost.

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EXECUTIVE SUMMARY

This document provides guidance to terminal operators and engineers in evaluating mobile treatment systems for wastewater generated at petroleum distribution terminals. Some of the variables that must be considered include the characteristics of the wastewater, the permitting process, and contractor experience. This executive summary provides an overview of the evaluation process; the gray highlight boxes identify the sections in the document for further discussion. The four steps in the process are:

- problem definition
- technology selection
- contractor selection
- implementation

The first step in the evaluation process is to define the treatment problem. The operator/engineer should start by collecting information on the wastewater and terminal site. The wastewater is characterized by:

- Consideration of typical wastewater sources, and
- Sampling and analysis of the terminal's wastewater to define its quality and volume/flow rate.

Identifying the constraints of the site (such as location, size and access to utilities) and the applicable permits (e.g., RCRA, NPDES, and air) completes the problem definition.

> **PROBLEM DEFINITION**
> - Identify and Characterize the Wastewater (Section 2.1)
> - Identify Site and Permit Constraints (Sections 2.2 and 2.3)

Once the problem is defined, the next step is to evaluate and select the appropriate treatment technology. This is done by first identifying the contaminants, based on the wastewater characteristics and site/permit limitations defined earlier. The terminal operator/engineer should use information on the available mobile treatment technologies and their efficiencies in treating specific contaminants (see Tables 3-1 and 3-2) to select an appropriate treatment technology.

The operator/engineer should consider the economic ramifications such as the capital, operation, and maintenance costs as well as the technical feasibility of each technology.

TECHNOLOGY SELECTION (Flow Chart, Figure 3-1)
• Select Technologies Based on Technical Feasibility (Tables 3-1 and 3-2)
• Evaluate Technologies Based on Economic Feasibility (Section 3.3)

Once the treatment technology is chosen, the terminal operator/engineer should select a competent contractor to mobilize and operate the treatment system. In Section 4.0, there is a checklist (Figure 4-1) that identifies the essential elements of contractor selection. The issues to consider in contractor selection are:

- Experience (references and information on current projects)
- Cost (including mobilization, treatment and demobilization)
- Warranty (including liability for pilot tests and permitting)
- Residuals (handling, treatment and disposal)
- Additional services (including analytical and permitting services)

CONTRACTOR SELECTION (Checklist, Figure 4-1)
• Review Experience (Section 4.2)
• Review Financial Qualifications (Section 4.3)
• Review Liability Issues (Sections 4.4, 4.5, 4.6, and 4.7)

Prior to selecting the contractor, the operator/engineer should evaluate the proposed implementation of the mobile treatment system. Also, he/she should review the contractor's past performance and proposed methodology for performing:

- Treatability testing
- Performance verification
- Process control instrumentation
- Startup/shutdown procedures
- Standard Operating Practices (SOPs)
- Operator certification and training (including health and safety)
- Spill control
- Contingencies

Before committing to a mobile treatment system and contractor, the terminal operator/engineer should assess potential pitfalls such as:

- Control of the contractor
- Regulatory changes
- Emergencies
- Accumulation storage (RCRA)

IMPLEMENTATION ISSUES
• Review Oversight Issues (Section 5.0)
• Assess Potential Pitfalls (Section 6.0)

This document provides sufficient information to guide an operator/engineer through evaluation of mobile treatment systems, including problem definition, treatment technology selection, contractor selection and implementation. Additional information and guidance should also be obtained from in-house technical and legal staff, or outside consultants.

1.0 INTRODUCTION

1.1 Purpose of the Document

This document provides guidance to terminal operators and engineers in evaluating and selecting mobile treatment systems for wastewater generated at petroleum distribution terminals.

1.2 Why Consider Mobile Treatment?

Three reasons for terminal personnel to consider the use of mobile treatment include:

- wastewater does not meet final disposal requirements (e.g., NPDES permit limits)
- wastewater flow is of short duration (less than 3 months per year) and can have significant volume (more than 10,000 gallons)
- resources (labor, time, and capital budget) are limited

Mobile treatment systems may not be appropriate for all wastewater streams at a petroleum terminal. In some cases, transportation to an off-site treatment facility or construction of a permanent treatment system is a better choice.

1.3 When to Use Mobile Treatment (Comparison to Other Alternatives)

As indicated on Table 1-1, mobile treatment systems have distinct advantages over other alternatives. Mobile treatment is often more appropriate than on-site permanent treatment or transportation off-site. First of all, mobile treatment requires little or no capital improvements to implement. Treatment can begin rapidly because the mobilization and installation are so quick. Mobile treatment technologies are flexible so that they can be easily moved from site to site to treat flows that occur over a short time period. In addition, the labor and expertise to install and operate a mobile system are supplied by the contractor - a critical consideration when the terminal's resources are limited.

There are some limits, however, to using mobile treatment. Even though capital costs are generally small (e.g., utility hookup), long-term operating costs, and the costs of mobilization and demobilization, should be considered. Residual disposal and treatment costs will also increase the operation and maintenance cost. Another disadvantage of mobile treatment is the liability incurred by having contractor personnel and equipment on site for a period of time.

TABLE 1-1

Comparison of Mobile Treatment to Permanent Treatment and Off-Site Transportation

	Mobile Treatment	Permanent Treatment	Transportation to Off-Site Treatment
Advantages	Minimal Capital Investment Treats Periodic Flow Labor & Expertise Included	Equipment Always Available Treats Continuous Flow	No Capital Investment Required Treats Periodic Flow Minimal Oversight Required Minimal Permitting Administrative Burden
Disadvantages	Cumulative O&M Cost Contractor Liability Oversight Required Size Limited to Mobile Platform Hookups Required	High Capital Cost Labor & Expertise Required	High Transportation Cost for Distant Treatment Facility Expensive for Volumes Above 10,000 Gallons Liability Increased by Transportation Dependent on Acceptance by Treatment Facility

Another drawback is the required time to manage the contractor (e.g., initial negotiations, setup, and oversight).

When considering the use of mobile treatment, weigh the benefits and drawbacks of mobile treatment in relation to the other two alternatives on Table 1-1. The specific characteristics of the terminal (wastewater and location) will affect selection of the most appropriate alternative for the petroleum terminal. In general, mobile treatment should be used if there is a large volume (>10,000 gallons) of wastewater and flow is periodic and of short duration. On the other hand, permanent treatment should be implemented if the wastewater stream is continuous and the flow rate is relatively large. As a rule of thumb, off-site treatment should be used if the wastewater volume is small (<10,000 gallons) and flow is periodic.

1.4 Document Overview

This document addresses the four-step process for evaluating and selecting a mobile treatment system and contractor. Section 2.0 summarizes the problem definition process that includes characterization of the wastewater and identification of permitting and site constraints. Section 3.0 summarizes the treatment technology selection process. Section 4.0 describes the contractor selection process. Sections 5.0 and 6.0 summarize the implementation issues to consider prior to project initiation.

2.0 PROBLEM DEFINITION

Overview

The first step in the evaluation process is to define the treatment problem. Start by collecting information on the wastewater and terminal site. The wastewater is characterized by:

- Consideration of typical wastewater sources, and
- Sampling and analysis of the terminal's wastewater to define its quality and volume/flow rate.

The second step is to identify the problem constraints (e.g., applicable permits and site constraints).

2.1 Wastewater Characterization

2.1.1 Sources, Quality, and Volume of Typical Terminal Effluents

Sources: The primary sources of wastewater at a typical terminal are tank bottoms water (which may be a product, if petroleum hydrocarbons are recovered from it), water collected from secondary containment areas and storm water. Tank bottoms water collects in the bottom of bulk storage tanks. It results from water included in outside deliveries, tank breathing and condensation of moisture in the air, and rain water leaking through floating roof seals. Spill containment wastewater includes all the water that collects in the loading rack spill collection system including minor amounts of oil from drips, leaks and spills. Table 2-1 summarizes the typical sources and likely contaminants in petroleum terminal wastewater.

Quality: Typical marketing terminal wastewater contains dissolved organic matter measured as biochemical oxygen demand (BOD_5), chemical oxygen demand (COD), total organic carbon (TOC), and the soluble fraction of oil and grease, which may include benzene, toluene, ethylbenzene and xylenes (BTEX), phenols, oxygenates, surfactants, and naphthenic acids. Most terminal wastewater will contain oily contaminants including oil and grease, total petroleum hydrocarbons (TPH), and the oily fraction of BOD_5, COD, and TOC (e.g., aliphatics and polynuclear aromatic hydrocarbons [PAHs]). Terminal wastewater usually contains suspended solids and settleable material that can contribute to BOD_5, COD and TOC.

TABLE 2-1

Petroleum Products Terminals Wastewater and Likely Contaminants

Wastewater Type	Oil & Grease	TPH	BOD	COD	TOC	Ammonia	pH high, low	TSS
Tank bottoms water	H	H	H	H	H	H	M	H
Spill containment wastewater	H	H	L	L	L	0	0	H
Truck wash water	H	H	M	M	M	0	H	H
Truck maintenance wastes	H	H	H	H	H	0	L	0
Ballast water	H	H	M	M	M	0	0	M
Produced groundwater	M	M	L	L	L	0	0	0
Vapor recovery water	H	H	M	M	M	0	0	0
Haulback material water bottoms	H	H	M	M	M	0	0	L
Hydrostatic test water	L/0	L/0	L/0	L/0	L/0	0	0	0
Boiler blowdown	0	0	0	0	0	0	H	L
Steam condensate	0	0	0	0	0	0	H	0
Laboratory wastes	M	M	M	M	M	?	?	?
Sanitary wastes	0	0	H	H	H	?	0	H
Detergents	L	L	H	H	H	?	H	H

Wastewater Type	Sulfide	Phenols	TDS	Naphthenic Acids	BTEX	Surfactants	Metals	Toxicity After Treat
Tank bottoms water	M	H	H	H	H	H	L	M
Spill containment wastewater	0	0	0	0	H	0	0	0
Truck wash water	0	0	M	0	0	H	0	M
Truck maintenance wastes	0	0	L	0	0	0	0	H
Ballast water	L	0	H/L	0	?	0	?	M
Produced groundwater	?	0	?	0	H	0	?	L
Vapor recovery water	0	0	0	0	H	0	0	0
Haulback material water bottoms	0	0	0	0	H	0	0	L
Hydrostatic test water	0	0	L	0	0	0	0	0
Boiler blowdown	0	0	H	0	0	0	?	L
Steam condensate	0	0	0	0	0	0	0	0
Laboratory wastes	?	?	?	0	?	?	M	?
Sanitary wastes	M	0	L	0	0	M	L	?
Detergents	0	0	H	0	0	H	0	M

H = High concentration or probability
M = Medium concentration or probability
L = Low concentration or probability
0 = Very low concentration or probability
? = Unknown concentration or probability

(Source: Texaco Inc. 1994)

Note: Toxicity refers to the toxic effects of wastewater on aquatic life as measured by acute or chronic bioassays.

Table 2-2 presents research data on the concentration of parameters commonly found in terminal wastewater.

Volume: Wastewater volume at petroleum terminals varies considerably and should be characterized, if possible, at each terminal prior to treatment. The volume of the wastewater, and the time frame during which the wastewater must be treated, determine the flow rate. This flow rate is required to properly size the storage, equalization and treatment units. Based on previous surveys, terminal effluent is produced at a rate of approximately 1000 gallons per week (Texaco, 1994). Yearly wastewater production at terminals can range from 10,000 to 100,000 gallons (Brown and Caldwell, 1986). Tank bottoms water makes up a small portion of the wastewater flow, but contains recoverable product. Storm water collected in loading rack spill containment systems (spill containment wastewater) makes up a larger portion of the flow. Hydrostatic test water, on the other hand, may result in high flow rates because the large volume (from a bulk storage tank or pipeline) is released over a short time period.

Flow characterization data determine the size of feed, equalization, or effluent storage tanks for continuous wastewater treatment. Wastewater flows from a feed tank through the treatment units and into an effluent collection tank. If feed water and effluent storage tanks are provided, feed water and effluent can be characterized prior to treatment and discharge. The treatment technology can be adjusted to feed water characteristics and compliance with permit limits can be demonstrated. These advantages often justify the cost of the storage tanks. Once the wastewater characteristics are consistent and the technology is proven, effluent discharge without collection may be more economical. As a rule of thumb, it is impractical and expensive to collect effluents of greater than approximately 50,000 gallons.

2.1.2 Characterization of Specific Wastewater Streams

Identification of Contaminants of Concern: Contaminants of concern are those chemical parameters that are limited by a discharge permit or those that limit the effectiveness of potential treatment technologies. These compounds can be identified by reviewing existing characterization data, considering which parameters may be in the water as a result of operations, and reviewing existing permits. Once the parameters are identified, appropriate analyses can be defined. Table 2-3 describes the analyses for compounds commonly regulated in discharge permits for the petroleum industry.

TABLE 2-2

Terminal Wastewater Quality*

Contaminant	Units	Gasoline Tank Bottoms(9)			Diesel/Fuel Oil Tank Bottoms(2)			Terminal Wastewater(4)		
		Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum
BOD	ppm	4369	7177	1961	1305	1617	982	1412	2600	570
COD	ppm	27778	58000	8075	8688	9175	8200	3935	6000	1700
TOC	ppm	5936	12760	2741	1786	2381	1191	999	1980	290
Oil & Grease	ppm							100	240	25
TPH	ppm							42	250	2
Ammonia	ppm	1650	4300	16	1635	2500	770	22.7	116	0.1
Benzene	ppm							5.3	11	0.8
Toluene	ppm							9.3	19	0.11
Xylenes	ppm							5.6	14	0.011
Ethyl Benzene	ppb							2397	6200	180
MTBE	ppm							105	290	8.5
Methanol	ppm							143	630	<1
Ethanol	ppm							4	12	<1
Phenols	ppm							10	52	0.4
2,4 Dimethyl Phenol	ppb							603	1300	97
MBAS	ppm							6.1	16.2	1.1
CTAS	ppm							5.4	14	0.2
TSS	ppm							195	768	45
TDS	ppm							1893	3660	646
Conductivity								2260	4000	1013
Sulfide	ppm							<0.5	2	<0.01
Cyanide	ppm							<0.01	<0.01	<0.005
Arsenic	ppb	6073	20794	381	101	195	6	167	430	28
Cadmium	ppb		<3	<3	<3	<3	<3		14	<5
Chromium	ppb		62	<5		<5			90	<10
Copper	ppb	3576	8028	179	1478	2235	720		550	<20
Lead	ppb		1669	<1		<1			550	<60
Mercury	ppb		1	<0.2		<0.2				
Nickel	ppb	345	779	30	66	100	31			
Zinc	ppb	2153	9696	126	246	445	47	492	1700	20

TABLE 2-2 (Cont'd) *

Contaminant	Units	Gasoline Tank Bottoms(13)			Diesel Tank Bottoms(2)			Jet A Tank Bottoms(4)		
		Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum
TOC	ppm	1796	5570	553	923	1300	546	706	2560	54.9
Oil & Grease	ppm	12	42	2	253	265	241	35	131	2
pH		6.26	7.43	5.55	7.98	8.15	7.81	6	7.36	4.26
Benzene	ppm	27	52	12	0.435	0.46	0.41	0.28	0.52	0.034
Toluene	ppm	68	240	8	0.635	0.92	0.35	3.15	10	0.19
Xylenes	ppm	23	165	4.1	0.81	1.06	0.56	1.02	2.06	0.53
Ethyl Benzene	ppm	7	50	0.35	0.54	0.72	0.36	0.25	0.77	0.037
Naphthalene	ppb	735	2200	190	545	550	540	1361	4100	3
Phenols	ppm	29	80	1.2	23.8	42	5.6	7.47	27	0.4
2,4 Dimethyl Phenol	ppb	1550	8500	21	7700	14000	1400	191	450	4.2
TSS	ppm	144	512	7	21	36	6	36	64	12
TDS	ppm	22353	50500	3920	24750	26900	22600	20775	32800	11800
Chloride	ppm	10646	19600	1670	13350	14900	11800	10330	17600	6120
Sulfate	ppm	1424	2430	168	524	715	333	1095	2410	284
Cyanide	ppm	0.050	0.216	0.005	0.093	0.181	0.005	0.006	0.01	0.005
Arsenic	ppb	218	903	5	163	213	113	152	514	10.2
Cadmium	ppb	5	16	2	3.5	5	2	4.8	7	3
Chromium	ppb	6	12	3	6.5	7	6	163	625	3.6
Copper	ppb	33	160	3	4.5	6	3	4.8	7.3	2
Iron	ppm	42	144	1.29	4.06	6.73	1.39	19	37.1	5.29
Lead	ppb	150	754	3	3	3	3	1060	4180	3
Mercury	ppb	0	1.3	0.2	0.2	0.2	0.2	0.20	0.2	0.2
Nickel	ppb	91	645	12	15	15	15	139	515	12
Selenium	ppb	64	183	5	35.4	65.8	5	35.9	44.5	30.6
Zinc	ppb	1039	7630	24	157	312	2	876	2460	147

*From analysis of samples of tank bottoms and terminal wastewaters. Numbers in parentheses on column titles are the number of samples in the data sets. Data were taken from the following sources:
Analysis and Reduction of Toxicity in Biologically Treated Petroleum Product Terminal Tank Bottoms Water, API 4665, April 1998.
Comparative Evaluation of Biological Treatment of Petroleum Product Terminal Wastewater by the Sequencing Batch Reactor Process and the Rotating Biological Contractor Process. API 4582, July 1992.
Minimization, Handling, Treatment, and Disposal of Petroleum Products Terminal Wastewaters, API 4602, 1994.
(Source: Texaco Inc. 1994)

TABLE 2-3

Common Petroleum Industry Wastewater Analyses

Test	Abbr.	Reference* (provided for general method information only; refer to your NPDES permit for guidance on specific method and reference)		Vol., mL	Container	Preservation**	Hold Time	Description	Interferences
		SM	EPA						
Biochemical Oxygen Demand	BOD-5	5210 B	405.1	1000	P,G	4°C	24 H	Oxygen uptake from biologically seeded samples at various dilutions	Ammonia may or may not nitrify to show nitrogenous BOD; to suppress, use nitrification inhibitors
Chemical Oxygen Demand	COD	5220 B 5220 C 5220 D	405.1 410.1 410.3 410.4	50	P,G	SA to pH <2	7 D	Consumption of strong chemical oxidizing agent	High chloride levels can show up as COD
Total Organic Carbon	TOC	5310 B 5310 C 5310 D	415.1	25	P,G	4°C SA to pH <2	24 H	Combustion and measurement of CO2 evolved	None
Oil and Grease, Gravimetric	O&G	5520 B	413.1	1000	G	4°C SA to pH <2	24 H	Extraction of oil from acidified sample with Freon®, evaporation of Freon® and weight of residue	Elemental sulfur is extracted by Freon®, and shows up as O&G; soluble material such as organic acids are also extracted
Oil and Grease, Infrared	O&G IR	5520 C	413.2	1000	G	4°C SA to pH <2	24 H	Extraction of oil from acidified sample with Freon®, determination of extract infrared spectrum in hydrocarbon bands	Soluble material such as organic acids are also extracted, but can be quantified as carbonyl bands in IR spectrum
Total Petroleum Hydrocarbons	TPH	5520 F	418.1 (IR)	1000	G	4°C SA to pH <2	24 H	Same as gravimetric or IR oil & grease, except that Freon® is treated with silica gel to remove polar organic compounds	Sulfur may be detected in gravimetric procedure

TABLE 2-3 (Cont'd)

Test	Abbr.	Reference* (provided for general method information only; refer to your NPDES permit for guidance on specific method and reference)		Vol., mL	Container	Preservation**	Hold Time	Description	Interferences
		SM	EPA						
Phenolics	Phenols	5530 C 5530 D	420.1 420.2 420.3	500	G	4°C PA to pH <4 CuSO4	24 H	Distillation, Chloroform extraction of colored complex made from 4-aminoantipyrine and K3Fe(CN)6. Colormetric or photometric finish	
Anionic Surfactants - Methylene Blue Active Substances	MBAS	5540 C	425.1	250	P,G	4°C	24 H	Extraction of surfactant-methylene blue dye complex into chloroform, spectrophotometric finish	Soaps (long-chain organic acid salts), although anionic surfactants, do not show up. Use sublation to purify and concentrate sample
Nonionic Surfactants - Cobalt Thiocyanate Active Substances	CTAS	5540 D		250	P,G	4°C	24 H	Extraction of cobalt thiocyanate into chloroform, spectrophotometric finish	Use sublation to purify and concentrate sample
Benzene, Toluene, Ethylbenzene, Xylenes	BTEX	6210 B/E 6220 B/D	602	40	G VOA Bottle	4°C 4 drops 6N HCl	14 D	Inert gas purging of water and collection of vaporized organics on a carbon trap, followed by heating the trap to drive vapors into a gas chromatograph, with various detectors	
Naphthenic Acids	NA			1000	G	4°C SA to pH <2	24 H	Run the same as oil & grease infrared method, except that naphthenic acid carbonyl peaks are used to make quantitative determination vs. standard naphthenic acids	Other carboxylic acids (such as soaps) may interfere

TABLE 2-3 (Cont'd)

Test	Abbr.	Reference* (provided for general method information only; refer to your NPDES permit for guidance on specific method and reference)		Vol., mL	Container	Preservation**	Hold Time	Description	Interferences
		SM	EPA						
Ammonia	NH3	4500-NH3 A/H	350.1 350.2 350.3	400	P,G	4°C SA to pH <2	24 H	Colorimetric phenate, colorimetric nessler, alkaline distillation and titration, ion-specific electrode	Amines are a positive interference
pH	pH	4500-H+ B	150.1	25	P,G	On-site		pH electrode	None
Acidity		2310 B	305.1	100	P,G	None	24 H	Titration with standard NaOH solution to pH endpoint	None
Alkalinity		2320 B	310.1 310.2	100	P,G	4°C	24 H	Titration with standard acid solution to pH endpoint	None
Sulfide	S=	4500 S2-D/E	376.1 376.2	500	P,G	2 mL zinc acetate NaOH to pH >9	24 H	Methylene blue colorimetric or iodometric	Reducing agents interfere. To isolate sulfide, precipitate with zinc acetate, discard water, and analyze precipitate.
Arsenic	As	3113 3114 3120	206.2 206.3 206.4 206.5	200	P,G	NA to pH <2	6 Mo	Electrothermal atomic absorption. Hydride generation atomic absorption. Inductively coupled plasma.	
Selenium	Se	3113 3114 3120	270.2 270.3	200	P,G	NA to pH <2	6 Mo	Same as arsenic	
Copper	Cu	3111 3113 3120	220.1 220.2	200	P,G	NA to pH <2	6 mo	Flame atomic absorption. Electrothermal atomic absorption. Inductively coupled plasma.	

TABLE 2-3 (Cont'd)

Test	Abbr.	Reference* (provided for general method information only; refer to your NPDES permit for guidance on specific method and reference) SM	EPA	Vol., mL	Container	Preservation**	Hold Time	Description	Interferences
Lead	Pb	3111 3113 3120	239.1 239.2	200	P,G	NA to pH <2	6 Mo	Same as Cu	
Zinc	Zn	3111 3120	289.1 289.2	200	P,G	NA to pH <2	6 Mo	Flame atomic absorption. Inductively coupled plasma.	
Total Dissolved Solids	TDS	2540 A	160.1	100	P,G	4°C	7 D	Evaporate 0.45 micron filtrate to dryness @105°C, weigh	
Total Suspended Solids	TSS	2540 D	160.2	100	P,G	4°C	7 D	Filter through 0.45 micron filter, dry filter paper @105°C, weigh	
Volatile Suspended Solids	VSS	2540 E	160.4	100	P,G	4°C	7 D	Ignite TSS filter paper @550°C, weigh	

*References:
SM = Standard Methods for the Examination of Water and Wastewater, APHA, AWWA, WEF, 18th Edition
EPA = U.S. Environmental Protection Agency,"Methods for Chemical Analysis of Water and Wastes," 3rd Edition
**Preservatives: SA = sulfuric acid; NA = nitric acid; PA = phosphoric acid
(Source: Texaco Inc. 1994)
(Note: Hexane will replace Freon in the extraction of oil for oil and grease and total petroleum hydrocarbon analyses under proposed EPA Method 1664)

Wastewater Sampling: Once the contaminants of concern and appropriate analytical methods are selected, samples are collected. The details of sample collection are included in other documents (Texaco, 1994; USEPA, 1988). Key issues to consider when sampling are:

- determining sample collection location
- documenting sample collection and transport (i.e., chain of custody)
- assuring representative samples
- assuring proper sample size, type (composite or grab), container (e.g., VOA vial, etc.), and preservation
- collecting quality assurance samples (i.e., duplicates and blanks)

2.2 Identification of Permitting Constraints

Permitting requirements generally define the performance goals of the required treatment or the solution to the problem. Therefore, it is essential to evaluate existing and potential permitting requirements as soon as possible. The issues to consider when identifying permit constraints are:

- applicable regulations (including NPDES, RCRA)
- discharge options
- agency relations

These three issues are considered together in defining the treatment process. The applicability of the regulations depends on the discharge option selected (and vice versa). Communication with local and federal agencies is critical in determining which regulations apply.

2.2.1 RCRA Considerations

Because the Resource Conservation and Recovery Act (RCRA) regulations, as well as NPDES regulations, have an impact on wastewater handling at petroleum distribution terminals, RCRA regulations are discussed in some detail here. Terminal operators should be aware that states authorized to implement RCRA are required to meet the USEPA RCRA standards *as a minimum*. If they choose, states can elect to implement stricter regulations pertaining to the handling of RCRA-regulated wastewater. States also differ in their approach to regulating on-site and off-site treatment and the use of contractors providing transportable treatment units. The terminal should always seek to keep informed of its state's regulatory requirements.

Terminal wastewaters have the potential to be classified as hazardous under RCRA if they have hazardous characteristics (i.e., ignitability, reactivity, corrosivity or toxicity). Some terminal wastewaters have the potential under RCRA to be defined as possessing the characteristic of toxicity due to elevated benzene levels, hence the following discussion addresses this toxicity characteristic. The other characteristics (ignitibility, reactivity and corrosivity) are not discussed further, because relatively few terminal wastewaters would possess such characteristics as defined in RCRA.

Tank bottoms water from petroleum product storage tanks may exhibit leachable benzene concentrations that exceed the Toxicity Characteristic Leaching Procedure (TCLP) limit of 0.5 mg/L, used to classify wastes as characteristically toxic under RCRA (40 *CFR* 261.24). Depending on whether or not the tank bottoms water undergoes product recovery (see below), TCLP exceedances may indicate RCRA requirements on handling and disposal must be met. TCLP limits have been set for several contaminants other than benzene (e.g., arsenic, cresol, lead, selenium); naturally, if leachable concentrations of these contaminants exceed TCLP limits, the same considerations apply. As state regulations may be more stringent, both federal and state regulations should be consulted to determine the appropriate course of action.

<u>Product Recovery</u>: Figure 2-1 presents a simplified flow diagram showing the various options for handling, treating, and disposing of water/product mixtures from petroleum terminals. The first step is to determine if further product recovery is viable. RCRA applies only to wastes, not products. As long as a product is being recovered, the water/product mixture is not yet a waste.

Mixtures of product and water, even if mostly water, may not be classified as waste during their generation, storage, and transportation, if useful product will be recovered from the mixture. Typically, hazardous wastewater is generated only after it leaves a product recovery operation such as a product recovery tank or an oil/water separator. In some cases, petroleum product terminals can ship process waters back to the refinery as product without any RCRA implications as long as the refinery recovers the product from the water/product mixture.

<u>Wastewater Handling Through NPDES and/or a POTW</u>: If further product recovery is not viable, the next step is to determine if the wastewater is hazardous. Analyze a representative sample of the wastewater for the TCLP criteria. If the wastewater does not contain contaminant concentrations equal to or greater than the applicable TCLP limits, the wastewater is not hazardous and can be managed as non-hazardous solid waste. If the wastewater is classified as hazardous, it may be possible to directly discharge the wastewater under a NPDES permit or

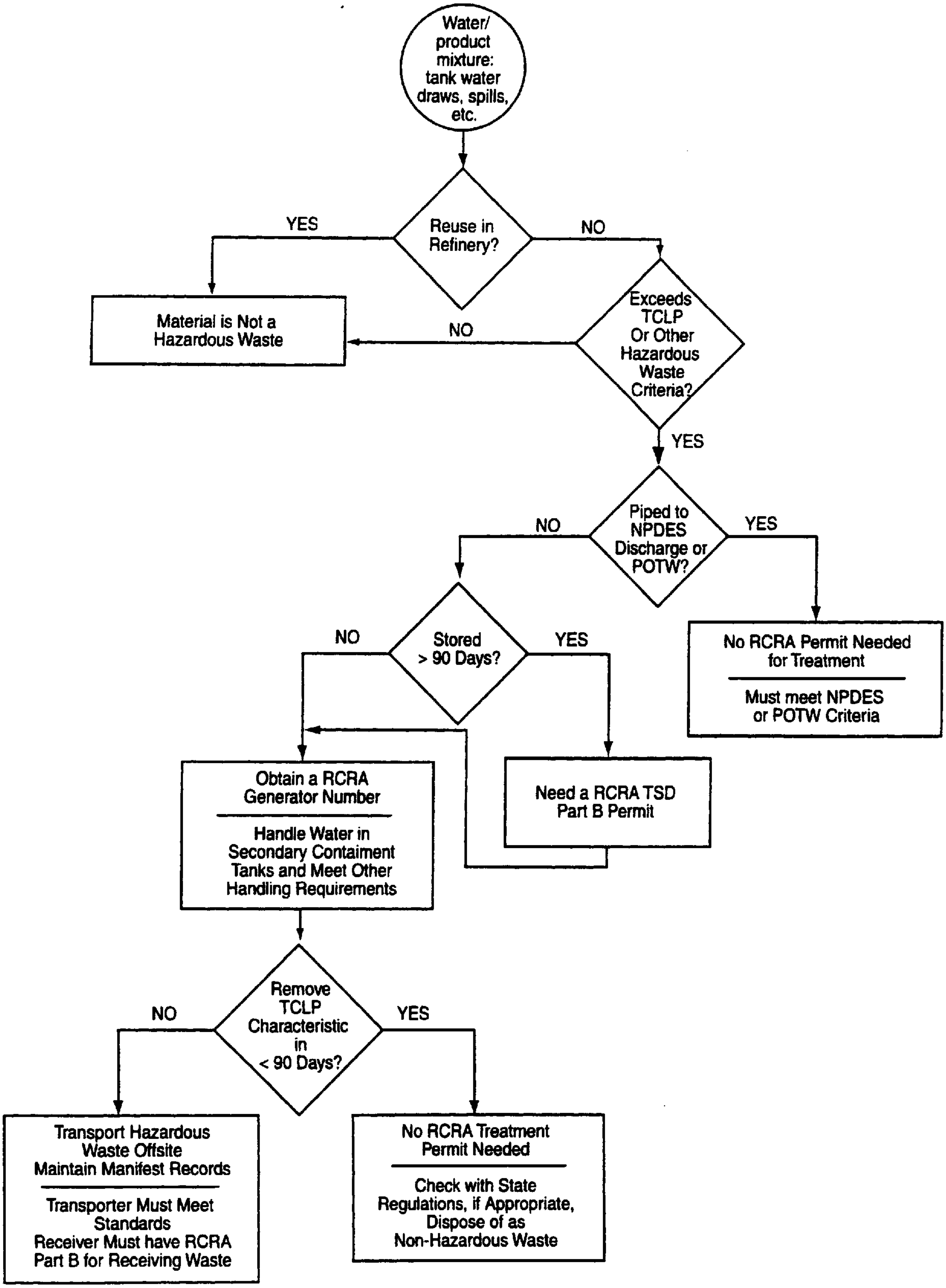

Figure 2-1
RCRA Guide for TCLP Hazardous Wastewater

indirectly discharge it through an NPDES-permitted POTW. As long as the wastewater is handled in tanks and delivered by hard piping (not earthen ditches or ponds) throughout the treatment system, outfall, or municipal sewer, the material is exempt from RCRA regulations.

Be aware that there are time limitations (as discussed further below), for storing a characteristically hazardous wastewater before discharge. These time restrictions depend on how the material is handled. Typically, the terminal should not store hazardous waste for longer than 90 days before discharge, treatment, or disposal.

Treatment and Disposal: The terminal can choose to treat the wastewater to non-hazardous levels and then dispose of it as non-hazardous waste (see below). If this is not feasible, the terminal can dispose the wastewater as hazardous waste. Disposing of the wastewater as hazardous waste requires meeting specific RCRA requirements including manifesting, labeling, and record keeping. Only approved hazardous waste transporters may transport the hazardous waste. In addition, the final treatment/disposal facility must have a RCRA permit that allows them to receive, store, treat, and dispose of such wastes. Be aware that *the generator retains all legal liability for the waste for all time.* It is very important to verify that on-site and off-site contractors (transportation, treatment, and/or disposal) are complying with all of the applicable laws, including RCRA.

If the terminal chooses to treat the wastewater on-site prior to disposal, most states will not require a RCRA permit as long as the storage and treatment are done within 90 days and the material is exclusively handled in tanks with secondary containment. This applies to on-site contractors as well. Be aware that different handling practices affect how the regulations are applied. For example, a contractor who transfers the wastewater via hard piping from the facility's tank into a transportable treatment unit, and discharges from that unit via hard piping under an NPDES permit, would not be required to obtain a RCRA permit. Similarly, a contractor discharging an effluent via hard piping to an NPDES-permitted POTW would also not require a RCRA permit. However, if that same contractor placed the effluent in a truck and transported the material to a POTW, a RCRA permit may be required even if the effluent is non-hazardous. Terminal operators should obtain regulatory advice prior to treating hazardous wastewater on-site. In addition, it is very important to analyze the treated wastewater periodically to verify its non-hazardous classification.

2.2.2 Discharge Options

Based on the regulatory context described above, the constraints of the various discharge options should be defined prior to selecting a treatment system. If the discharge limits require benzene removal, for example, then the mobile system should remove benzene in addition to other contaminants of concern. The four treated wastewater discharge options that have potential permitting constraints include:

- Discharge to a local POTW
- Discharge to a local surface water
- Discharge to groundwater
- Disposal at an off-site location

An existing discharge permit may be the simplest means of wastewater disposal. (Return of the wastewater to a refinery for product recovery does not require a permit.)

POTW: The local publicly owned treatment works (POTW) is generally a biological wastewater treatment facility. With the municipality's permission, treated water may be discharged to the POTW via an existing sewer connection to the municipal sanitary sewer. Because POTWs operate under NPDES permits, they will only accept discharges that meet pretreatment limits. The municipality usually charges fees that can increase over time. If an existing sewer is unavailable, the contractor may have to install a temporary connection to the POTW.

Surface Water Discharge: Discharge to a local water body directly or via a storm sewer may be appropriate for treated effluent from mobile treatment systems, if the proper permits are obtained. The costs and regulatory requirements make this option difficult, except in the case where a general permit applies. Obtaining an NPDES permit is a time-consuming process (several months). In some special cases, such as one time or rare (once every 10 years) discharges, a temporary discharge permit (usually lasting a month) may be obtained.

Groundwater Discharge: Discharge to groundwater via an infiltration basin may be an option for treated effluent in locations where other discharge options are not possible. Permits for groundwater discharge can be difficult to obtain or prohibited in some states. Consult state and local agencies to determine if such a discharge option is available. Generally, permits for groundwater discharge require the installation of groundwater monitoring wells, and regular water sampling of these wells to ensure compliance with permit requirements.

Off-Site Disposal: Hauling treated wastewater off site for disposal at a commercial waste disposal facility is a viable option. Most commercial waste disposal companies must meet discharge permit requirements and will only accept wastewater that complies with their requirements for certain parameters of concern. For example, if the benzene levels exceed the RCRA TCLP criterion after treatment, the waste disposal company will accept the waste as a hazardous waste and charge more for treatment than for a non-hazardous waste.

2.2.3 Agency Relations

Identifying permitting constraints usually involves contacting the regulatory agencies. If possible, the regulatory agency should be contacted early in the process. A positive and cooperative attitude with agency personnel goes a long way toward obtaining accurate permitting information and eventually obtaining appropriate permit limits.

Contacts: Agency representatives must be contacted during the problem definition phase of the project, either to obtain permit requirements or specific information on the state's interpretation of regulations. Prior to contacting regulators, as much information as possible should be obtained from internal resources (e.g., corporate environmental staff) or from external industry association experts. When contacting the agency:

- Find the correct person at the local agency. This may be the most difficult part of the process. At least one person within the terminal will have had previous contact with the agency. If this is not the appropriate contact, he/she will usually direct you to the correct agency contact.

- Do not leave a message, unless it is the appropriate agency contact. Asking the receptionist for an equivalent person who can help will generally save time.

- Follow corporate protocol. Obtain the proper procedure and approval to contact the agency. Sometimes ongoing negotiations can be hindered by phone calls to inappropriate contacts.

- Do not give out more information than required, especially if questions are generic in nature.

Routine Reporting Requirements: One of the critical permitting constraints to identify during consideration of discharge options is routine reporting of discharge monitoring results associated with each option. Typical NPDES permits (for direct discharge to surface water or groundwater) require monthly reporting of monitoring results using discharge monitoring reports (DMRs). Local permits (for discharge to a POTW) generally require less frequent reporting (i.e., quarterly or biannually) of monitoring results. Obtain information on routine reporting requirements from corporate environmental staff or industry association experts prior to contacting the regulatory agency.

Negotiations: In most cases, it is unlikely that permit limitations will be negotiated at the commercial terminal level. Most negotiations should be completed by corporate staff because they generally have the experience and resources to discuss complex regulatory issues. Keep in mind that it is indeed possible to renegotiate a NPDES permit once it has been issued. However, it can be more difficult to renegotiate rather than to obtain favorable permit limitations in the first place. These negotiations can be complex and require a thorough understanding of the regulations. Consultants or other technical resources should be contacted when attempting negotiations.

2.3 Identification of Site Constraints

In addition to wastewater characterization and permitting limits, identifying potential site constraints is essential to defining the wastewater treatment problem. The following issues should be considered:

- utilities
- site location and access
- available storage area
- available staff
- facility specific safety protocols (e.g., electrical classification, confined space entry)

Because mobile treatment systems are designed with relocation in mind, provision must be made for utility hookups and a stable platform. The terminal is usually responsible for providing the following utilities:

- water
- electricity
- air
- lighting
- sanitary sewers

In addition the terminal is usually responsible for installing the hookup (e.g., electrical lines and boxes) and paying for usage (e.g., electric or water bills from the local utility). In most cases, a graded gravel or paved surface is sufficient for mobile treatment systems. In some cases a concrete pad may be required, as, for example, for a skid-mounted unit. See Sections 3.3 and 5.4 for more details on hookup installation costs and logistics.

Some terminals may not have adequate storage area for small mobile treatment units. The location of the mobile treatment unit within the terminal may be a limitation in terms of utilities and fire prevention. For example, even though there may be sufficient space around bulk storage tanks, the electrical equipment (without adequate spark protection) on a mobile unit may preclude locating the unit near the tanks.

Depending on the terminal, there may be a variety of staffing configurations to monitor mobile treatment units. If no terminal staff are available, then the contractor should be responsible for all the activity during the treatment process. Terminal staff are responsible for contractor oversight. If staff are available, then the terminal could assume some responsibility for monitoring and maintenance tasks. Such arrangements should be clearly defined with regard to responsibilities, liabilities and emergency procedures.

3.0 TREATMENT TECHNOLOGY SELECTION PROCESS

Overview

Once the wastewater is characterized and the site constraints are identified, the appropriate treatment technology can be chosen. Treatment technology selection can be a collaborative effort between the terminal operator and the contractor; however, it often is performed by the contractor alone. The contractor will often choose a technology that is most familiar and can treat wastewater profitably. This section presents a logical selection process so that the terminal operator can, at a minimum, confirm that the contractor has selected the most appropriate technology to treat the wastewater to specified permit limits, within budget, without hindering operations, and meeting all applicable regulations.

3.1 Selection Process Description

There are five steps to selecting the appropriate mobile treatment technology:

- Identification of Potential Technologies
- Evaluation of Technical Feasibility
- Evaluation of Administrative Feasibility
- Evaluation of Economic Feasibility
- Comparison and Selection of Appropriate Technology.

<u>Identification of Potential Technologies</u>: The first step in the selection process is refining the problem definition. Analytical results from the wastewater characterization should be compared with the limits identified for the existing or potential permit. This comparison determines which parameters must be treated.

<u>Evaluation of Technical Feasibility</u>: The second step in the selection process is to screen potential technologies for their ability to treat the pollutants to meet the limits of the existing or potential permit. To make this determination, obtain independent treatability test results and as much other information as possible to prove that a proposed technology can attain the required results. See Section 5.1 for a description of treatability testing. For conventional technologies this information is readily available in EPA databases, engineering textbooks, and API manuals (Metcalf & Eddy, USEPA RREL, Texaco). For innovative technologies, this information is often more difficult to obtain. Contact local vendors or industry associations regarding the performance of certain technologies.

A technology can only be effective if certain conditions are met. It is important to identify the conditions that limit treatment. For example, high iron concentrations can foul an air stripper. Pretreatment requirements for each technology can be identified during this evaluation by consulting the resources cited above. It is also important to consider the limitations of certain treatment processes under adverse weather conditions (e.g., biological treatment is limited by extreme cold) or other site characteristics when evaluating technical feasibility.

Evaluation of Administrative Feasibility: The third step in the process is to evaluate the administrative feasibility of the technology. Questions to ask include: Is the treatment unit available for the work? Can it be mobilized to the terminal in time for the planned activity (e.g., hydrostatic test)? Can it remain as long as it is needed?

The other measure of administrative feasibility is permitting. Can the terminal obtain a permit to operate the mobile treatment system within its implementation schedule? Sometimes the regulatory review process can delay the implementation of certain innovative technologies, or even some conventional technologies, for several months.

Evaluation of Economic Feasibility: The fourth step in the evaluation is to consider the cost of each technology, including the preparation, operation and maintenance costs, including utility, chemical and energy costs, and residuals disposal costs. Pretreatment and weatherization costs should also be considered.

Comparison and Selection of Appropriate Technology: The final step in the process is the selection of the most appropriate technology. Technology selection begins by comparing each technology. This can be as simple as creating a table specifying the relative feasibility of each technology, or as complicated as developing a scoring system to rate each technology. Because differences among some alternatives may be subtle, it is critical to evaluate and select the technology based on site-specific conditions.

3.2 Treatment Technologies

The mobile treatment technologies most appropriate to wastewater generated at a marketing terminal include:

- oil-water separation
- biological treatment
- chemical oxidation
- activated carbon adsorption
- air stripping
- filtration
- flocculation/precipitation/clarification
- alkaline stripping

These technologies can treat a variety of wastewater streams. Table 3-1 identifies the treatment technologies which are most suitable for treatment of a given parameter. Many of these technologies can be used sequentially (e.g., sand filtration followed by activated carbon adsorption). Table 3-2 briefly describes the advantages and disadvantages of each technology. For further details on these technologies, see API Publication Number 4602 (Texaco, 1994). In some regions, these technologies may not be readily available as mobile treatment units. As a result, the contractor may have to custom-assemble a skid or trailer mounted system to treat a specific wastewater.

3.3 Cost Evaluation Procedures

One of the critical aspects of technology selection is cost because it impacts the operating budget of the terminal. Costs for mobile treatment systems are based primarily on the distance to the site and the volume of wastewater to be treated. For example, for volumes (generated on an infrequent periodic basis) less than 10,000 gallons, it is generally less expensive to have the wastewater hauled away for treatment than to use an on-site mobile treatment system. Comparable cost estimates should be obtained from at least three contractors. Experienced contractors can be found in buyer's guides (under the headings "waste management or treatment" or under the specific technology) published annually by industry magazines, in the local or regional yellow pages; and on the Internet. The most practical method of obtaining comparable cost estimates is by submitting a formal letter request defining the scope of work, the assumptions and the method of costing (lump sum or time-and-materials). If the request is verbal, the contractors should respond with a written proposal that includes any assumptions.

Once a written quote is provided, each proposal should be checked to verify every contractor has included a similar itemized list. This will ensure an accurate comparison. If a required item is not included, the contractor should be contacted to obtain additional information. Typical items included in contractor quotes are:

TABLE 3-1

Contaminants and Appropriate Treatments

Treatment Technology	Organics	BTEX	Separable Oil	Emulsified Oil	Suspended Solids	Soluble Metals	Ammonia	Phenol	Sulfide	MTBE	Organic Toxicity
Oil Water Separation			1								
Biological Treatment	1	1		1	1	1	1	1	2		1
Chemical Oxidation	2	2						2	1	1	2
Activated Carbon Adsorption	2	2		2		3		2			2
Air Stripping		1								2	
Filtration				3	2						
Precipitation						2					
Alkaline Stripping							2				

Numbers are the approximate order of suitability of a treatment for a contaminant; 1 = most suitable; 2 = next most suitable; Blank means not suitable
From API Publication Number 4602 (Texaco, 1994)

TABLE 3-2

Treatment Technology[1] Description

Treatment Technology	Description	Advantage	Concern
Oil/Water Separation	Physical separation of oil via gravity, mechanical means or coalescence.	Simple reliable operation.	Emulsions and soluble compounds not removed. Emulsions may increase dissolution of BTEX.
Biological Treatment	Aerobic biological degradation of pollutants in the water.	Aerobic biological treatment is effective for many organic pollutants, including BTEX and phenol. Biological treatment is a commonly-used technology for treatment of biodegradable organics. Biological systems can be operated intermittently or continuously.	If toxins are present in the water they could inhibit biodegradation. Air emissions from aeration vessel may require additional controls. Handling/disposal of sludge may be required. Requires consistent waste stream characteristics. Requires protection (heat, insulation, covers) in cold weather.
Chemical Oxidation	Addition of chemicals to oxidize pollutants in the water and thereby achieve destruction.	Chemical oxidation, or a combination of UV radiation and chemical oxidations, may remove a variety of organic pollutants including BTEX, oxygenates, and phenols.	Incomplete destruction may generate harmful intermediate products. Effectiveness dependent on the oxidant and its stoichiometric excess. Ignition source possible. UV/oxidation configuration is difficult to render explosion proof. Flow equalization required.
Activated Carbon Adsorption	Adsorption on activated carbon to remove VOCs, BTEX, phenols and other adsorbable contaminants.	Carbon adsorption can be used as a treatment step, or as a polishing step. Carbon adsorption is a proven technology for removal of adsorbable organics. Carbon can be operated intermittently or continuously.	Concentrated wastes containing adsorbable organics may exhaust carbon capacity quickly. Spent carbon requires further handling. Pretreatment for solids removal may be required.

TABLE 3-2 (Cont'd)

Treatment Technology	Description	Advantage	Concern
Air Stripping	Stripping to remove volatile organic compounds such as chlorinated VOC and BTEX.	Stripping will remove VOCs and some semivolatile organics by transfer of pollutants to vapor phase. Advantages include simplicity of operation and ability to operate intermittently.	Air emissions control such as vapor phase carbon adsorption or catalytic oxidation may be required on stripper. May need an air permit for air stripper. Potential for biofouling with high BOD waste streams. Pretreatment for metals removal may be required. Small strippers with high air:water ratio may freeze (unless using heated air) in cold weather. May need reduction in off-gas humidity to maintain acceptable vapor treatment efficiency.
Filtration	Filtration is the removal of insoluble materials, usually suspended solids, via granular media or paper or cloth.	Relatively compact and proven technology for removal of materials that may interfere with treatment and discharge.	Potential for production of side stream from filter backwash, which may need further treatment.
Precipitation/ Flocculation	Conversion of soluble substance to insoluble form (salt) and particle agglomeration. Applicable for removal of dissolved or suspended material.	Used to remove dissolved or suspended material in relatively large quantities. Proven technology for removal of metals and other material that may interfere with treatment and discharge.	Potential to generate sludge requiring further handling and disposal. Flow equalization required.
Alkaline Stripping	Increase pH in air stripper influent to about 10.8-11.5 with caustic or lime addition to enhance ammonia removal.	Removes ammonia when biological treatment is not viable.	Potential to corrode appurtenant equipment. Highly susceptible to air temperature variations. Large flow variations may make pH control difficult.

Note:
[1]All the treatment techniques have been adopted reliably for mobile treatment. As noted above, the use of biological treatment may be limited by its relatively slow acclimation to variations in wastewater characteristics.

- mobilization/demobilization cost
- treatment cost (unit cost in $/gallon)
- treatment residual management/treatment cost
- non-treatment costs (permitting, treatability studies), laboratory analysis

In addition, the contractor will include a list of assumptions and conditions. These items should be examined carefully to ensure that the terminal is not responsible for a task that cannot be performed. For example, if no power is available in the area where the mobile treatment unit will be located and the terminal cannot provide power, then the contractor should provide it. The quote should clearly state which party is responsible for expenses such as:

- site preparation/access
- utility hookup (including sewer discharge)
- chemicals
- power (and other utility costs)
- process instrumentation
- monitoring (sampling and analysis)
- routine maintenance

Generally the terminal is responsible for providing site preparation, utility hookup and utility costs. In addition, the quote should be checked for potentially hidden costs for each technology as listed below:

- Oil/water separation - oil and sludge disposal costs, vapor handling, parts replacement costs.
- Biological treatment - electrical costs in aerated systems, bacteria seeding and nutrient costs, costs of coagulants and other chemical additives, sludge disposal costs.
- Activated carbon adsorption - disposal of used carbon (potentially as a hazardous waste) or reactivation of the carbon and disposal of cleaning backwash, carbon usage rates, pretreatment costs (see filtration).
- Air stripping – blower and pump electrical costs, disposal/cleaning of internal packing material, vapor handling, pretreatment costs (filtration).
- Media filtration - backwash disposal, chemical additives, air supply.
- Surface filtration - disposal of used filters or cartridges (cloth or paper).
- Precipitation - chemical additive, sludge dewatering, and sludge disposal costs.
- Alkaline stripping - electrical costs to operate blowers/pumping system, chemical costs, disposal/cleaning of internal packing material, vapor handling, pretreatment costs (filtration).

Once it is confirmed that the proposals are based on the same set of assumptions, they should be compared to determine the most qualified bidder. Review the technical qualifications and references of each bidder prior to final selection. To provide guidelines for cost evaluation, order-of-magnitude example treatment costs for a range of wastewater volumes are included in the following table.

These costs do not represent all the regions of the country and all petroleum terminal wastewaters. The most effective way to obtain a range of treatment costs for specific terminals is by contacting legitimate local contractors and comparing the quoted costs. Remember that the specific characteristics of wastewater from each terminal can substantially change treatment costs. In addition, mobilization and demobilization costs can vary greatly depending on the distance from the terminal to the contractor's home base.

Example Treatment[1] Costs for Terminal Wastewater

Wastewater	Volume[2]	Unit Price	Total Price
Tank Bottoms[3]	25,000 gallons	$0.40/gallon	$10,000
Tank Bottoms	50,000 gallons	$0.32-0.36/gallon	$16,000-18,000
Tank Bottoms	100,000 gallons	$0.24-0.28/gallon	$24,000-28,000
Hydrostatic[4] Test	2 million gallons	$0.02/gallon	$40,000

Notes: (1) Typical treatment train includes O/W separator/filtration/GAC (or air stripper with vapor phase carbon)/discharge to POTW. Alternatively for oxygen demand removal and discharge to receiving water, the treatment train would include bioaeration or chemical oxidation. Chemical oxidation would have additional chemical costs not included above.

(2) For volumes less than 10,000 gallons, mobile treatment is typically more costly than transportation to off-site facilities.

(3) Wastewater characteristics: BTEX=100-150 mg/l; TPH=50-100mg/l; TOC= 2000-4000 mg/l, treatment system flow=30-50 gpm.

(4) Treatment using similar treatment train only larger units (for large flow rate).

Information based on professional judgment and conversations with environmental contractors, 1996, 1997

4.0 CONTRACTOR SELECTION PROCESS

Overview

Once the treatment technology is selected (or reviewed), the terminal operator or engineer should evaluate and select a competent contractor to mobilize and operate the treatment system.

4.1 Mobile Treatment Contractor Checklist

The contractor checklist should be reviewed when considering a contractor's verbal or written proposal to perform treatment services. On Figure 4-1, the items have been organized into three major categories: experience, financial qualifications, and other important issues (including residuals handling, permitting and analytical services, and health and safety record).

4.2 Experience

The contractor's experience should be considered. This will help predict the contractor's ability to treat the wastewaters to the required permit limits safely, efficiently, and at minimal cost. The contractor should generally guarantee the efficiency of the process in treating the terminal's contaminants of concern. Generally, the contractor should also have experience working at petroleum distribution terminals. When reviewing contractor experience the following issues should be considered:

- Scale: Has the contractor treated similar wastewater?
- Mobility: Has the contractor used mobile treatment equipment before?
- Understanding of process: What are limits of this treatment process?
- Understanding of terminals: Does the contractor understand typical operational problems at terminals? Is the contractor familiar with characteristics of terminal wastewater? Is the contractor familiar with typical safety procedures?
- Understanding of regulations: Does the contractor understand the RCRA/NPDES implications of mobile treatment?

4.2.1 References

The most effective way to verify a contractor's experience is to check references. A list of references should be obtained, along with brief descriptions of the work performed, addresses, and <u>telephone numbers</u> of the clients. Once the contractor supplies the reference list, it is important to review and research the listed work. Call the references to verify the work description and ask relevant questions, such as:

Figure 4-1
Mobile Treatment Contractor Checklist

Experience

- ☐ Does the contractor have technical expertise installing and operating the proposed wastewater treatment scheme at facilities similar in scale to distribution terminals?
- ☐ Does the contractor understand the limits of this treatment process?
- ☐ Does the contractor understand typical operational problems at terminals? Is he familiar with characteristics of terminal wastewater?
- ☐ Does the contractor understand the RCRA/NPDES implications of mobile treatment?
- ☐ Has the contractor recently completed similar treatment projects?
- ☐ Can references with telephone numbers be provided?
- ☐ Have any accidents occurred at recent projects?
- ☐ Was the work completed within predicted schedule and cost estimate?
- ☐ Will the contractor have time and materials to give the project the priority required?
- ☐ Can the contractor meet the schedule?
- ☐ Do unfinished projects mean financial or regulatory concerns?
- ☐ Does the contractor have a good health and safety record?
- ☐ Are permitting difficulties slowing contractor's existing projects?

Financial Qualifications

- ☐ Can the contractor guarantee the work?
- ☐ Does the contractor provide a warranty?
- ☐ Does the contractor have adequate insurance to cover its workers in the event of injury? To cover property loss or damage?
- ☐ Can the contractor provide a current financial statement?
- ☐ Can an itemized written quote be provided?
- ☐ Does the quote include potentially expensive hidden costs?
  - ☐ Residual (e.g., sludge, carbon, hazardous waste, etc.) disposal
  - ☐ Chemical addition
  - ☐ Replacement of parts
  - ☐ Power
  - ☐ Health and safety equipment (including personal protective equipment)
  - ☐ Analytical costs
  - ☐ Mobilization/demobilization/equipment shipping/setup

Other Important Issues

- ☐ Does the contractor have permits, certifications, and other legal documents qualifying him to perform the treatment work (including handling residuals)?
- ☐ How will the contractor handle treatment residuals including:
  - ☐ Oil and sludge from separators
  - ☐ Bags and filters
  - ☐ VOC releases to the atmosphere
  - ☐ Potentially hazardous carbon and filter media
  - ☐ Precipitation and biological treatment sludges
  - ☐ Other treatment residuals

- ☐ Is contractor certified by state and federal regulators to perform the proposed analytical services?
- ☐ Does the contractor have a sampling plan and a sampling and analytical quality assurance/quality control plan?
- ☐ Is an audit of laboratory facilities required?
- ☐ Does the contractor have a good health and safety record?
- ☐ Is health and safety program documented, implemented and monitored?
- ☐ If contractor subcontracts out some work, does subcontractor meet all requirements from above checklist?

- Were you satisfied with the results? Did you achieve your goals?
- Did any accidents occur?
- What worked? What went wrong?
- Did the contractor complete work within predicted schedule and cost?
- Would you use the contractor again?

If the references provided by the contractor are not available after a few calls, call the contractor for more references. At least three references should be contacted. Typical valuable references would be a previous client, government regulator, and consulting engineering firms.

4.2.2 Current Activities

A review of the contractor's experience will help to predict how he will perform at the terminal facility. A review of the contractor's current activities will further assist in predicting the contractor's performance in the near term. The operator/engineer should obtain a list of the contractor's current projects and the phone numbers of existing clients. In addition to the list of questions noted above, the following issues should be considered:

- Status and number of existing projects: Will the contractor have time and materials to give the project the priority required? Are there many unfinished projects? Can the contractor meet the schedule? Do unfinished projects mean financial or regulatory concerns?
- Health and safety issues: Does the contractor have a good health and safety record?
- Permitting issues: Is permitting slowing existing projects?

4.3 Financial Qualifications

In addition to the contractor's experience, his financial qualifications, including the cost estimate and warranty in his proposal, should be carefully evaluated prior to final selection.

4.3.1 Cost

As noted in Section 3.3, cost evaluation is one of the most critical aspects of contractor selection because it directly impacts the terminal's operating budget. The potentially expensive hidden costs in a cost estimate are usually associated with less tangible items such as operation and maintenance and residual handling costs. (See Section 3.3 for the complete list of potential hidden costs.) The other cost issue to be aware of is "low balling." Contractors may provide a low estimate to win the contract, but will add change orders over the course of the project to recuperate costs not accounted for in the original estimate.

4.3.2 Warranty

The contractor should generally guarantee the results of the treatment process. The standard for such a warranty is often permit limits. As a result, the contract should include language stating that the contractor guarantees performance of the system to meet the limits according to a given schedule. The warranty should include a reasonable time period to provide notice of defects (in the case where the standard was not met). The remedy, should the warranty standard not be met, should be defined in the contract. Any contract documents should be developed in consultation with corporate contracts and legal staff.

4.3.3 Alternatives to Warranty

In addition to warranties, the terminal can limit potential liability during mobile treatment by reviewing the contractor's financial viability. All treatment wastes can be potential sources of liability whether they are considered hazardous or not. Therefore, a consideration in the selection of a mobile treatment contractor should be whether the contractor has the financial resources to share in legal costs, should suits related to waste management arise. Auditing the contractor's operations is another method of limiting liability.

4.4 Residuals

All treatment processes create byproducts or residuals that must be managed. Depending on the process used, residuals can be minor or major issues. For typical mobile treatment configurations the following residual management issues should be discussed with the contractor prior to selecting the contractor and implementing the technology:

- Oil and sludge from oil/water separator
- Used cartridge and bag filters
- Releases of volatile organic compounds (VOC) to the air from air strippers and biological aeration
- Concentration of certain compounds in activated carbon or other filter media (potentially rendering the used carbon a hazardous waste)
- Sludge from precipitation equipment and biological treatment

Some separator sludges may be classified as hazardous wastes. Relatively small quantities of sludge will be removed from the oil/water separator during typical mobile treatment applications. Generally, the contractor will not treat separator sludge and floatables (oil and other material skimmed off the top) but will leave these residuals for reprocessing by the terminal.

The paper or cloth used in cartridge or bag filters will generally be handled by the contractor. Any benzene-containing oily product retained on the filter could render it hazardous. The material should be properly disposed as a non-hazardous or hazardous waste, as appropriate.

Aeration strips volatile organics from wastewater during air stripping or, to a lesser degree, during biological treatment. Depending on the concentration, this VOC-contaminated air can be released in certain areas without treatment. Obtaining proper permits and any additional treatment equipment (e.g., vapor phase carbon adsorption system) required to manage this air stream should be discussed with the contractor.

The carbon used to remove VOC from the wastewater or the air stream may accumulate concentrations of benzene or other compounds which may render the used carbon a characteristic hazardous waste. Most carbon regeneration facilities and incinerators will accept carbon that is a characteristically hazardous waste. Regeneration costs will be higher than for non-hazardous carbon. The contractor should take responsibility (and liability) for these residual wastes and should be listed as the generator on any manifests.

Sludge management can be a critical issue for some treatment techniques. For example, dewatering and disposal costs for the sludge produced during biological treatment can be larger than other operational costs. In addition, the metals content of certain sludges could eliminate disposal options such as land application or landfilling. The terminal operator should ensure that the contractor is responsible for sludge management.

4.5 Permitting Services

In addition to treatment services, contractors often provide additional services such as permitting and sample analysis. Contractors who offer these services can provide a complete package similar to a "turnkey" approach. Permitting is a valuable service if the contractor understands the process and can take on the associated liability of the work. The credibility of any contractor providing permitting services should be thoroughly reviewed. Some concerns with contractor permitting are:

- Inadequate knowledge of regulations could put entire organization at risk
- Incomplete knowledge of terminal operations could result in an incorrect permit
- Contractor is the third party without liability for results
- Contractor may be less aggressive in negotiating permits than company negotiator

Many of these concerns can be resolved by ensuring that the contractor has extensive experience, a thorough understanding of the regulatory framework, and the financial viability to endure potential litigation.

4.6 Analytical Services

Many contractors provide analytical services as an optional part of the treatment package. Again, this service is valuable if it is legitimate and economical. The major concerns with contracted analytical services are:

- Technical competence
- Objectivity
- Quality assurance/quality control
- Technical resources

Included in the analytical services should be an appropriate quality assurance/quality control (QA/QC) program, including collection and analysis of field blanks, matrix spikes, and replicates. QA/QC data provide an objective measure of the analytical service's data quality. Data of poor quality should be rejected and should not be submitted for compliance determination.

The above concerns can also be addressed by confirming the certification of the contractor's laboratory. Generally the state regulators will provide a list of laboratories, their certification status, and the analyses that they are certified to perform. The certification process ensures that a laboratory meets minimum standards. However, additional information may be required to ensure that the quality of the results is consistent. Additional laboratory audits by independent qualified chemists are suggested if a large number of samples will be analyzed. Confirm the credentials of the laboratory by reviewing references and resumes for the critical management personnel. If the analytical services provided by the contractor do not meet requirements, a separate laboratory should be contracted to perform analytical services.

4.7 Health and Safety

The contractor should provide documentation that the wastewater treatment system has undergone appropriate safety reviews and has met the client's process and safety management requirements. At a minimum, the following should be conducted:

- A hazards operability (hazops) analysis,
- A mechanical integrity review,

- Specification of standard operating practices,
- Specification of operator training requirements, and,
- Specification of the maintenance program.

The health and safety (H&S) record of any treatment contractor should be reviewed prior to project award. A good health and safety record should predict safe operation of the mobile treatment system. In addition, a thorough H&S program indicates that the contractor understands the treatment business and will organize the other aspects of the project in a similar manner.

These reviews and specifications should be approved by the client prior to the arrival and installation of equipment on-site.

5.0 CONTRACTOR OVERSIGHT

Overview

There are several issues to consider during the implementation of the mobile treatment system:

- verification that the installed unit operations and treatment train is consistent with contractor's proposal
- validity of treatability testing
- verification of performance via sampling and analysis
- logistics of setup
- process control instrumentation
- startup/shutdown procedures
- spill control

The terminal operator/engineer should request written information from the contractor on how these issues will be addressed. This information should be reviewed and compared with actual practice during mobile treatment operations.

5.1 Treatability Testing

Because wastewater characteristics at petroleum product terminals are not the same throughout the industry, a terminal may need to test a treatment method to determine its effectiveness. Testing can take place under laboratory conditions (bench scale) or at the site (pilot tests). For complex wastewater streams and innovative treatment processes, testing should be conducted before selecting the mobile treatment scheme.

Contractors will often request a representative sample of the terminal wastewater (normally a few gallons) to perform screening tests. These tests determine whether the proposed treatment process will effectively treat the wastewater. There are several ways to collect the sample to ensure it is representative of the terminal wastewater. For example, small samples can be collected over a given time period and mixed in one container. A sample from that mix is a composite sample. See the USEPA sampling manual (USEPA, 1988) for more details on collection of statistically representative samples.

Treatability tests are preliminary indicators of efficiency and should be verified by a pilot test at the facility. The pilot test is usually performed using a miniature version of the full-scale system to treat a low wastewater flow. In some cases, a contractor may propose to perform a treatability test at full scale for a few months (especially with an innovative treatment scheme).

The issues to consider during treatability testing are:

- Replicability of bench-scale test results under actual field conditions
- Replicability of field-scale pilot test results at full scale
- Liability associated with on-site treatability testing
- Responsibility for costs, including sampling and analysis
- Meeting the permitting schedule

5.2 Performance Verification

The contractor and/or terminal operator should develop a sampling and analysis plan (SAP) to verify that the system is performing according to requirements (i.e., treating wastewater to meet permit requirements) during full-scale operation.

The typical SAP includes:

- objectives: to measure performance within permit limits
- sampling: locations, frequency, procedures
- analysis: parameters of concern, analytical method
- data quality validation: calibration checks, duplicate sample analysis, matrix spikes
- methodology: to assess data precision, accuracy and completeness

Many contractors will have a standard plan to assess the effectiveness of their treatment scheme for previous projects. In addition to meeting permit requirements, the contractor will be concerned about the treatment operation. The contractor will be taking samples at additional locations within the treatment process (e.g., to measure pass-through after carbon adsorption). Review the contractor's SAP to ensure that it applies to the specific terminal. At a minimum, the parameters and analyses listed in the permit should be included in the SAP.

5.3 Process Control Instrumentation

The contractor must not only monitor the wastewater to confirm that it is being treated to permit limits (as described above), but also monitor and control the treatment process (and shut it down completely if necessary). Process control instrumentation provides the operator with the information to assess and adjust the process.

Typical process control instrumentation can include:

- flow measurement devices
- pH/dissolved oxygen measurement devices
- level measurement devices and alarms
- mechanical system devices (e.g., pressure gauges, temperature gauges, and oil gauges)

The instrumentation may include automatic data collection and recording devices. A fully automated system also includes a central alarm system to notify operators of any upsets or emergencies. The primary considerations in process control are:

- Calibration of instruments
- Backup systems
- Alarm systems

The instrumentation should be kept in good working condition to accurately measure the parameters of concern. If the instruments are not calibrated, the control system may not function properly. There should be a backup system if the central control system breaks down. An alarm system should be incorporated into the process control scheme so that, during an emergency, the system can shut itself down or an operator can be notified to make repairs or adjustments to the system.

5.4 Setup Logistics

The setup of a mobile treatment system at a terminal requires cooperation and clear communication between the contractor and terminal personnel. Potential logistical issues to address prior to setup include:

- responsibility for utility hookups
- determination and timing of hookups
- location of treatment system relative to storage or utilities
- contacting subcontractors to install hookups

In general, the terminal is responsible for providing access to utility hookups. The contractor generally is responsible for extension cords, piping, etc., to connect the system to the hookup provided by the terminal. For example, the contractor would provide the piping from the wastewater storage tanks to the treatment system and from the treatment system to the discharge point. These responsibilities can, however, be taken by either the terminal or the contractor depending on site-specific requirements. In any case, the responsibilities for utility hookups should be agreed to and clarified prior to treatment startup.

Generally, the contractor provides the terminal with the treatment system utility requirements in his written proposal. The terminal operator should also request potential utility usage rates from the contractor at the proposal stage. So that delays can be minimized, utility hookups should be provided prior to the contractor's arrival on site. The terminal can contact local electricians or plumbers to extend the required utilities to the proposed treatment system location. In general, to minimize pumping and piping costs, the treatment system should be located adjacent to the wastewater storage tanks.

5.5 Startup/Shutdown Procedures

The essential process control steps are startup and shutdown. The contractor should provide a detailed written description of the mobile treatment system's startup or shutdown procedures. Typical startup procedures include:

- Checkout: Verify that all system components are properly installed (e.g., vibration may loosen or disconnect pipe connections; level-sensitive equipment such as skimmers may be off center).
- Testing: Verify integrity of components (electric wiring may have deteriorated, pipe or ductwork may be cracked).
- Startup: Equipment should be operated with clean water to test for leaks and proper mechanical operation. (Once this water passes through the system, it should be returned to the system feed tank.) Control systems should be energized before process equipment. Check position of all valves and control set points prior to starting process equipment. Once the system is running at or close to expected full operation, the entire system should be checked.

Shutdown procedures are usually the startup procedures in reverse order. It is critical that the treatment system be shutdown in a manner that does not result in spills or the discharge of untreated water. Safeguards to prevent overheating of motors, overfilling of tanks, or pump damage (due to pumping dry) during shutdown should be implemented.

5.6 SOPs

Standard operating practices (SOPs) are the step-by-step detailed instructions provided by equipment manufacturers and developed by the contractor on the operation and maintenance of equipment. The contractor should have copies of SOPs for each major piece of equipment (e.g., tanks, pumps, blowers, filters) in the mobile system. The terminal operator/engineer should review the SOPs and confirm that the contractor is following them. Many contractors assemble the diverse pieces of equipment into a single mobile treatment unit. As a result, some of the equipment may have been altered to fit a mobile application. The altered equipment SOPs should be inspected to ensure that the system could still be operated safely. If SOPs are not available for each equipment unit, the contractor should have a complete operation and maintenance (O&M) manual for the system. The O&M manual should describe in detail each system component and its operation. In addition, it should include a troubleshooting section for quick assessment and repair, and a contingency plan in case of emergency.

5.7 Operator Certification

A critical element in the safe and effective operation of the mobile treatment system is the operator's competency. Does the operator understand the system so that immediate decisions on modifications and emergencies can be made? One way of confirming the operator's competency and experience is certification. Many states require operators of POTWs and industrial treatment facilities to obtain a license (based on exam results and experience). The levels of certification required correspond to the size and complexity of the plant. For example, a chief operator of complex treatment plants in Massachusetts must have a Grade 7 license (equivalent to eight years experience and successful completion of the appropriate exam). Although a license may not be required to operate small mobile treatment systems in many states, licensed operators should certainly be competent to manage a small mobile system. In addition, though not specifically required, HAZWOPER certification of treatment operators confirms operator competence in relation to potential hazardous conditions. Because licensing requirements vary from state to state, the local or state board of health should be contacted to determine which licenses are required.

5.8 Spill Control

According to RCRA requirements and good engineering practice, temporary spill control structures and practices must be implemented during the operation of the mobile treatment system operation. (It is unlikely that the terminal wastewater will contain sufficient oil in water to acquire an amendment to the terminal SPCC plan.) Generally, the spill control equipment must be able to contain and control a spill of 110% of the entire volume of the largest storage tank. For example, the spill control structure for a treatment train with a 10,000 gallon tank and two 3000 gallon tanks should be able to hold an 11,000 gallon spill. Spill containment equipment can be purchased from many suppliers. Inflatable or plastic solid berms can be installed at the perimeter of the mobile treatment system. In addition, spill kits containing absorbent booms and other equipment should be located adjacent to the treatment system for smaller spills.

Notification requirements for spills of certain materials must be kept at the treatment unit. Contractor personnel should be familiar with these requirements should a regulated material spill occur. The information should include the reportable quantities of each material (above which the spill should be reported) and the phone number of the agency contact to notify.

5.9 Contingencies

Although the contractor cannot be prepared for all potential changes in terminal conditions (e.g., flooding, fire), he should be prepared to meet certain contingencies including:

- changes in wastewater characteristics (e.g., less flow at higher strength than originally predicted)
- hazardous situations (e.g., higher explosion potential, spills)

The contractor should be prepared for certain contingencies by developing emergency response plans and providing additional valving to supplemental equipment. It is critical that contingencies be discussed with the contractor prior to project award and mobilization.

5.10 Case Studies

The following case studies in which mobile treatment was implemented at petroleum terminals illustrate the practical framework of mobile treatment. Table 5-1 summarizes these examples.

Case 1: Rack Water in Dallas, Texas

At a petroleum terminal located east of Dallas, Texas, water from the loading rack and tank bottoms had been stored in an aboveground storage tank (approximately 100,000 gallon capacity). The terminal operator hired a specialty contractor to treat and dispose of the water based on recommendations from his corporate environmental staff. The contractor was hired to complete a turnkey operation from initial permitting to treatment to final disposal.

Permits: The contractor negotiated successfully with a nearby municipality to discharge the treated water to the POTW located approximately 55 miles from the terminal. The contractor was directly responsible for compliance with the POTW permit requirements (listed in Table 5-1). In addition to obtaining the discharge permits, the contractor obtained the air registration exemption per Texas regulations.

TABLE 5-1

Summary of Case Studies
Mobile Treatment of Terminal Wastewater

Case	Wastewater Characteristics	Cost	Treatment Train	Operation	Discharge	Misc.
(1) Dallas: Rack Water/ Tank Bottoms	Volume: 123,323 gal BTEX: 100 mg/l TPH: 50-100 mg/l TOC: 2000 mg/l	Treatment: $22,000 Mob/Demob: $2,500 (300 miles) Hauling to Offsite POTW: $5,000 (55 miles) Total: $29,500	O/W separation-> bag filters-> bentonite clay-> air stripper-> (w/vapor GAC) GAC-> Frac Tank Flow = 30 gpm	Batch process, fed from storage tank, discharge to six 20,000 frac tanks, sample each batch, analyze (24-hr turnaround), remove and haul in vacuum truck to POTW	Haul to POTW, permit limits: Vol <20,000 gal/dy, TPH <10 mg/l, Benzene <50µ/l, BTEX <250µ/l	44 ft trailer, setup in diked containment area, terminal utilities, contractor hose and electric cable
(2) Houston: Tank Bottoms	Volume: 39,500 gal BTEX: 150 mg/l TPH: 50-100 mg/l TOC: 4000 mg/l	Treatment: $9,875 Mob/Demob: $2,500 (200 miles) Total: $12,375	same as above	Batch process, fed directly from 6 tanks to central sump, discharge to 2 frac tanks prior to discharge to nearby city sanitary sewer	Same limits as above except no volume limit. Discharge via contractor supplied hose to sewer manhole located adjacent to the property	44 ft trailer, setup on elevated roadway between 6 storage tanks, collected composite sample prior to discharge from 2 frac tanks

Note: Case studies are examples and are not necessarily representative of the range of situations and costs that may be encountered by terminal operations in mobile treatment of terminal wastewater.

Operation: Once the permit was obtained, the contractor mobilized his treatment unit (mounted on a 44-foot trailer) and crew to the terminal. The mobile treatment system was installed so that the water could be fed directly to the system via gravity. The effluent flowed into the six frac tanks (20,000 gallon each) that were mobilized to the site. The permit limited discharge to 20,000 gallons per day. Each day the contractor collected grab samples of treated water from the frac tank and submitted them to an independent laboratory for analysis. Once the results of the analysis were received (24-hour turnaround) and the water was considered to be in compliance with the permit conditions, the contractor removed the treated water and hauled it (via vacuum truck) to the POTW.

Treatment Train: The mobile treatment system consisted of five separate units mounted on a 44-foot-long trailer with a hydraulic capacity of 30 gpm. The units included: an oil/water separator, bag filters (10 micron weave), bentonite clay canisters (for removal of heavy organics), an air stripper (to remove BTEX) with vapor phase carbon (to treat offgas), and finally granular activated carbon (GAC) canisters. Analytical results of the treatment system effluent consistently met pretreatment requirements for benzene, total BTEX, and TPH.

Setup/Utilities: The crew set up the unit within the storage tank containment berm on the hardpan surface. The terminal supplied the electric power and water required to conduct an initial test of the system. The contractor provided the appropriate wire to connect the system to an existing on-site electric box. The terminal's electrician connected the contractor-supplied wire to the terminals in the box. The contractor connected a water hose to the nearby terminal potable water spigot to fill up the system during startup. Contractor personnel used the toilets in the terminal driver's shed.

Costs/Schedule: Treatment of the 123,000 gallons of rack water and tank bottoms was completed in five days (not including mobilization and demobilization) for a total cost of $29,500, or 24 cents per gallon.

Case 2: Houston, Texas; Tank Bottoms

At a petroleum distribution terminal near Houston, Texas, approximately 40,000 gallons of tank bottoms water required treatment. The tank bottoms were not transferred from the floating roof tanks to a separate storage tank. As in the previous case, the terminal manager hired the same contractor. The terminal was again responsible for the utilities. The selected contractor used the same treatment trailer in both cases.

Permits: The contractor obtained a permit from the local POTW to discharge to a local sewer (located on adjacent property). The permit limits were similar to the previous case. As indicated on Table 5-1, the tank bottoms contained somewhat higher concentrations of organics than the rack water of the previous case. In addition to obtaining the discharge permit, the contractor obtained the air registration exemption per Texas regulations.

Operation: Once the permits were obtained, the crew mobilized to the site (approximately 200 miles). The crew set up the treatment trailer on an elevated road that crossed the tank farm (containing the six aboveground storage tanks from which the tank bottoms water would be drawn). The contractor installed a sump pump to lift the tank bottoms water into the treatment system. The effluent was collected in two 20,000 gallon frac tanks prior to discharge to the nearby sewer manhole. Once the effluent was collected in the two tanks, the contractor collected a composite sample of treated water from the tanks and submitted it to an independent laboratory for analysis. Once the results of the analysis were received (24-hour turnaround) and the water was considered to be in compliance with the permit conditions, the contractor discharged the water to the sewer.

Costs/Schedule: Treatment of the approximately 40,000 gallons of tank bottoms was completed in three days (not including mobilization and demobilization) for a total cost of $12,350, or 31 cents per gallon.

As these two case studies illustrate, the collection and discharge of the terminal wastewater can be as difficult to perform as the actual treatment. These examples also show the logistics involved in setting up and operating a mobile treatment system.

6.0 IDENTIFICATION OF CONCERNS/PITFALLS

Introduction

Certain issues arise during contractor selection and project initiation which warrant re-emphasis. Some of these issues, concerns, and pitfalls including contractor control, regulatory changes, emergencies, and accumulation storage, are described in the following section.

6.1 Control of Contractor

Selecting the contractor is the first critical aspect of subcontracting mobile treatment services. The second most critical aspect is supervising and controlling the contractor once the mobile treatment equipment is on site. Even though the contractor is paid to manage the treatment project in a safe and effective manner, it is the terminal operator's responsibility to ensure that the contractor does his job so the terminal's operations are protected. The major contractor management issues are:

- health and safety
- compliance verification
- schedule
- cost control
- daily operations

The contractor should provide and follow a written health and safety plan for the mobile treatment operation. He should also provide and have available the material safety data (MSD) sheets for any chemical used on-site. The terminal health and safety plan should be distributed to the contractor for implementation. The terminal operator should review the contractor's plan to ensure that hazardous situations will be minimized. Remember that the contractor personnel, while on site, are ultimately the responsibility of the terminal operator.

The contractor should comply with all local and federal regulations (in addition to the site NPDES permit as discussed in Section 5.2). The contractor should provide copies of all the required permits to the terminal operator prior to initiation of treatment. Typical permits include:

- Permit to discharge to local sewer (municipality)
- Permit to operate treatment system (state and local)
- Licenses for system operators (state)
- Permit to discharge offgas to air
- Fire department approvals

The terminal operator should review and note the permit conditions. During the treatment operation, the contractor should provide the terminal operator with documentation of compliance with permit conditions (e.g., lab results or field notes) and copies of any correspondence with the permitting authority (e.g., the state).

The project schedule for a contracted mobile treatment process is often the basis of payment (or non-payment due to delays), and is based on terminal-defined limits (permitting or operational benchmarks). As a result, it is critical to obtain a written schedule from the contractor at project initiation and require that it be followed. The project schedule should be updated as frequently as possible to reflect any changes. Regular formal and informal communication with the contractor regarding schedule is essential to project management.

Although the contractor usually takes responsibility for cost control (especially if the project is a lump-sum project), the terminal operator should be concerned about progress review costs and minimization of financial liability. The terminal operator can trace progress by measuring the quantity treated (i.e., the accumulated flow) and calculating the total cost (based on the unit cost in the quote). In this way, the terminal will verify the contractor's invoices for payment.

Daily monitoring of the contractor is an essential element in assuring the smooth completion of the treatment project. Communication is key to the success of the project. Progress, problems, and plans should be discussed with the contractor on a daily basis. Meetings can be informal or formal depending on the style of the participants. The operation should be carefully observed for signs of failure such as leaks, releases of steam, or other unexpected occurrences. Questions should be asked as needed. The contractor should be willing and pleased to provide information about his process, since he should want terminal staff to be confident in his work.

6.2 Regulatory Changes

Regulations define the treatment requirements for terminal wastewater, so it is essential that all applicable regulations are reviewed prior to selecting a contractor. Because regulatory changes usually occur with notice (at least 6 months on the federal level), an adequate understanding of the current regulatory climate and potential future regulations should avert any surprise regulatory requirements which could delay the treatment project.

Occasionally, a regulatory change will occur which may adversely affect the project without notice. First, the potential effects of the new regulations must be understood. Corporate legal and environmental staff, if available, should be consulted. If adverse effects are minimal, the treatment scheme can be modified without delay. If the impact is significant, the project may need to be halted. A meeting should then be held among terminal staff, the contractor and legal representation, to discuss the effects of the new regulations and to negotiate the existing contract so that the project can be completed. This situation should especially be of concern for repeat treatment contracts.

6.3 Emergencies

Emergencies or accidents may occur during mobile treatment operations. Written contingency plans and health and safety plans, provided by the contractor at project initiation, should be followed under these conditions. These plans should include the notification requirements (e.g., reportable quantities and agency phone numbers) in the case of spills. Advance planning will minimize any injury, property damage, or environmental impact.

6.4 Accumulation Storage

As noted previously, wastewater treated via mobile treatment is not subject to most RCRA regulations if it is hard-piped to an NPDES-permitted discharge. If the treated water is not hard-piped and is a characteristic hazardous waste, it cannot be stored on-site for more than 90 days after generation without a RCRA permit. As a result, the treated water must be shipped to a licensed facility for disposal as soon as possible after treatment. In the same manner, once the wastewater passes through an oil/water separator, it may be considered a hazardous waste, so treatment within 90 days may be required. For many mobile treatment systems, the 90-day storage limit is not an issue because the hazardous constituents (e.g., benzene) are removed from the wastewater within minutes of the separation step. However, wastewater stored after oil/water separation and prior to treatment, should be transported off site within the 90-day time period.

7.0 SUMMARY

This document assists terminal operators and engineers in evaluating mobile treatment systems for wastewater generated at petroleum distribution terminals. Some of the variables that must be considered include the characteristics of the wastewater, the permitting process, and contractor experience. Obtaining as much information as possible on these variables is key to properly selecting the appropriate technology and contractor. The essential aspects of evaluating mobile treatment at petroleum distribution terminals are summarized in Figure 7-1, Summary Checklist. The checklist should be followed to ensure that no major steps are missed during this critical process.

Figure 7-1
Summary Checklist

- ☐ (1) Determine whether mobile treatment is appropriate (Section 1.0).
- ☐ (2) Determine wastewater volume and flow rate (Section 2.1.1).
- ☐ (3) Collect and analyze representative wastewater samples for parameters limited in discharge permit (Section 2.1.2).
- ☐ (4) Obtain and understand the discharge permit requirements (Section 2.2).
- ☐ (5) Identify the terminal site constraints (Section 2.3).
- ☐ (6) Identify and understand the treatment options (Section 3.2).
- ☐ (7) Obtain proposals from three reputable contractors (Section 3.3).
- ☐ (8) Use the checklist (Figure 4-1) to select the contractor (Section 4.0).
- ☐ (9) Supervise the contractor during actual treatment (Sections 5.0 and 6.0).

GLOSSARY

BOD_5, Biochemical Oxygen Demand: The quantity of oxygen used by bacteria in consuming organic matter in a sample of wastewater, typically measured over a five-day period.

BTEX: Benzene, toluene, ethylbenzene and xylenes.

COD, Chemical Oxygen Demand: The quantity of oxygen used to chemically oxidize both organic and inorganic compounds in water.

Chemical Oxidation: A chemical reaction with oxygen or oxygen-bearing materials (ozone, hydrogen peroxide, etc.), often resulting in a degradation or breakdown of the chemical of interest. More broadly, oxidation is any chemical reaction in which electrons are given up by the chemical of interest.

Effluent: A discharge from a point source.

Naphthenic Acids: A class of water-soluble organic acids normally found in crude oils and refined products. Naphthenic acids are somewhat toxic to aquatic life.

NPDES, National Pollutant Discharge Elimination System: The national program established under the Clean Water Act (CWA) that provides for issuing, modifying, revoking, reissuing, terminating, monitoring, and enforcing permits for discharging to the surface waters of the U.S.

Oil and Grease: The amount of material extracted into a solvent, then left behind after evaporation of that solvent.

Oxygenates: Oxygen-bearing chemicals, such as ethers and alcohols, added to gasoline to improve octane and reduce certain types of air emissions in automobiles. They are produced in petrochemical processes or by fermentation.

pH: The negative logarithm of the hydrogen ion concentration. A measure of the acid or alkaline intensity of a liquid.

Phenols: A class of organic compounds that are byproducts of petroleum refining, tanning, and textile, dye, and resin manufacturing. Low concentrations cause taste and odor problems in water.

RCRA, Resource, Conservation and Recovery Act: The 1980 amendment to the Solid Waste Disposal Act in which "cradle to grave" management and tracking of hazardous waste, from generator to transporter to treatment, storage, and disposal were established.

Surfactants (Surface-Active Agents): Emulsive materials which can mobilize oil and grease in water. Part of the surfactant molecule is oil soluble and another part is water soluble. Examples are household soaps and detergents. They stabilize oil/water emulsions and inhibit oil separation, and are also known toxicants. Common sources of surfactants in terminal wastewater are naphthenic acids, detergents purchased for cleaning purposes, and fuel additives.

TCLP, Toxicity Characteristic Leaching Procedure: The analytical procedure used to determine whether or not a waste is a characteristic hazardous waste. The procedure is designed to simulate leaching from a municipal landfill.

TPH, Total Petroleum Hydrocarbons: A test to specifically measure hydrocarbons.

TOC, Total Organic Carbon: A measure of organic compounds in wastewater, expressed in terms of the weight of carbon in those compounds.

TSS, Total Suspended Solids: Measure of suspended solids in wastewater, effluent, or waterbodies, determined using tests for total suspended non-filterable solids.

Volatile Organic Compounds (VOC): A group of chemicals that react in the atmosphere with nitrogen oxides in the presence of heat and sunlight to form ozone; does not include methane and other compounds determined by EPA to have negligible photochemical activity.

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