DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF OIL AND GAS MANAGEMENT

DOCUMENT NUMBER: 550-5600-001

TITLE: Waste Minimization in the Oil and Gas Exploration and Production Industry

EFFECTIVE DATE: December 21, 2001

AUTHORITY: The Oil and Gas Act (P.L. 1140, No. 223) (58 P.S. Section 601.101 et seq.)
Coal and Gas Resource Coordination Act (P.L. 1069, No. 214) (58 P.S. Section 501.1 et seq.)
Oil and Gas Conservation Law (P.L. 825, No. 359) (58 P.S. Section 401.1 et seq.)
The Clean Streams Law (P.L. 1987, No. 394) (35 P.S. Section 691.1 et seq.)
Solid Waste Management Act (P.L. 380, No. 97) (35 P.S. Section 6018.101 et seq.)
The Administrative Code (P.L. 177, No. 175) (71 P.S. Section 510-1 et seq.)
25 Pa. Code Chapters 78, 79, 91, 92, 93, 95, 96, 102, 105, 106, 260, 261, 287, 288, 289, 291, 293, 299

POLICY: Department staff will follow the guidance to promote pollution prevention in the oil and gas producing industry.

PURPOSE: This document will provide persons and companies operating in the oil and gas exploration and production industry with information about reducing the amount of waste they generate.

APPLICABILITY: This document provides guidance to department staff and the oil and gas exploration and production industry to promote pollution prevention.

DISCLAIMER:

The policies and procedures outlined in this guidance document are intended to supplement existing requirements. Nothing in the policies or procedures shall affect regulatory requirements.

The policies and procedures herein are not an adjudication or a regulation. There is no intent on the part of the Department to give these rules that weight or deference. This document establishes the framework, within which DEP will exercise its administrative discretion in the future. DEP reserves the discretion to deviate from this policy statement if circumstances warrant.

PAGE LENGTH: 90 pages

LOCATION: Vol. 10, Tab 04

DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF OIL AND GAS MANAGEMENT

IMPACT ANALYSIS

Waste Minimization in the Oil and Gas Exploration and Production Industry

A. This guidance does not implement laws or regulations more stringent than federal requirements.

B. This guidance is not prescriptive or technology specific.

C. This guidance will affect members of the oil and gas industry who are interested in reducing the amount of waste they generate.

D. Members of the oil and gas industry may achieve cost savings by reducing the amount of waste they need to handle and from increased operating efficiency.

E. This guidance will have a minimal cost to the DEP.

F. Operators who achieve a reduction in waste generation will be able to more easily comply with DEP regulations for handling waste.

G. The guidance will provide information to oil and gas operators about developing an environmental management system (EMS) to reduce the quantity of waste generated during their daily operations.

H. This guidance will not affect the time necessary to process DEP reviews and approvals.

I. This is a new guidance

J. There are not any expected controversial aspects of this guidance.

Commonwealth Of Pennsylvania

Department Of Environmental Protection

Bureau Of Oil And Gas Management

DRAFT

Waste Minimization in the Oil and Gas Exploration and Production Industry

DEP Technical Guidance Document ID# 550-5600-001

TABLE OF CONTENTS

LIST OF TABLES

Chapter 1

INTRODUCTION

WASTE MINIMIZATION - A WORTHWHILE GOAL

Historically, management of large quantities of produced water, as well as drilling fluids and associated wastes, was perceived as an unavoidable, everyday fact-of-life in the oil field. As a result, environmental protection efforts by both industry and regulators generally concentrated on the most effective methods for treatment and disposal of wastes after the wastes had been generated. Prior to the early 1980's there were relatively few practical incentives to focus on reducing or eliminating wastes in oil field processes and practices.

In the past several years, however, significant changes in environmental regulations and industry perspectives have made an "end-of-pipe" approach to waste management much less desirable. More stringent state and federal waste management regulations have resulted in substantially increased treatment and disposal costs. These new costs, coupled with a heightened awareness of environmental impacts and an expanded emphasis on environmental protection, have provided a greater incentive for operators to improve oil field processes and practices to reduce or eliminate wastes.

WHAT BENEFITS DOES WASTE MINIMIZATION PRODUCE?

About 63% by volume of the oil and gas wastes produced consisted of produced water in 1999 in Pennsylvania. Drilling fluids and associated wastes made up about 37% of oil and gas wastes in that same year. Although large volume reductions may not be expected for produced water using today's technologies, some waste minimization technologies - predominately recycling by injection in enhanced recovery projects - do exist for produced water. Produced water can also be treated to reduce contaminate concentrations. Many possibilities already exist for reducing the volumes and toxicity of drilling fluids and associated wastes. A voluntary waste minimization program offers the best opportunity for an individual company to reduce the pollution potential of oil and gas wastes.

Oil and gas operators can obtain information and technical assistance from the DEP that can make it easier for them to identify waste minimization opportunities and, therefore, easier for them to comply with changing environmental regulations. Voluntary waste minimization efforts by oil and gas operators can help reduce the call for additional future regulation.

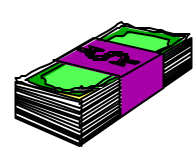
The potential benefits to a company that implements a waste minimization program include:

- Increased revenue
- Reduced costs of operating, materials, waste management and disposal, energy, and facility cleanup
- Improved operating efficiency
- Reduced regulatory compliance concerns
- Reduced potential for both civil and criminal liability
- Enhanced public perception of the company and the industry as a whole.

Numerous waste minimization opportunities exist for oil and gas operations. Initiation of a waste minimization program does not have to be expensive or complicated. With some advance planning and effort, there are many inexpensive, common sense practices that are feasible for even the smallest company.

IS WASTE MINIMIZATION ECONOMICALLY FEASIBLE?

WHAT IS THE POTENTIAL - AND THE INCENTIVE - FOR EXPLORATION AND PRODUCTION (E&P) OPERATORS TO REDUCE THE VOLUME AND TOXICITY OF WASTE THEY GENERATE?



This question is gaining more attention nationwide, especially as Congress considers reauthorizing the Resource Conservation and Recovery Act (RCRA) Subtitle C and possibly subjecting all oil and gas wastes to hazardous waste regulation. Even if Congress imposes no additional restrictions on oil and gas waste management options, waste management costs have already risen dramatically, not only in terms of disposal fees, but also in terms of regulatory compliance costs and potential future liability. In many instances, source reduction and recycling are cheaper in the long run than treatment or disposal of wastes, particularly when the time and cost of regulatory compliance is considered. In addition, the cost of remediating just one site where improper waste disposal or a spill has occurred can be a significant incentive to reduce or eliminate waste.

This manual has been prepared as an aid to the oil and gas operator in recognizing effective waste minimization options, and using those options in the development of a waste management plan.

WASTE MANGEMENT HIERARCHY OF PREFERENCE

Today, in order to protect the environment, reduce waste management costs, and increase compliance, our focus on waste management must shift from the end-of-the-pipe to the very beginning.

The first step in shifting our focus on waste management is for individual waste generators to adopt the Waste Management Hierarchy of Preference endorsed in the federal Pollution Prevention Act of 1990. The overriding principle of the hierarchy is the reduction . . . if not elimination . . . of both the volume and toxicity of waste that is introduced into the environment. From an environmental perspective, disposal is the least preferred waste management option. To the extent practicable, waste management choices should be based upon the following hierarchy of preference:

WASTE MANAGEMENT HIERARCHY

Most Preferred

SOURCE REDUCTION

RECYCLING

TREATMENT

DISPOSAL

Least Preferred

SOURCE REDUCTION

Source reduction is given the highest priority in the waste management hierarchy because avoiding waste generation altogether, or generating the least toxic waste possible, minimizes the problems associated with waste management. Waste that is not generated need not be managed. Waste that is generated, but is of the lowest possible volume and/or toxicity, can be managed most costeffectively.

RECYCLING

In some cases, reduction at the source will not yet be technically possible or economically feasible. Therefore, recycling opportunities should be investigated for all wastes that are unavoidably generated. Recycling involves reclaiming useful constituents of a waste material, or removing contaminants from a waste so that it can be reused. Recycling may also involve the use or reuse of a waste as a substitute for a commercial product, or as feedstock in an industrial process. Recycling helps to preserve raw materials and reduces the amount of material that requires disposal.

SOURCE REDUCTION AND RECYCLING EQUAL WASTE MINIMIZATION

SOURCE REDUCTION AND RECYCLING MINIMIZE THE QUANTITY OF OIL AND GAS WASTE THAT REQUIRES SUBSEQUENT TREATMENT AND DISPOSAL.

TREATMENT

Treatment should be investigated for any waste that is unavoidably generated and that cannot be recycled in its current form. Treatment is any method, technique, or process that changes the physical, chemical, or biological character of a waste. Treatment renders the waste less hazardous and, therefore, recyclable or safer to transport, store, and dispose of. Note that treatment does not prevent the creation of pollutants. Treatment involves changing the nature of the waste or reducing or eliminating the pollutants in a waste.

DISPOSAL

Waste disposal generally is the discharge, deposition, injection, dumping, spilling, leaking, or placing of any waste into or on land, water, or air. In the waste management hierarchy, disposal is the least preferred waste management option. Disposal also involves the greatest potential liability.

Chapter 2

WASTE MANAGEMENT PLANS

There is increasing emphasis on pollution prevention in oil and gas operations. This emphasis has resulted in numerous efforts to define the elements of a successful waste management plan. A relatively new concept for controlling waste generation and disposal is the Environmental Management System (EMS). The EMS is a company's blueprint for limiting the waste they generate and for handling the waste that is generated. The American Petroleum Institute (API)[1, 2], C. T. Stilwell[3], EPA[4], and NSF[5] have published guidelines for waste management plans which include waste minimization as an integral part of the plan. The following pages present an overview of some of the steps recommended by API[2] for developing a waste management plan. This plan can be considered the company's Environmental Management System (EMS).

STEP 1: COMPANY MANAGEMENT APPROVAL

Management approval should include established goals, such as a specific waste volume reduction in a set time frame. Key personnel and resources to be committed to the plan should be defined. Additionally, management should develop a mission statement. An example of a mission statement used by a major E&P company is provided below.

WASTE MANAGEMENT POLICY AND ENVIRONMENTAL POLICY

At (Company), we recognize the importance of safeguarding the environment wherever we conduct our business. This extends from the production of crude oil and natural gas through the manufacture and distribution of our products.

Therefore, in keeping with the (Company's) Guiding Principles and Objectives, (Company's) Environmental Policy is as follows:

- *To comply* with environmental laws and regulations.

- *To conduct* our operations in a manner that demonstrates respect for the quality of the environment.

- *To cooperate* with federal, state, and local governments in analyzing emerging environmental issues, finding solutions to environmental problems, and developing cost-effective, scientific environmental standards.

- *To maintain* effective environmental procedures and equipment, consistent with available technology.

- *To respond* quickly and effectively to environmental incidents involving (Company's) facilities, equipment, or products under our control.

- *To endorse* research to advance scientific knowledge concerning the causes and prevention of environmental deterioration.

- *To encourage* development of new technology which inherently provides improvement in the quality of the environment.

- *To provide* environmental training programs for employees, emphasizing individual responsibility for sound environmental management.

- *To maintain* corporate and departmental environmental monitoring programs to ensure compliance with (Company's) policy and governmental requirements.

STEP 2: REGULATORY ANALYSIS

Evaluate federal, state, and local laws and regulations. Evaluate landowner and lease agreement conditions. Using these evaluations, define operating conditions and requirements.

STEP 3: WASTE IDENTIFICATION

Identify the type, amount, and frequency of generation of each waste within Pennsylvania. A brief description of each type of waste should be provided.

Note: A general overview of drilling operations, oil field production operations and gas production operations is presented in Chapter 4. Examples of wastes potentially generated by each type of operation are included in the overview. This overview may help you in preparing a waste management plan.

STEP 4: WASTE CLASSIFICATION

Classify each waste stream with respect to its regulatory status (e.g., hazardous or nonhazardous and exempt or nonexempt from regulation as a hazardous waste under the Resource Conservation and Recovery Act (RCRA)). Pennsylvania's hazardous waste regulations largely incorporate the Federal hazardous waste regulations.

STEP 5: LIST AND EVALUATE WASTE MANAGEMENT AND DISPOSAL OPTIONS

List all waste management practices and determine the environmental acceptability of each. Consider regulatory restrictions, engineering limitations, economics, and intangible benefits to determine the feasibility of a practice. See 25 Pa. Code § 78 (Oil and Gas Wells), §§ 16, 92, 93, 95, 96, and 97 (Wastewater Treatment), §§ 260-270 (Hazardous Waste Management), and §§ 287-299 (Residual Waste Management) for Pennsylvania's regulatory requirements.

STEP 6: WASTE MINIMIZATION

Analyze each waste generating process for opportunities to reduce the volume generated, reduce the toxicity, recycle, reclaim, or reuse. Apply the Waste Management Hierarchy presented in Chapter 1.

> **Waste management plans are an important component of successful waste management. An effective plan will emphasize waste minimization, and, in turn, promote more effective waste management.**

STEP 7: SELECT PREFERRED WASTE MANAGEMENT PRACTICES

Choose the management practice for each waste stream. Implement waste minimization options identified in Step 6 whenever feasible. Provide specific instructions for the implementation of the selected practice.

STEP 8: PREPARE AND IMPLEMENT THE WASTE MANAGEMENT PLAN

Compile all the preferred waste management and minimization practices and write summaries for handling each waste.

STEP 9: REVIEW AND UPDATE WASTE MANAGEMENT PLAN

Establish a procedure to periodically review the plan and evaluate new or modified waste management and minimization practices. Revise the plan as necessary.

Chapter 3

HAZARDOUS AND NONHAZARDOUS OIL AND GAS WASTES

OIL AND GAS WASTES

Pennsylvania has jurisdiction over oil and gas wastes, which include all wastes generated in association with the following activities:

- Drilling, operation, and plugging of wells associated with the exploration, development, or production of oil and gas, including oil and gas wells, fluid injection wells used in enhanced recovery projects, and disposal wells.
- Separation and treatment of produced fluids in the field.
- Storage of crude oil at the well site.
- Underground storage of hydrocarbons and natural gas.
- Solution mining of brine.
- Storage, hauling, disposal, or reclamation of wastes generated by these activities.

RCRA AND THE E&P EXEMPTION

The federal Resource Conservation and Recovery Act (RCRA), originally enacted in 1976, authorizes EPA to regulate the management of wastes resulting from industrial, commercial, mining, agricultural, and community activities. RCRA Subtitle C contains a comprehensive program for the regulation of hazardous wastes. Nonhazardous wastes are subject to regulation under RCRA Subtitle D.

Recognizing the unique characteristics of oil and gas wastes, in 1980 Congress specifically exempted "drilling fluids, produced waters, and other wastes associated with the exploration, development, or production of crude oil or natural gas or geothermal energy"[6] from regulation under RCRA Subtitle C as hazardous wastes. This exemption is commonly called the "E&P Exemption." The E&P exemption is explained in the following section.

The exempt oil and gas wastes are unique, which is the rational for the exemption. They are generated in large quantities, but are relatively low in toxicity. Exempt oil and gas wastes are generated by a large number of individual oil and gas operations. Oil and gas wastes are generated in diverse operational and environmental settings. Finally, exempt oil and gas wastes are adequately regulated under state and federal programs (other than RCRA Subtitle C) that have evolved over the years.

SCOPE OF THE E&P EXEMPTION

On July 6, 1988, after performing the study of oil and gas wastes mandated by Congress, EPA published its regulatory determination[7] (see Appendix A). In its regulatory determination, EPA concluded that the exemption for produced water, drilling fluids, and associated wastes should continue. EPA also made its first efforts to define the scope of the exemption. EPA reviewed both the statutory language and the legislative history and determined that the exemption for wastes associated with the exploration, development, and production of oil and gas covers only those wastes **uniquely associated** with **primary field operations**. Primary field operations include primary, secondary, and tertiary production of oil or gas.

With respect to **oil production**, primary field operations include activities occurring at or near the wellhead or production facility, but before the point where the custody of the oil is transferred from an individual field facility or a centrally located facility to a carrier for transport to a refiner. In the event no custody transfer occurs, the primary field operation ends at the last point of separation. Crude oil stock tanks are considered separation devices for the purpose of defining areas of primary field operations.

With respect to **natural gas production**, primary field operations are those activities occurring at or near the wellhead, production facility, or gas plant (including gathering lines to the plant), but before the point of transfer of the gas from an individual field facility, a centrally located facility, or a gas plant to a carrier for transport to market, or before the point of the use of natural gas in a manufacturing process.

In order to be covered under the E&P exemption, wastes from primary field operations must also be unique to E&P operations. Clearly, wastes such as produced water and drilling fluid are unique. However, other wastes commonly generated in E&P operations are used in other types of industries. For example, cleaning wastes, painting wastes, and waste lubricating oil are commonly generated in activities other than E&P activities (i.e., are not unique) and are, therefore, not covered by the E&P exemption.

In March 1993[8], EPA provided clarification of the regulatory determination regarding the status of certain oil and gas wastes (see Appendix B). In that clarification, exempt waste was more precisely defined:

> In particular, for a waste to be exempt from regulation as a hazardous waste under RCRA Subtitle C, it must be associated with operations to locate or remove oil and gas from the ground, or to remove impurities from such substances, and it must be intrinsic to and uniquely associated with oil and gas exploration, development or production operations (commonly referred to as exploration and production or E&P). The waste must not be generated by transportation or manufacturing operations . . . One common belief is that any wastes generated by, in support of, or intended for use by the oil and gas E&P industry . . . are exempt. This is not the case; in fact, only wastes generated by activities uniquely associated with the exploration, development or production of crude oil or natural gas . . . (i.e., wastes from down-hole or wastes that have otherwise been generated by contact with the production stream during the removal of produced water or other contaminants from the product) are exempt from regulation under RCRA Subtitle C . . .

In its March 1993 clarification, EPA addressed the applicability of the E&P exemption to wastes generated by crude oil reclaimers, service companies, gas plants and feeder pipelines, crude oil pipelines, and underground gas storage fields. The clarification included the following explanations of the RCRA exemption.

- For the purpose of defining primary field operations, the change of custody criterion refers to product (e.g., crude oil and natural gas), not waste.

- The off-site transport of exempt waste from a primary field site for treatment, reclamation, or disposal does not negate the exemption.

- Wastes derived from the treatment of an exempt waste, including any recovery of product from an exempt waste (e.g., crude oil reclamation from tank bottoms), generally remain exempt from the requirements of RCRA Subtitle C.

- Vacuum truck and drum rinsate from trucks and drums transporting or containing exempt waste is exempt, provided that the trucks or drums only contain E&P exempt wastes and that the water or fluid used in the rinsing is not subject to RCRA Subtitle C (i.e., is itself nonhazardous).

- Wastes generated by a service company that do not meet the basic criteria listed in the regulatory determinations (i.e., are not uniquely associated with oil and gas E&P operations) are not exempt from Subtitle C. However, an oil and gas waste generated by a service company in primary field operations, and that is also uniquely associated with E&P, is an exempt oil and gas waste.

- The removal of elemental sulfur from hydrogen sulfide gas at a gas plant is considered treatment of an exempt waste.

- Wastes uniquely associated with operations to recover natural gas from underground gas storage fields are covered by the exemption.

EPA included a list of exempt wastes and a list of nonexempt wastes in its regulatory determination. These lists are not comprehensive. They were intended only to provide examples of the types of wastes that fall under the exempt and nonexempt categories. Generators will need to make individual determinations regarding the status of a number of other incidental wastes. The DEP or the EPA should be contacted for guidance in the event the regulatory status of a waste is in doubt.

Exempt Wastes

Exempt wastes make up the bulk of all wastes that are regulated by Pennsylvania. Table 1 is a list of wastes designated as exempt in EPA's regulatory determination dated July 6, 1988[7]. It is a listing of most, but not all, oil and gas wastes that are exempt from hazardous waste regulation.

Although many oil and gas wastes are exempt from hazardous waste regulation, other regulations will apply.

Nonexempt Wastes

The wastes that EPA has determined are not covered under the exemption may be hazardous wastes subject to regulation under RCRA Subtitle C. Nonexempt wastes include, no matter where generated, those wastes that *are not uniquely associated* with an exploration and production activity, such as cleaning wastes or lubricating oil. Further, *all* wastes that are not associated with primary field operations are nonexempt. Table 2 provides the list of nonexempt wastes in EPA's regulatory determination[7]. This is a listing of most, but not all, oil and gas wastes that are not exempt from regulation as hazardous wastes.

Not all nonexempt wastes are hazardous wastes. For example, empty drums and insulation will probably not be hazardous waste. However, some wastes, such as paint wastes, spent solvents, unused fracturing materials that can no longer be used for their intended purpose may be hazardous. The following section, "Hazardous Oil and Gas Wastes," explains how an operator may identify a nonexempt waste as hazardous or nonhazardous.

TABLE 1. OIL AND GAS WASTES EXEMPT FROM RCRA HAZARDOUS WASTE REGULATION*

- Produced water
- Drilling fluids and drill cuttings
- Rigwash
- Well completion, treatment, and stimulation fluids
- Workover wastes
- Basic sediment & water and other tank bottom sludge from storage facilities that hold product and exempt waste
- Accumulated materials such as hydrocarbons, solids, sand , and emulsion from production separators, fluid treating vessels, and production impoundments
- Pit sludges and contaminated bottoms from storage or disposal exempt wastes
- Spent filters, filter media, and backwash (assuming the filter itself is not hazardous and the residue in it is from an exempt waste stream)
- Packing fluids
- Produced sand
- Pipe scale, hydrocarbon solids, hydrates, and other deposits removed from piping and equipment prior to transportation
- Hydrocarbon-bearing soil
- Pigging wastes from gathering lines
- Wastes from subsurface gas storage and retrieval, except for the listed nonexempt wastes
- Constituents removed from produced water before it is injected or otherwise disposed of
- Liquid hydrocarbons removed from the production stream but not from oil refining
- Gases removed from the production stream, such as hydrogen sulfide and carbon dioxide, and volatilized hydrocarbons
- Materials ejected from a producing well during blowdown
- Waste crude oil from primary field operations and production
- Light organics volatilized from exempt wastes in reserve pits or impoundments or production equipment

*Note: All exempt waste *must* be generated in primary field operations.

TABLE 2. RCRA NONEXEMPT OIL AND GAS WASTES

- Unused fracturing fluids or acids
- Painting wastes
- Oil and gas service company wastes, such as empty drums, drum rinsate, vacuum truck rinsate, sandblast media, painting wastes, spent solvents, spilled chemicals, and waste acids
- Vacuum truck and drum rinsate from trucks and drums transporting or containing nonexempt waste
- Liquid and solid wastes generated by crude oil and tank bottom reclaimers*****
- Used equipment lubrication oils
- Waste compressor oil, filters, and blowdown
- Used hydraulic fluids
- Waste solvents
- Caustic or acid cleaners
- Laboratory wastes
- Sanitary wastes
- Pesticide wastes
- Radioactive tracer wastes
- Drums, insulation, and miscellaneous solids

*NOTE: Residual material from reclamation of crude oil from exempt waste is also exempt

Implementing a waste minimization program can simplify compliance with the requirements of RCRA and may reduce costs and future liability for the disposal of hazardous and nonhazardous wastes.

MANAGEMENT OF NONHAZARDOUS OIL AND GAS WASTES

The Commonwealth of Pennsylvania has regulatory programs in place for the management of nonhazardous and exempt oil and gas wastes. The Department of Environmental Protection's Bureau of Oil and Gas Management is responsible for regulating oil and gas exploration and production activities. The "Oil and Gas Operators Manual " is a good reference.

MANAGEMENT OF HAZARDOUS OIL AND GAS WASTES

Hazardous oil and gas wastes are those oil and gas wastes that are not RCRA-exempt and that are listed hazardous wastes or characteristically hazardous under RCRA Subtitle C.

RCRA Subtitle C mandated that EPA develop and adopt regulations for management of hazardous wastes. The regulations adopted by EPA under RCRA Subtitle C are very complex and lengthy. These regulations are contained in 40 Code of Federal Regulations (CFR) Parts 260 through 270. These regulations apply to the generation, transportation, treatment, storage, and disposal of hazardous waste.

Pennsylvania has been delegated RCRA authority by the EPA. Pennsylvania's regulations for hazardous waste are in 25 Pa. Code § 260 through 270a. The criteria for determining if a waste is hazardous are adopted from the Federal regulations. Therefore, the determination of exempt and nonexempt wastes is the same for Pennsylvania and Federal Regulations. The Bureau of Land Recycling and Waste Management should be contacted for specific information.

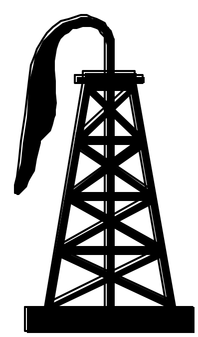
NOTES

Chapter 4

POTENTIAL WASTE GENERATION IN OIL AND GAS OPERATIONS

This chapter provides a general overview of the waste streams associated with various oil and gas operations. The overview is presented in an outline format for easy reference. Separate sections are presented for drilling operations, oil and gas production operations, and general operations. Examples of wastes potentially generated by each type of operation are included in the overview. The overview may help during a thorough audit of the wastes generated in each operation. Developing a list of the wastes generated in an operation, with a description of the regulatory status of each waste, is an important first step in preparing an effective waste management and minimization plan (Step 7 and Step 8 of the Waste Management Plan, Chapter 2).

DRILLING OPERATIONS [1,10,11]



I. Well site construction and access road development are conducted in preparation for drilling activities.

- **Wastes: Sediment in runoff from the site, possible contamination from oil or fuel leaking from heavy equipment, debris left at the site by workers.**

II. Drilling activities include the operation of the rig, a drilling air or mud system, and drill string to make a hole.

A. The drilling rig is used to handle the drill pipe and bit and to set casing to complete the well. Rig operation and maintenance uses numerous systems and various types of machinery.

- **Wastes: Pipe dope, hydraulic fluids, used oils and oil filters, rigwash (water used to spray down the rig that could contain fluids from the well or any other material that could be spilled onto the rig), spilled fuel, drill cuttings, produced water, drums and containers, spent and unused solvents (Hydrochloric acid,**

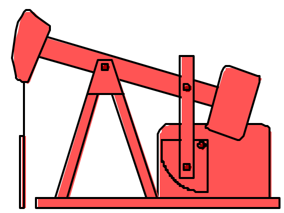
methanol, Parasal, and xylene have been used as solvents in Pennsylvania.), paint and paint wastes, sandblast media, scrap metal, solid waste, and garbage.

B. Drilling pits receive drill cuttings and solids, used drilling fluids, rigwash, and if not constructed properly, surface runoff from the drilling location.

- **Wastes: Drill cuttings and solids, used drilling fluids, rigwash.**

(*Note: Nonexempt hazardous oil and gas waste should not be allowed to enter the reserve pit.)*

OIL AND GAS PRODUCTION OPERATIONS [1]



I. Wells produce oil and/or gas by natural flow or artificial lift.

A. Flowing wells consist of the wellhead assembly and associated equipment used for well treatment.

- **Wastes: Paraffin, oil and produced water-contaminated soils, produced water, scale, treating chemicals, sand, and paint.**

B. Artificial lift is accomplished by use of beam pumps (horsehead pumps).

- **Wastes: Used lubrication oil and filters, gas lift engine fuel, released crude oil (from stuffing box), paraffin, produced water contaminated soils, produced water, scale, treating chemicals, sand, and paint.**

II. Flowlines (gathering systems) are used to move produced oil to treatment and storage facilities (e.g., tank batteries).

- **Wastes: Paraffin, produced water, treating chemicals, contaminated soil, scale, and other materials collected in pig traps.**

III. Separation and processing are often conducted at points along the gathering system.

A. Two-phase separation of produced liquids from gases, three-phase separation of produced water from liquid hydrocarbons, and/or gas floatation treatment may be installed.

- **Wastes: Separator bottoms, blowdown, produced sand and scale, skim oil.**

B. Free water knockouts are used to separate oil and water at appropriate locations in the gathering system.

- **Wastes: Produced water, produced sand and scale bottom sludges.**

C. Heater treaters and electrostatic treaters separate emulsified oil and water.

- **Wastes: Produced water, produced sand and scale bottom sludges, oil absorption media.**

D. Filtering improves the quality of liquids and produced water.

- **Wastes: Used filters, filter media, backwash.**

IV. Tank batteries consist of separation and treatment equipment and storage tanks.

A. Stock tanks are used to store treated crude oil and produced water. The tanks require periodic cleaning to remove tank bottoms or basic sediment and water (BS&W).

- **Wastes: Produced sand, scale, BS&W.**

B. Crude oil custody transfer is typically accomplished by moving the oil onto tank trucks via a loading line or into a pipeline.

- **Wastes: Spilled crude oil, crude oil-contaminated soil.**

V. Handling of produced water is often required in preparation for recycling or proper disposal.

A. Produced water may be stored in tanks or pits conforming to 25 PA Code §78.57 for removing solids and oil separation.

- **Wastes: Solids and additional oil.**

B. Underground injection, using electric or gas engine powered pumps to pressurize water, is a method for management of produced water.

- **Wastes: Used lubricating oil and filters, produced water filters and filter media, filter backwash, produced water-contaminated soil, and unused or spent chemicals.**

VI. Completions and workovers are conducted to facilitate the production of a well.

A. Workover rigs are used for well completions and well workovers (i.e., treatment and/or stimulation). Workover rigs are generally mobile units.

- **Wastes: Hydraulic fluids, rigwash, spent solvents, used lubricating oil and filters.**

B. Well workovers may involve recompleting in a different pay zone by deepening the well or plugging back. Operations may generate wastes with the volume and characteristics of drilling operation waste.

- **Wastes: Refer to drilling operations.**

C. Well treatment and stimulation use various chemicals and products to improve the producing characteristics of a well.

- **Wastes: Drums and containers, weighing agents, surfactants, muds, produced water, acids, frac fluids, inhibitors (scale and corrosion), gel, solvents, and other materials.**

D. Workover pits are sometimes constructed to receive oil and gas wastes generated during workover operations.

- **Wastes: Drilling solids, drilled cement, liners or contaminated soil and metal (e.g., bridge plugs).**

VII. Enhanced oil recovery operations (EOR) typically involve the injection of water into a producing formation, as well as injection of certain chemicals.

- **Wastes: Unused or spent chemicals, polymers, etc.**

OPERATIONS IN GENERAL

Several wastes are common to most, if not all, types of oil and gas operations:

- **Contaminated soil:** Any uncontrolled release of chemicals, brine, oil, drilling fluid, or other materials, will result in soil contamination.

- **Used or spent solvents:** Solvents are used in tasks such as cleaning, degreasing, and painting. Hydrochloric acid, methanol, Parasol, and xylene have been used in Pennsylvania. Unused solvent intended for disposal is considered a waste.

- **Used oil and used oil filters:** Engines and other machinery in all areas of operations require lubricating oil and oil filters.

- **Drums and containers:** Drums and containers are required for delivery and storage of chemicals and materials used in all areas of operations.

- **Sandblast media:** Sandblasting is typically used to prepare equipment for painting and to remove scale from equipment.

- **Paint and paint wastes:** Painting is generally required for maintenance of equipment. Paint thinners, solvents, and unused paint are generated wastes.

- **Vacuum truck rinsate:** Vacuum trucks recover waste liquids generated by various operations.

- **Scrap metal:** Scrap metal consists of damaged tubulars or other equipment, crushed drums, remnants of welding operations, cut drill line, etc. Scrap metal may contain naturally occurring radioactive materials (NORM). A survey of drill pipe in Pennsylvania did not find NORM.

API GENERIC LIST OF HAZARDOUS CHEMICAL CATEGORIES FOR THE E&P INDUSTRY

Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA) requires industries to report the use of certain "hazardous" chemicals. The American Petroleum Institute (API) and the Independent Petroleum Association of America (IPAA) have published a guidance document[9] to assist E&P operators with the preparation of reports required by SARA Title III (§311 and §312). This guidance document includes a generic listing of chemicals used in the oil and gas industry. This list is provided as Appendix D and may be used as an additional guide for identifying wastes that can be minimized.

> *Note: The list refers to the chemicals as "hazardous." For the purposes of SARA Title II, "hazardous" indicates any chemical required to have a material safety data sheet (MSDS). All chemicals listed in Appendix A are not necessarily hazardous waste as defined by regulations adopted under RCRA.*

CHAPTER 5

Source Reduction Opportunities and Case Histories of Waste Minimization in the Oil and Gas Drilling and Production Industry

DRILLING OPERATIONS

Source Reduction Opportunities in Drilling Operations

Preplanning

The best place to start waste minimization efforts for a drilling operation is in the planning stages. The drilling plan should be evaluated for potential waste generation and modified to take advantage of source reduction and recycling options discussed below. A discussion of anticipated waste generation and management should be an integral part of the pre-spud meeting. This preplanning can make a significant impact on the waste management requirements of the drilling operation.

Drilling Fluid Systems: An operator should design the drilling fluid system with waste minimization in mind. Several waste minimization opportunities for drilling fluid systems, such as improved system monitoring, substitute fluids and improved solids control, are available. These waste minimization techniques should be integrated into the drilling fluid system portion of the drilling plan. Generally in Pennsylvania, wells can be drilled using compressed air. Deep wells may require the use of drilling muds.

Product Substitution

Product substitution is one of the easiest and most effective source reduction opportunities. Vendors are becoming more attuned to operators' needs in this area and are focusing their efforts on providing less toxic, yet effective, substitutes. Vendors and suppliers may start offering less toxic substitutes in response to a company establishing inventory control procedures. Material Safety Data Sheets (MSDSs) can be used to determine toxicity of materials. A few examples of effective and beneficial product substitution for drilling operations are provided below.

Drilling Fluid Additives: Many of the additives used in the past for drilling fluids have contained potential contaminants of concern such as chromium in lignosulfonates. Also, barite weighting agents may contain concentrations of heavy metals such as cadmium or mercury. The use of such additives has diminished. However, an operator should take care to select additives that are less toxic and that will result in a less toxic drilling waste. The design of the drilling fluid system is the best place to implement this product substitution opportunity.

Equipment Modification

More Efficient Equipment: Operators should consider doing a cost analysis to determine if newer more efficient equipment may save them money. Newer equipment could save on maintenance costs, result in fewer leaks or spills requiring cleanup, and more efficient use of energy**.**

Process or Procedural Modifications

Segregating Wastes: Operators should consider segregating their wastes. It may be beneficial to separate fluids and drill cuttings above the casing seat from those below it. The disposal requirements for fluids and drill cuttings above the casing seat are less stringent (disposal in unlined pits or by land application) than for those below the casing seat (disposal in lined pit or by land application depending on contaminant concentrations). See 25 Pa. Code § 78. Operators should also insure that non-exempt RCRA waste does not come into contact with exempt RCRA waste as this will make all of the waste non-exempt leading to much more expensive disposal costs.

Slim Holes: The drilling industry has improved the technology of slim hole drilling over the past few years. Slim hole drilling should be considered when planning a drilling project. If feasible, slim hole drilling reduces the volume of waste drilling fluid and the volume of drill cuttings. The total cost of a slim hole drilling operation may be considerably less than for conventional hole sizes due to the reduced fluid system and waste management costs. Also, smaller casing is required, which may help reduce the total cost of the operation.

There was difficulty setting cement properly on several wells near Erie where slim hole drilling was used. The annulus was too small and rivulets formed in the cement which allowed gas to escape. Slim hole drilling may not be effective in some formations such as the Salina. Operators should evaluate whether slim hole drilling will be effective for the well they are drilling before deciding to use this technique.

Solids Control for the Drilling Fluid System: An effective way to reduce the volume of drilling fluid waste is the use of solids control. The efficient use of solids control equipment (e.g., hydrocyclones and centrifuges) in combination with chemical flocculants minimizes the need for makeup water to dilute the fluid system. An enhanced solids control system designed to compliment a specific drilling operation is a very effective waste minimization technique that can save money. Of course, the simplest way to reduce drilling fluid waste is to drill on air where possible.

Closed-Loop Drilling Fluid Systems: Closed-loop drilling fluid systems provide many advantages over discharging fluids to a drilling pit. Closed-loop drilling fluid systems use a series of steel tanks that contain all drilling fluid and equipment used to remove cuttings. These systems enhance the operator's ability to monitor fluid levels and characteristics. The result is more efficient use of the drilling fluid and less drilling waste remaining at the end of the operation. Also, the operator may more easily recycle the waste drilling fluid (also see "Recycling"). Even though it is not always cost effective, some companies have elected to use only closed-loop drilling fluid systems in their operations. Other companies, have found that use of this system is cost-effective under certain circumstances. Regardless, whenever a closed-loop system is used, the operator reduces his potential future liability associated with a conventional earthen pit and the waste management and site closure costs. It's also good for the company image and public relations.

Fluid Runoff from Pulled Drill String: Running drill pipe into and out of the hole can contribute to the volume of waste in the drilling pit. Lost fluids and the excess rigwash required for cleaning it from the rig floor can be major contributors and can be minimized. Devices are available that wipe clean the inner diameter of the drill pipe as it is pulled so that the fluid does not run onto the rig floor.

Reduction In Water Use

Segregating tophole water (water that is brought to the surface while drilling through the strata containing fresh groundwater and water that is fresh groundwater or water that is from a body of surface water)from other fluids when drilling a well can help reduce the amount of water requiring hauling or treatment after drilling is completed. Pennsylvania regulations allow for tophole water to be discharged on-site if the water has not come into contact with pollutional materials, pH is between 6-9, specific conductivity is less than 1,000 mhos/cm, and there is no sheen from oil and grease.

Continuous Air Drilling: When saline or fresh water is encountered during drilling, the well should be completed as rapidly as possible to minimize the time water is being blown back to the surface. Drilling on a 24-hour schedule to eliminate daily blow off of water accumulated in the well bore and doing everything possible to reduce the likelihood of an extra “trip” can result in substantial savings in terms of water blown to the pit. When water is encountered in an excessive amount, it may be advantageous, from a fluid reduction position, to stop drilling and isolate the water zone by pressure plugging or casing off the source horizon.

Intermediate Strings: In some areas, while drilling below the surface casing, specific geologic horizons or zones may produce large quantities of brine during air drilling. While it may, at times, be possible to overcome this water with large air volumes or pressures, it may be desirable to shut these zones off with intermediate strings of casing. In this procedure, the subject formation or zone is fully penetrated, a string of pipe is placed in the hole, and a seal established at the bottom of the pipe. The seal may be made permanent by cementing the annular space between the well bore and the intermediate casing back to the surface, or spotting cement over the salt water producing zone**.**

Plugging Water Bearing Zone: Another technique that can be used to isolate salt water producing zones involves cementing off the zone. In this procedure, cement or another water blocking material, is placed over the subject zone. This may be done under elevated pressure to promote penetration of the formation with the cement or other water blocking material. This technique is usually not as successful as using intermediate casing.

Rig Wash Hoses: A simple way to minimize the volume of waste rigwash is to use high-pressure/low-volume nozzles on the rigwash hose. A rigwash hose left running can contribute significantly to the volume of waste in a reserve pit and water for the drilling operation. If feasible, collection and treatment of rigwash for reuse is a good waste minimization technique.

<u>Good Housekeeping and Preventative Maintenance</u>

Drill Site Construction and Rigging-Up: Drill site construction and rigging-up involve the use of heavy equipment, such as bulldozers. Heavy equipment should be well maintained to reduce the potential for fuel and lubricating oil leaks that may contaminate the site. Preventative maintenance and good housekeeping during the construction phase can help prevent the generation of contaminated soil and water. For example, secondary containment beneath fuel storage drums can prevent accidental releases to soil and water.

Recycling Opportunities in Drilling Operations

Drilling Fluids: Drilling fluids comprise the largest waste stream associated with a drilling operation. Generally in Pennsylvania, drilling fluids will consist of drill cuttings, formation water, and, possibly, water added to the system to keep dust down because most wells are drilled using compressed air. In some cases where deep wells are being drilled mud may be used.

The cost of closing a drilling site is increased if drilling fluids must be dewatered and/or stabilized prior to closure. A better alternative is to recycle or reuse the waste drilling fluids. A cost-effective alternative for reuse of waste drilling mud is in plugging or spudding of other wells.

Drilling Pit Water: A drilling operation should consider reclaiming water from the drilling pit by using a dewatering technique. The reclaimed water can then be used as rigwash water, makeup water for the drilling fluid system, and other rig water usage. Additionally, collected stormwater runoff may be suitable for use. This technique can reduce the need for fresh water and save money.

CASE HISTORIES OF SUCCESSFUL WASTE MINIMIZATION IN DRILLING OPERATIONS

Closed Loop Drilling Fluid System

Problem: A small independent operator was concerned about the volume of drilling waste in conventional reserve pits at his drilling locations. Waste management costs were a concern, as well as the costs associated with impact on adjacent land due to pit failures. The operator was concerned about the potential for surface water or ground water contamination and the associated potential liabilities.

Solution: The operator was drilling relatively shallow wells in normally pressured strata. Because the drilling plan was relatively simple, the operator investigated the feasibility of using a closed-loop drilling fluid system for these wells. The use of a closed-loop system eliminated the need for a conventional drilling pit. The operator negotiated with drilling contractors to obtain a turn-key contract that required the drilling company to use a closed-loop system and take responsibility for recycling the waste drilling fluid.

Benefits: The turn-key contract was incrementally more expensive. However, because of reduced drill site construction and closure costs, reduced waste management costs, and reduced surface damage payments, the operator realized a savings of about $10,000 per well. Also, the operator reduced the potential for environmental impact and associated potential liability concerns.

Drilling Rig Lubricating Oil

Problem: A drilling company was concerned with the volume of waste lubricating oil and filters generated by diesel power plants on its rigs. Also of concern was the expense of replacement lubricating oil and filters and waste management costs. The drilling company recognized that the problem stemmed from performing oil and filter changes at 500-hour operating intervals as recommended by the manufacturer. In general, the basis for the company's concerns was reducing the daily operating costs of its rigs.

Solution: The company extended the operating interval between lube oil changes for the diesel power plants. They performed sampling and analysis of the lube oil to determine the need for a change. Specific analytes, such as contaminants, additives, and metals, were given threshold values. Whenever a threshold value was exceeded, a lube oil and filter change was made. In any event, the maximum operating interval was set at 1,250 hours.

Benefits: The change in the procedure for determining the need for lube oil and filter changes resulted in a decrease in oil costs from $64/day to $41/day in two years, which translates to a 36% reduction in waste generation. Additional cost savings were realized due to decreased maintenance requirements, improved operating efficiency, and reduced waste management requirements. Importantly, no harm or unusual wear was experienced in the diesel power plants.

Dusting to Manage Uncontaminated Drill Cuttings

Problem: Authorities from the Allegheny National Forest wanted to decrease the size of the well pads in the forest.

Solution: Companies proposed an alternate method for disposal of drill cuttings which only contacted fresh ground water and did not come into contact with any drilling additives. The proposal was to spray the cuttings around the well site while drilling. This alternate method was reviewed and approved by the Department of Environmental Protection. It is commonly practiced in the Allegheny National Forest.

Benefit: No residual waste pits need to be constructed. The size of the well site is reduced because no pit is needed. The amount of drill cuttings needing disposal is reduced.

PRODUCTION AND WORKOVER OPERATIONS

Source Reduction Opportunities in Production and Workover Operations

Preplanning

Spill Prevention and Control: A site should be constructed such that any releases of crude oil are contained, even if the site is not subject to the federal Spill Prevention Control and Countermeasure (SPCC) requirements (40 CFR Part 112). As well, the spill containment should be designed to capture releases of produced water. Such planning will help an operator recover most spilled crude oil and minimize the extent of soil contamination that must be remediated under applicable environmental regulations.

Site Equipment: An operator can also include in a production facility's design, tanks, separators, and other associated equipment to enhance waste minimization. Features such as drip pans, elevated flowlines, drip or spill containment devices (e.g., beneath load line connections), stock tank vapor recovery systems, and constructed storage areas for containers of chemicals and wastes are good waste minimization ideas. Many of these waste minimization opportunities are discussed further in the following sections.

Workovers and Well Servicing: A preplanning opportunity for workover and well treatment operations is to carefully design the operation so that only the volume of chemicals necessary for the operation are brought to the site. An operator who takes this step can reduce the amount of leftover chemicals (e.g., acids) that may have to be managed as waste. Also, the potential for contamination from spills is reduced. The selection of contractors for conducting workovers is an important step.

Product Substitution

Organic Solvents: Solvents such as bulk xylene (trade name used in Pennsylvania is Parasol) which can contain xylene, toluene, and ethylbenzene has been used for dissolution and removal of organic deposits (e.g., paraffin) in well bores and producing formations. Service companies have developed non-toxic solvents that will substitute for bulk xylene. Check with your service company or chemical vendor for these substitute solvents before purchasing aromatic solvents such as bulk xylene.

Equipment Modifications

Basic Sediment and Water (BS&W), or Tank Bottoms: Many operators have used simple techniques to minimize the volume of BS&W that accumulates in tanks and sediments that accumulate in other production vessels. Devices such as circulating jets, rotating paddles, and propellers may be installed in crude oil stock tanks to roll the crude oil so that paraffin and asphaltene remain in solution (or at least suspension). Also, emulsifier can be added to the stock tank to accomplish the same result. Another method used is to circulate the tank bottoms through a heater treater to keep the paraffin and asphaltene in solution.

Process or Procedural Modifications

Cementing "On-the-Fly:" When conducting cementing operations, a significant volume of unused premixed cement may remain after completing casing or plugging jobs. Of course, one way to prevent excess cement is careful preplanning. However, service companies now provide systems that mix neat cement and additives on-the-fly. These systems are also referred to as automatic density control systems. The advantage of mixing on-the-fly is that the mixing process can be stopped as soon as the cementing job is complete. Also, the mixing system can be shut down if the cementing job is interrupted for some reason, thus saving the generation of a much larger volume of unusable premixed cement. The only unused cement mixture is that remaining in the mixing system. The unused neat cement and additives are not wastes and can be returned to the service company for use in the next cementing job.

Frac Jobs "On-the-Fly:" Oil field service companies now offer equipment that mixes fracturing fluids on-the-fly, just as for the cements described in the preceding example. The on-the-fly system will continuously mix dry gel at a selected concentration or mix a liquid concentrate that is later diluted to the required concentration. Significant advantages of this type of system are elimination of the need for diesel-based liquid gel concentrates and reduced waste subject to more strict regulation. The process is also more efficient.

Remote Monitoring of Production Operations: Although it does not appear so, the remote monitoring of production operations is a source reduction technique. Microcomputer-based monitoring of parameters such as pumping unit load, stuffing box leaks, polished rod temperature, gun barrel water level, heater treater temperature and pressure, and tank levels and temperatures can be transmitted to the field office by microwave transmission. Because the system immediately alerts the operator of any upset condition or imminent equipment failure, the operator can quickly address the problem. By doing so, the operator can avoid unnecessary waste generation. For example the operator can prevent equipment failures that would require a workover (workovers generate waste), replace stuffing box rubbers prior to failure (oil leaking from a stuffing box may contaminate soil), prevent tank overflows, and detect loss of fluid from tanks (e.g., leaks or theft). Remote monitoring systems are offered commercially and according to vendors may replace, at a comparable cost, the routine manual measurements.

Workovers Using Coiled Tubing Units: Operations using conventional workover rigs typically generate wastes that must be managed after completion of the workover. An alternative to using workover rigs is to use coiled tubing units for through tubing workovers. Over the past several years, service companies have developed suitable through tubing tools for this purpose. A coiled tubing unit workover eliminates the need for pulling tubing, displacing well fluids, and well blowdown, all of which generate wastes. When feasible, coiled tubing units are a good choice for well workovers.

Paraffin Control: Paraffin deposition can cause operational problems and result in unwanted waste generation. Paraffin deposition can cause sticking and parted rods in the well bore, plugging and rupture of surface flowlines, increased tank bottom generation, and reduced crude oil quality at the sales point. Frequently, the results are ongoing hot oil and solvent treatments, cleanups of crude oil and saltwater-contaminated soils, and dissatisfied crude oil purchasers. At the bottom line, the operator realizes reduced operating efficiency, reduced revenue, and increased regulatory compliance concerns.

Another technique for controlling paraffin deposition is the application of microbes in the well. Bacteria introduced into the producing well bore and formation biodegrade the high carbon chain paraffins, which in turn improves the properties of the crude oil with respect to paraffin deposition. The authors of one technical paper (Society of Petroleum Engineers 22851) suggest that microbial treatment is "potentially limited to wells that produce water, are pumping wells, and have bottom hole temperatures below 210oF." Reports in that technical paper and in other technical papers indicate microbial control of paraffin deposition is effective.

Leaking Gas: Operators should develop a program for detecting and eliminating leaks in gas lines from the wells to the main transmission line. Eliminating leaks will result in more gas for sale and reduce emissions to the atmosphere.

Reduction In Water Use

Water Floods for Enhanced Recovery: In some instances, operators of water floods for enhanced recovery use fresh water from surface sources or from water wells. If feasible, an operator should find sources of produced water to replace fresh water injection. Adjacent operators may produce water that is compatible with the injection zone and is also economically and technically feasible to transfer between leases.

Good Housekeeping and Preventative Maintenance

Containment of Fluids Used in Workovers: Wastes generated by workover rigs may add to the management concerns of an operator. One of the most common problems is contamination of soil by tubing runoff and other spills on the workover rig floor. Several techniques can control this source of waste. First, a containment device beneath a raised rig floor can capture runoff and direct it to collection tanks or containers. Also, heavy-duty tarps (commercially available) laid over the well site will perform the same function.

Another solution to the problem of tubing runoff and spills is construction of an impermeable wellhead sump (i.e., a better cellar) during preparation for the original drilling operations. Later, when the well is completed and producing, the wellhead sump will collect any runoff or spills associated with workover operations. As well, the wellhead sump will collect any crude oil leakage from stuffing boxes, thus preventing contamination of soil around the wellhead. The wellhead sump is covered by a metal grate for safety.

Recycling Opportunities in Production and Workover Operations

Produced Water: Look for opportunities to direct produced water to Class II wells that are permitted for enhanced recovery. Produced water that is injected for enhanced recovery is considered to be recycled.

Roadspreading: Spreading brine on dirt roads is an effective means of dust suppression. The chlorides in the brine are hygroscopic and absorb moisture from the atmosphere keeping the road compacted. Treated brine from treatment plants is preferred since metals and organics are removed while chlorides are retained. Roadspreading allows for the beneficial use of brine as opposed to simply disposing of it. Any use of brine for dust suppression must be approved by the DEP and follow roadspreading guidelines developed by DEP.

Reuse of Frac Water: By containing the flow back from a well after hydrofracturing, it may be possible to re-use some of the water on successive stages of the same job or on other wells. On-site pretreatment, such as flocculation, settling or filtration may be necessary to re-use the water. This activity has a dual advantage in that: 1) flow-back water is carefully controlled and not allowed to spill onto the land surface or discharge to streams, and 2) the total volume of water required is reduced. The re-use of frac water has caused formation plugging and may not be suitable for every operation.

Use of Efficient Frac Fluids: Service companies in the Appalachian Basin have brought into use hydrofracturing fluid systems that are so efficient in transporting and depositing the propping agent in the created fracture that smaller volumes of fluid can achieve the same results. One example is the foam frac. One company reported not using this because it is more expensive and requires higher grade casing. The fluid consists of a gas and water phase with large concentrations of surfactants. This system can reduce the water requirements by more than 75% over conventional gel or water fracs. Sand concentrations in excess of 15 pounds per gallon of water are possible. While this system is not used in open hole completions because of the danger involved, it is an effective fluid reduction technique in cased wells. Although it is the more expensive method, the great reduction in spent fracturing fluid, the reduction in water handling, clean up and storage and the reduced reservoir damage are definite benefits. The results of this type of fracturing may be unsatisfactory in some formations.

Water-Oil Ratio Improvement Chemical: Although experimental and relatively new on the market, water-oil ratio improvement chemicals have been developed which, when applied to certain producing formation, may improve profitability by decreasing water production and permitting additional oil to be produced. A polymeric material which decreases the relative permeability of the rock to water as compared to oil, is introduced into the formation by pumping under pressure. Thus, a more favorable water-to-oil ratio is achieved.

Tank Bottoms: Tank bottoms, or BS&W, can be managed by sending them to a crude oil reclamation plant. An operator should contact nearby crude oil reclamation plants to determine if an economically feasible arrangement is possible before considering disposal options.

Lubricating Oil and Filters: Recycling is the preferred method of managing these wastes. Companies that handle lube oil and filters for recycling are not difficult to locate. Recycling facilities for used oil and filters are available throughout Pennsylvania. For a current list of recycling sites go the DEP web page at www.dep.state.pa.us. Click on Subjects and find and click on Oil Recycling. This site has a list of oil and filter recyclers.

Also, an operator can recycle his waste lube oil by adding it to a crude oil stock tank. Amendments to 40 CFR (Code of Federal Regulations) Part 279 (regarding standards for management of lubricating oil) provide for this option. There is a regulatory limit of 1% lube oil by volume. An important consideration in choosing this recycling option is the requirements of the crude oil purchaser and the receiving refinery. Make sure they will accept a crude oil and lube oil mixture. (Some refineries are not able to handle such mixtures, and may suffer damage to catalysts and other processes.)

Cements: Leftover cement may be used for other purposes, such as construction of on-site erosion control structures or pads. The Oklahoma Corporation Commission publication, "Oilfield Pollution Prevention," reports that one major service company in that state has arranged to provide leftover cements to local governments for use in their construction projects.

CASE HISTORIES OF SUCCESSFUL WASTE MINIMIZATION IN PRODUCTION AND WORKOVER OPERATIONS

Automatic Rod-Pump Shut-Off

Problem: A small independent oil producer operates a shallow, 40-well oil field in an area subject to extremely cold winters. The operator's poly flowlines would freeze and rupture in the cold weather. Increased paraffin deposition also contributed to this problem. The flowline ruptures resulted in contaminated soil that had to be cleaned up under a Texas rule. Also, to prevent rupture of the flowlines, the rod-pumps had to be shut down when freezing weather was predicted resulting in loss of production and revenue.

Solution: The operator designed and installed an automatic pump shut-off system on each well. A low cost system was designed (about $75/well including parts and labor). The total investment for installing the devices on each of the 40 wells was about $3,000 ($75/well). The automatic shut-off system was made using an automotive brake light switch (pressure switch), copper tubing, hydraulic fluid, and a simple relay switch. The circuit was designed such that the pump must be manually restarted after the cause of shut-off is determined.

Benefits: Since installation of the automatic shut-off systems, the operator has not experienced a single flowline rupture. As a result, soil cleanups and loss of production and revenue have been eliminated. The operator did not provide the specific economics for this project. However, it is clearly cost effective. The savings from reduced soil cleanups and increased revenue from more efficient production would easily recover the nominal capital investment.

Pump-Jack Gear-Box Lube Oil

Problem: A small independent operator felt that the cost of replacing lube oil in pump-jack gear boxes, including maintenance and waste lube oil management, was excessive. The operator investigated opportunities to reduce these costs and the management of the waste lube oil.

Solution: The operator found a very simple solution. A service company was contracted to regenerate the gear box lube oil. The service company filters and treats (purifies) the lube oil on-site. The reclaimed lube oil is returned to the gear box for reuse. The cost is about $35 to $40 per pump jack.

Benefits: The operator's use of this service eliminated the generation and the management of waste lube oil and the associated maintenance requirements. The change in procedure was cost effective. New replacement lube oil costs about $175 per pump jack; therefore, a savings of about $135 per pump jack is realized. Additional savings are realized because of reduced waste management and maintenance costs.

Produced Water Filters

Problem: A small independent operator in Texas generated a large volume of waste filters from a produced water injection system for a water flood. About 14,000 barrels of produced water is reinjected each day. Two produced water filter units at 36 injection wells were replaced twice per month resulting in about 1,700 waste filters per year. The operator spent $4,148 per year for new replacement filters ($2.44 per filter x 1,700 filters). Additional expense was incurred from waste filter management and maintenance.

Solution: The operator changed the procedure by basing filter replacements on differential pressure, rather than on a twice-monthly schedule. Valves were installed on filter inlet and outlet to accommodate a temporary pressure gauge hookup for differential pressure measurement. A capital investment of $1,800 was required for installation of the valves.

Benefits: The operator's procedure change and simple equipment modification resulted in a significant reduction in the volume of waste filters. In the year following the change, a total of 28 waste filters were generated. The change was very cost effective due to reduced maintenance requirements, reduced waste management, and reduced filter replacements. The operator saved
about $4,000 per year due to the reduced filter replacement costs. The capital investment was recovered in about five months, based only on the reduction in new filter costs. Additional savings were gained from the reduced maintenance and the reduced waste management.

Roadspreading Brine

Problem: Produced brine is taken to treatment plants and then discharged. Transport and treatment costs place an economic burden on the operator.

Solution: In Pennsylvania, roadspreading brine for dust suppression is considered a beneficial use of the brine and is regulated by the State's Department of Environmental Protection. DEP's Bureau of Land Recycling and Waste Management is developing a general permit for use of brine as a prewetting (road salt is sprayed with brine before being applied to the road surface) and anti-icing (a thin layer of brine is applied to the road surface before a winter storm event) agent depending on the chemical makeup of the brine.

Benefit: Brine is being reused as opposed to being discharged to surface waters. This conforms to the waste management hierarchy, which prefers reuse to disposal. Operators save on disposal costs and may receive revenue for the use of their brine.

Reuse of Produced Water in Plugging Operations

Problem: Produce water is shipped to a treatment plant or disposal well. The operator pays for the transport and treatment and disposal.

Solution: Use produced water to mix with gels used as spacers between cement plugs in plugging operations.

Benefit: Operator saves on disposal costs and brine is reused instead of being discharged or disposed.

Reuse of Fracing Fluids

Problem: After using fracing fluids to treat a well, it has to be shipped to a treatment facility for disposal. The operator pays the treatment facility to treat and discharge the frac fluids.

Solution: Some companies are reusing frac fluids. The frac fluids are reconditioned and used at other well sites the company is servicing.

Benefit: Less residual waste is generated. The company saves money on treatment costs. Operators can save approximately $3,500 per well site if they reuse frac fluids assuming all of the frac fluid returns and they use about 50,000 gallons per site. Typically operators will reuse frac water two to three times before it becomes too contaminated.

WASTE MINIMIZATION APPLICABLE TO ALL OIL AND GAS OPERATIONS

Source Reduction Opportunities Applicable to All Oil and Gas Operations

<u>Preplanning</u>

A preplanning opportunity for a drilling or production operation is in the construction of the location and roads. The location and the associated roads should be planned so that they are constructed such that stormwater runoff is diverted away from the location, and that the location's stormwater runoff, which may be contaminated, is collected. Construction of the location and roads should be planned so that erosion is minimized. These steps will help minimize the volume of contaminated stormwater runoff to be managed. Also, the location size should be only as large as absolutely necessary. Location construction costs, including the cost of the disposition of cleared trees and vegetation, can be reduced. As well, the image of such an operation, as perceived by the general public, is enhanced. Construction of the location and associated roads must meet the requirements of 25 Pa. Code Chapter 102 and NPDES permitting. See the Oil and Gas Operators Manual for more information.

Careful attention should be paid to the type of grass used to reclaim a site. A mixture of perennial grasses should be used instead of an annual grass. An annual grass will leave the site exposed after a year and the establishment of a vegetative cover will have to be repeated.

Product Substitution

Product substitution is one of the easiest and most effective source reduction opportunities. Vendors are becoming more attuned to operators' needs in this area and are focusing their efforts on providing less toxic, yet effective, substitutes. Some operators have found that vendors and suppliers will start offering less toxic substitutes in response to a company establishing inventory control procedures. A few examples of effective and beneficial product substitution for all oil and gas operations are provided below.

Pipe Dope: Pipe connections require the use of pipe dope. American Petroleum Institute (API) specified pipe dope contains about 30% lead by weight and, therefore, can be of concern when disposed of. One simple waste minimization technique is to ensure that all pipe dope is used and containers are completely empty. However, lead-free, biodegradable pipe dopes are now available and, if feasible, should be substituted for API specified pipe dope. Even if API specified pipe dope is necessary for making the required connections, pipe supply companies should be asked to provide pipe with lead-free pipe dope on the thread protectors. That way you can recycle the thread protectors with fewer regulatory concerns.

Organic Solvents: Organic solvents, such as trichloroethylene and carbon tetrachloride, are commonly used for cleaning equipment and tools. These solvents, when spent, become listed hazardous oil and gas wastes, and are subject to stringent regulation. Alternative cleaning agents, such as citrus-based cleaning compounds and steam may be substituted for organic solvents. By doing so, a hazardous waste stream may be eliminated, along with the associated waste management and regulatory compliance concerns. Another solvent commonly used is Varsol (also known as petroleum spirits or Stoddard solvent). While most Varsol has a flashpoint below 140oF, which is a characteristically ignitable hazardous waste when spent, some suppliers may provide a "high flash point Varsol" with a flash point greater than 140oF. Ask for non-toxic cleaners that reduce your regulatory compliance concerns.

Also, commercially available mechanical cleaning devices use high pressure and/or high temperature water-based solvents to clean equipment. This type of equipment in many cases recycles the cleaning fluid to get the maximum use out of the solvent being used and minimize the volume of the waste generated.

Paints and Thinners: Oil-based paints and organic solvents (i.e., thinners and cleaners) are used less frequently today, nonetheless they are still used. These paints and thinners provide an excellent product substitution opportunity. Water-based paints should be used whenever feasible. The use of water-based paints eliminates the need for organic thinners, such as toluene. Organic thinners used for cleaning painting equipment are typically listed hazardous waste when spent. This substitution can eliminate a hazardous waste stream and reduce waste management costs and regulatory compliance concerns.

Equipment Modifications

High Energy Ion Plating: High energy ion plating of metal surfaces is an effective technology application that can reduce fugitive emissions and leaks. Ion plating involves the application of metal alloys, such as gold and nickel, to a valve stem, pipe thread, or other metal surface. The metal alloy is applied to the metal surface under high energy in an argon atmosphere, and the metal alloy attaches to the atomic lattice of the metal surface. The result is a metal surface that resists galling and wear. The metal alloy actually performs as a "super lubricant." This technology has been successfully applied to valve stems, pipe threads, and polished rods. An example of the benefits provided is that valve packing may be tightened to eliminate fugitive emissions, and the treated valve stem will last several times longer than an untreated valve stem.

Lubricating Oil Purification Units: A lube oil testing program used to extend operating intervals between oil changes is an effective waste minimization technique. However, an equipment modification also can effectively reduce the volume of waste lubricating oil and filters. Commercial vendors offer a device called a lube oil purification unit. These units use 1 micron filters and fluid separation chambers and are attached to the lube oil system of an engine. The unit removes particles greater than 1 micron in size and any fuel, coolant, or acids that may have accumulated in the oil. The unit does not affect the functional additives of the lube oil. The lube oil is circulated out of the system and through the purifier. The purified lube oil is then returned to the engine's lube oil system. Many operators have found that use of lube oil purification units has significantly reduced the need for lube oil changes, waste lube oil management, and concurrently, the cost of replacement lube oil. Also, a new engine that has been fitted with a lube oil purification unit will break in better and operate more efficiently over time, in part because bearing surfaces and piston rings seat better due to the polishing action of particles less than 1 micron in size.

Chemical Metering, or Dosing Systems: The occasional bulk addition of treating chemicals, such as inhibitors, can result in poor chemical performance and inefficient use of the chemical. A chemical dosing system that meters small amounts of the chemical into a system continuously can reduce chemical usage and improve its performance in the system. In many instances, this equipment modification can result in cost savings due to reduced chemical purchases and more efficient operation of the system.

Conventional Filters: A good target for waste minimization is the conventional filter that typically comprises a large part of an operation's waste stream. An operator can replace conventional filter units with reusable stainless steel filters or centrifugal filter units (spinners). These devices generate only filtrate as waste and eliminate from the waste stream the conventional filter media and filter body. Operators have found that the reduced costs of replacing lost oil, maintenance requirements, new filter purchases, and waste filter management recover the expense of installing these alternative filtering units.

If conventional filters must be used, an operator should change filters based on differential pressure across the unit. Differential pressure is a good indicator of the effectiveness of a filter unit and can be used to determine the actual need for replacement. This is a simple change that can significantly reduce waste filter generation.

<u>Reduction in Water Use</u>

One simple technique for reducing water use is to sweep surfaces with a broom or air rather than washing down surfaces with a water hose. Another simple technique is to use a low volume/high pressure nozzle on all water hoses.

<u>Good Housekeeping and Preventative Maintenance</u>

Drip Pans and Other Types of Containment: Tanks, containers, pumps, and engines all have the tendency to leak. A good housekeeping practice that can help reduce the amount of soil and water contamination that an operator has to remediate is installing containment devices. Even though a small investment is required, containment devices save money and regulatory compliance concerns in the long run. Also, they can capture valuable released chemicals that can be recovered and used. Some examples of containment include drip pans beneath lubricating oil systems on engines; containment vessels beneath fuel and chemical storage tanks/containers; drip pans beneath the drum and container storage area; and containment, such as a half-drum or bucket beneath chemical pumps and system valves/connections. Numerous companies have implemented good housekeeping programs to reduce the amount of crude oil, chemicals, products, and wastes that reach the soil or water. These companies have found these programs to be cost effective in the long run (i.e., less lost chemical and product plus reduced cleanup costs). Also, their regulatory compliance concerns and potential future liability concerns are reduced.

Preventative Maintenance: The companion of good housekeeping is preventative maintenance. Regularly scheduled preventive maintenance on equipment, pumps, piping systems and valves, and engines will minimize the occurrence of leaks and releases of chemicals and other materials to containment systems; or if there are no containment systems, to the environment. Numerous companies have implemented preventive maintenance programs and found them to be quite successful. Personnel should be trained to implement these programs. The programs have resulted in more efficient operations, reduced regulatory compliance concerns, reduced waste management costs, and reduced soil and/or ground water cleanup costs.

Chemical and Materials Storage: Another important aspect of good housekeeping is the proper storage of chemicals and materials. Chemicals and materials should be stored such that they are not in contact with the ground (e.g., on wooden pallets). Preferably, the raised storage area will include secondary containment and be protected from weather. All drums and containers should be kept closed except when in use. Federal Occupational Safety and Health Administration (OSHA) regulations (29 CFR 1910) require that all chemical and material containers always be properly labeled so that their contents may be identified at any time. Also, OSHA regulations require that material data safety (MSDS) sheets must be kept on file for all stored chemicals and materials. The use of bulk storage, rather than 55-gallon drums or smaller containers is a preferable way to store chemicals and materials. Compliance with OSHA regulations and implementation of the cited procedures allows quick and easy identification and classification of a chemical or material in the event of a leak or rupture. In some instances, that could save hundreds of dollars in soil sampling and laboratory analysis costs.

Inventory Control

Inventory control is one of the most effective ways to reduce waste generation, regulatory compliance concerns, and operating costs, especially, when combined with proper chemical and materials storage. An inventory control system is easy to implement, especially with the use of computer programs now available. An operator who tracks his chemicals and materials can use them more efficiently and reduce the volume of unusable chemical that must be managed as waste. (Note: Commercial chemical products that are returned to a vendor or manufacturer for reclamation or recycling are not solid wastes. Therefore, it is to the operator's advantage to require vendors to take back empty and partially filled containers for reclamation or reuse.)

Selection of Contractors

Operators should choose contractors who recognize the value of waste minimization and make efforts to apply it in their service. The operator may consider inspecting the contractor's equipment to appraise the general condition of the equipment. The contractor should bring on-site well-maintained equipment that will not leak fuel or lubricating oil or that will need maintenance, which may generate wastes. Any oil and gas waste generated at the operator's site is the operator's regulatory responsibility. Therefore, an operator who uses contractors who practice waste minimization can expect reduced waste management concerns, reduced regulatory compliance concerns, and reduced operating costs. The contractor may be instrumental in implementing the waste minimization opportunities discussed above. One operator in Pennsylvania reported that the garage that changes oil in their trucks, burns the oil to heat their garage.

Training

Training is probably one of the best waste minimization opportunities. An operator's efforts to minimize waste and gain the associated benefits will only be effective if the people in the field understand waste classification and the concept of waste minimization. Also, people in the field should be empowered to implement waste minimization techniques as they are identified. Waste minimization training is becoming more common. Oil and gas associations have begun publicizing waste minimization successes, and technical societies, such as the SPE, are publishing more and more papers on effective waste minimization techniques.

Recycling Opportunities Applicable to All Oil and Gas Operations

Lubricating Oil and Filters: Currently, waste lube oil and waste lube oil filters are generally banned from landfill disposal. Recycling is now the primary method of managing these wastes. Companies that handle lube oil and filters for recycling are not difficult to locate

Sorbent Pads and Booms: When cleaning up spills of crude oil and chemicals, use recyclable sorbent pads or booms. Try to avoid using granular adsorbent materials that must be disposed of. Several vendors offer sorbent pads and booms that are designed for repeated reuse.

Spent Organic Solvents and Other Miscellaneous Spent Chemicals: Many companies accept spent chemicals for recycling. In many instances the spent chemicals (especially organic solvents) are reclaimed for reuse or blended to make fuels for energy recovery.

Paint Solvent Reuse: A simple technique for reducing the volume of organic paint solvents is its reuse in stages. An organic solvent, such as toluene, may be used for cleaning painting equipment, but eventually it will become spent and ineffective. The "spent" solvent is not a waste if it is used for another intended purpose. A solvent spent from cleaning painting equipment is still suitable for use in thinning paint. This simple technique can greatly reduce the volume of waste paint solvent that would be subject to stringent hazardous waste regulation if disposed of.

Commercial Chemical Products: An operator should implement procedures that recycle any unused chemical products. Whenever a vendor is contracted to supply chemicals, the vendor should be required to take contractual responsibility for unused chemical products and the containers in which they were delivered. As noted under the source reduction opportunity, "Inventory Control," commercial chemical products that are returned for reclamation or recycling are not solid wastes. An operator that manages chemical products properly will avoid the unnecessary generation of chemical waste. In many instances, those chemical wastes would be hazardous if disposed of and subject to stringent regulation.

Scrap Metal and Drums: Scrap metal is a relatively easy waste to recycle. Many operators have found that scrap metal recycling companies will collect and remove tanks, drums, and other types of scrap metal from the lease at no charge to the operator. An additional consideration is regulatory requirements. Scrap metal that is recycled is not subject to hazardous oil and gas waste regulation; but if disposed of, it is subject to hazardous waste regulations. For example, an old steel tank coated with lead-based paint would possibly be determined hazardous if disposed of; however, if recycled it is excluded from regulation as a hazardous oil and gas waste.

An excellent way to ensure that steel 55-gallon drums are recycled is to have in the contract with a vendor the requirement that the vendor take back any delivered drum, including drums that still contain some chemical or product. Note that empty drums and commercial chemical product that are recycled are generally excluded from regulation as hazardous oil and gas waste.

A CASE HISTORY OF A SUCCESSFUL WASTE MINIMIZATION TECHNIQUE THAT CAN BE APPLIED IN ALL OIL AND GAS OPERATIONS

Inventory Control

Problem: The staff of an area of operation (which included drilling, gas production and compression) of a major oil and gas company determined that its inventory of chemicals was excessive and that much of the generation of chemical waste was unnecessary. The company was also concerned about the generation of hazardous wastes resulting from its chemical inventory management.

Solution: The company addressed the problem by designing and implementing an inventory control system. The inventory control system is based on a complete inventory of all chemicals in the area of operation. To minimize chemical waste the company identified suitable (e.g., less toxic) substitute chemicals, eliminated the use of all halogenated and nonhalogenated organic solvents, determined instances where a specific chemical could be used for multiple purposes, and eliminated the use of 55-gallon drums, where possible. An important part of the system is the evaluation of a chemical prior to its purchase using material safety data sheets (MSDSs) and other manufacturer's information. The purchase of a new chemical is approved only after it is determined that the chemical complies with the inventory control system guidelines. Finally, all purchased chemicals are closely tracked to ensure efficient usage.

Benefits: The company eliminated about 32 unnecessary chemicals and products within six months of the program's initiation, which resulted in reduced regulatory compliance concerns (e.g., hazardous waste regulations) and savings in operating costs. Waste management concerns and costs were reduced due to the reduction in the number of 55-gallon drums on inventory. Also, the company's chemical suppliers were aware of the inventory control system and worked to supply chemicals, which would be approved by the company's system.

Solution Salt Mining

Problem: A company is planning to create caverns to store natural gas in an underground salt formation. Fresh water will be injected into the salt formation. The water will dissolve salt and remove it from formation to create the caverns. The company will need to manage the saturated salt solution.

Solution: The company plans to recover food grade salt and distilled water through an evaporation process. The amount of salt recovered could be as much as 500,000 to 750,000 tons per year.

Benefits: The salt solution will not have to be disposed. The company will generate revenue by selling the salt and distilled water. They will not have to pay for treatment or the cost of disposal wells.

Coalbed Methane Production

Problem: Prior to mining coal, operators vented natural gas from coal formations. They needed to do this for safety reasons. The gas is wasted and also contributes to greenhouse gases.

Solution: Construct wells to collect natural gas and distribute it commercially for residential and industrial use.

Benefits: This practice reduces the amount of natural gas in the coalbed. Natural gas is used as a resource and is not wasted. Greenhouse gas emissions are reduced. There is an economic benefit to the region where natural gas is produced.

APPENDIX A

REGULATORY DETERMINATION FOR OIL AND GAS AND GEOTHERMAL EXPLORATION, DEVELOPMENT, AND PRODUCTION WASTES

53 Federal Register 25446-25459 (July 6, 1988)

APPENDIX B

CLARIFICATION OF THE REGULATORY DETERMINATION FOR WASTES FROM THE EXPLORATION, DEVELOPMENT, AND PRODUCTION OF CRUDE OIL, NATURAL GAS, AND GEOTHERMAL ENERGY

58 Federal Register 15284-15287 (March 22, 1993)

NOTES

APPENDIX C

LIST OF E&P WASTES:
EXEMPT AND NONEXEMPT

NOTES

LIST OF E&P WASTES: EXEMPT AND NON EXEMPT

The lists below are not complete lists of exempt wastes and nonexempt wastes. Additional wastes may be discovered during your day-to-day E&P operations. It is important to remember that a material that is unique to E&P operations must be used in primary field operations to gain exemption as a waste. Chapter 3 of this manual, and the references cited in Chapter 3, can provide guidance in determining the waste's regulatory status. Please note, however, your state or the EPA should be contacted for guidance in the event the regulatory status of a waste is in doubt.

EXEMPT WASTES

Activated charcoal filter media

Basic sediment and water (BS&W) - see Tank bottoms

Caustics, if used as drilling fluid additives or for gas treatment

Condensate

Cooling tower blowdown

Debris, crude oil soaked

Debris, crude oil stained

Deposits removed from piping and equipment prior to transportation (i.e., pipe scale, hydrocarbon solids, hydrates, and other deposits)

Drilling cuttings/solids

Drilling fluids

Drilling fluids and cuttings from offshore operations disposed of onshore

Gas dehydration wastes:
a. Glycol-based compounds
b. Glycol filters (see process filters), filter media, and backwash
c. Molecular sieves

Gas plant sweetening wastes for sulfur removal:
a. Amines (including amine reclaimer bottoms)
b. Amine filters (see process filters), amine filter media and backwash
c. Amine sludge, precipitated
d. Iron sponge (and iron sulfide scale)
e. Hydrogen sulfide scrubber liquid and sludge

Gases removed from the production stream (i.e.,H_2S, CO_2, and VOCs)

Liquid hydrocarbons removed from the production stream but not from oil refining

Liquid and solid wastes generated by crude oil and tank bottom reclaimers

Oil, weathered

Paraffin

Pigging wastes from producer operated gathering lines

Pit sludges and contaminated bottoms from storage or disposal of exempt wastes

EXEMPT WASTES (Continued)

Process filters

Produced sand

Produced water

Produced water constituents removed before disposal (injection or other disposal)

Produced water filters (see Process filters)

Rigwash

Slop oil (waste crude oil from primary field operations and production)

Soils, crude oil-contaminated

Sulfacheck/Chemsweet waste

Tank bottoms and basic sediment and water (BS&W) from: storage facilities that hold product and exempt waste (including accumulated materials such as hydrocarbons, solids, sand, and emulsion from production separators, fluid treating vessels, and production impoundments).

VOCs from exempt wastes in reserve pits or impoundments or production equipment

Well completion, treatment, stimulation, and packing fluids

Workover wastes (i.e., blowdown, swabbing and bailing wastes

NONEXEMPT WASTES

Although the wastes listed below are not exempt from RCRA Subtitle C, they are not necessarily hazardous or necessarily subject to hazardous waste regulation. Use process knowledge or testing to determine the waste characteristics prior to management.

Batteries: lead acid

Batteries: nickel-cadmium

Boiler cleaning wastes

Boiler refractory bricks

Caustic or acid cleaners

Chemicals, surplus

Chemicals, unusable (including waste acids)

Compressor oil, filters, and blowdown waste

Debris, lube oil contaminated

Drilling fluids, unused

Drums/containers containing chemicals

Drums/containers containing lubricating oil

Drums, empty (and drum rinsate)

Filters, lubrication oil (used)

Gas plant cooling tower cleaning wastes

Hydraulic fluids, used

Incinerator ash

Laboratory wastes

Mercury

Methanol, unused

Oil, equipment lubricating (used)

Paint and paint wastes

Pesticide and herbicide wastes

Pipe dope, unused

Radioactive tracer wastes

Refinery wastes (e.g., unused frac fluids or acids)

Sandblast media

Scrap metal

Soil, chemical-contaminated (including spilled chemicals)

Soil, lube oil-contaminated

Soil, mercury-contaminated

Solvents, spent (including waste solvents)

Thread protectors, pipe dope-contaminated

Vacuum truck rinsate

Waste in transportation pipeline related pits

Well completion, treatment and stimulation
fluids, unused

QUESTIONABLE STATUS WASTES

These wastes were not specifically listed by EPA as exempt, however, they do appear to be exempt based on the Regulatory Determination[6] and Clarification[7] provided by EPA.

> Cement slurry returns from the well and cement cuttings (unused cement slurries would be nonexempt)
>
> Gas plant sweetening unit catalyst
>
> Natural gas gathering line hydrotest water
>
> Produced-water-contaminated soil
>
> Sulfur recovery unit wastes

SPECIAL CATEGORY WASTES

Special category wastes are subject to waste specific regulations.

Naturally occurring radioactive materials (NORM):

> The possession, use, transfer, transport, disposal, and/or storage of NORM or the recycling of certain NORM-contaminated materials is regulated by some states.

Polychlorinated biphenols (PCBs) and PCB-contaminated soils:

> Regulated under the federal Toxic Substances Control Act (TSCA). At the state level, oil and gas wastes contaminated by PCBs are regulated by some states.

Asbestos:

> Regulated under the National Emissions Standards for Hazardous Air Pollutants (NESHAP).

APPENDIX D

SARA TITLE III LISTED CHEMICALS

NOTES

The specific chemicals listed are representative examples in each applicable Hazardous Chemical Category

LIST OF SARA TITLE III CHEMICALS

The American Petroleum Institute (API) and Independent Petroleum Association of America (IPAA) have developed a generic report approach for oil and gas operators' use in complying with the requirements of Title III of SARA (Superfund Amendments and Reauthorization Act). This is also known as the Emergency Planning and Community Right-to-Know Act of 1986. API/IPAA developed two generic reports to assist an E&P operator in complying with the reporting requirements. The following Generic List of Hazardous Chemical Categories is provided as Exhibit A in the API/IPAA document of November, 1988, titled:

Superfund Amendments and Reauthorization Act of 1986
Emergency Planning and Community Right-to-Know Act
Sections 311 and 312

Generic Hazardous Chemical Category List and Inventory
for the Oil and Gas Exploration and Production Industry

NOTES

SARA TITLE III § 311
GENERIC LIST OF HAZARDOUS* CHEMICAL CATEGORIES
FOR THE OIL AND GAS EXPLORATION AND PRODUCTION INDUSTRY

Hazardous Chemical Category (With Examples of Representative Chemicals)	**Physical and Health Hazards**
Acids, Inorganic	Reactivity, Immediate (Acute)
Hydrochloric acid (<30%) (CAS#7647-01-0)	
Acids, Inorganic - Hydrofluoric Acid	Immediate (Acute)
Hydrofluoric acid (<12%) (CAS#7664-39-3)	
Acids, Inorganic - Sulfuric Acid	Reactivity, Immediate (Acute)
Sulfuric Acid (CAS#7664-93-9)	
Acids, Organic	Fire, Reactivity, Immediate (Acute)
Acetic acid (CAS#64-19-7)	
Acetic anhydride (CAS#108-24-7)	
Benzoic acid (CAS#65-85-0)	
Citric acid (CAS#5949-29-1)	
Formic acid (CAS#64-18-6)	
Acrylamide Monomer (CAS#79-06-1)	Immediate (Acute), Delayed (Chronic)
Alkalinity and pH Control Materials	Reactivity, Immediate (Acute)
Calcium hydroxide (CAS#1305-62-0)	
Potassium hydroxide (CAS#1310-58-3)	
Soda ash (CAS#497-19-8)	
Sodium bicarbonate (CAS#144-55-8)	
Sodium carbonate (CAS#497-19-8)	
Sodium hydroxide (CAS#1310-73-2)	
Biocides	Fire, Immediate (Acute), Delayed (Chronic)
Amines	
Glutaraldehyde (CAS#111-30-8)	
Isopropanol (CAS#67-63-0)	
Thiozolin	
Biocides - Acrolein	Fire, Sudden Release of Pressure, Reactivity, Immediate (Acute)
Acrolein (CAS#107-02-8)	
Biocides - Anhydrous Ammonia	Sudden Release of Pressure, Immediate (Acute)
Anhydrous ammonia	

- Note: The list refers to the chemicals as "hazardous;" however, for the purposes of SARA Title III, "hazardous" indicates any chemical required to have a material data safety sheet (MSDS). All chemicals listed in this appendix are not necessarily hazardous as defined by RCRA.

Hazardous Chemical Category (With Examples of Representative Chemicals)	**Physical and Health Hazards**
Biocides - Formaldehyde	Fire, Immediate (Acute), Delayed (Chronic)
Formaldehyde	
Breakers, Emulsion/Gel	Fire, Immediate (Acute)
Ammonium persulfate (CAS#7727-54-0)	
Benzoic acid (CAS#65-85-0)	
Enzyme	
Sodium acetate (CAS#127-09-3)	
Sodium persulfate (CAS#7772-27-1)	
Buffers, pH	Immediate (Acute)
Sodium acetate (CAS#127-09-3)	
Sodium bicarbonate (CAS#144-55-8)	
Sodium carbonate (CAS#497-19-8)	
Sodium diacete	
Calcium Compounds	Immediate (Acute)
Calcium bromite (CAS#71626-99-8)	
Calcium hypochlorite (CAS#17778-54-3)	
Calcium oxide (CAS#1305-78-8)	
Gypsum (CAS#10101-41-4)	
Lime (CAS#1305-78-8)	
Cement (CAS#65997-15-1)	Immediate (Acute)
Cement Additives - Accelerators	Immediate (Acute)
Calcium chloride (CAS#10035-04-8)	
Gypsum (CAS#10101-41-4)	
Potassium chloride (CAS#7337-40-7)	
Sodium chloride (CAS#7647-14-5)	
Sodium metasiliate	

Hazardous Chemical Category (With Examples of Representative Chemicals)	**Physical and Health Hazards**
Cement Additives - Fluid Loss	Immediate (Acute)
Cellulose polymer	
Latex	
Cement Additives - Miscellaneous	Immediate (Acute)
Cellulose flakes (CAS#9004-34-6)	
Coated aluminum	
Gilsonite (CAS#12002-43-6)	
Lime (CAS#1305-78-8)	
Long chain alcohols	
Cement Additives - Retarders	Immediate (Acute)
Cellulose polymer	
Lignosulfonates	
Cement Additives - Weight Modification	Immediate (Acute)
Barite (CAS#7727-43-7)	
Bentonite	
Diatomaceous earth (CAS#68855-54-9)	
Fly ash	
Glass beads	
Hematite (CAS#1317-60-8)	
Ilmenite	
Pozzolans	
Chlorine Gas	Sudden Release of Pressure, Reactivity, Immediate (Acute), Delayed (Chronic)
Corrosion Inhibitors	Fire, Immediate (Acute), Delayed (Chronic)
2-Butoxyethanol	
4-4' Methylene dianiline (CAS#101-77-9)	
Acetylenic alcohols	
Amine formulations	
Ammonium bisulfite (CAS#10192-30-0)	
Gelatin	
Ironite sponge (CAS#1309-37-1)	
Sodium chromate (CAS#7775-11-3)	
Sodium dichromate (CAS#10588-01-9)	

Sodium polyacrylate
Zinc carbonate (CAS#3486-35-9)
Zinc lignosulfonate
Zinc oxide (CAS#1314-13-2)

Crosslinkers (Polymer Linking) Fire, Immediate (Acute), Delayed (Chronic)
Boron compounds
Organo-metallic complexes

Defoaming Agents Immediate (Acute)
Aluminum stearate
Fatty acid salt formation
Mixed alcohols
Silicones
Tributylphosphate (CAS#126-73-8)

Deflocculants Immediate (Acute)
Acrylic polymer
Calcium lignosulfonate
Chrome-free lignosulfonate
Chromium lignosulfonate
Iron lignosulfonate
Quebracho
Sodium acid pyrophosphate (SAPP)
Sodium hexametaphosphate (CAS#10124-56-8)
Sodium phosphate (oilfos)
Sodium tetraphosphate
Sodium tripolyphosphate (STP)
Styrene, maleic anhydride co-polymer salt
Sulfo-methylated tannin

Detergents/Foamers Fire, Immediate (Acute)
Amphoteric surfactant formulation
Detergents
Ethoxylated phenol

Hazardous Chemical Category (With Examples of Representative Chemicals)	**Physical and Health Hazards**
Explosives	Sudden Release of Pressure
Charged well jet perforating gun, Class C explosives	
Detonators, Class A explosives	
Explosive power device, Class B	
Filtration Control Agents/Flocculants	Immediate (Acute)
Acrylamide AMPS copolymer	
Aniline formaldehyde copolymer hydrochlorite	
Anionic polyacrylamide	
Causticized leonardite	
Leonardite	
Partially hydrolyzed polyacrylamide	
Polyaklanolamine ester	
Polyamine acrylate	
Polyanionic cellulose	
Potassium lignite	
Preserved starch	
Sodium carboxymethyl cellulose (CAS#9004-32-4)	
Starch (CAS#9905-25-8)	
Sulfomethylated phenol formaldehyde	
Vinylsulfonate copolymer	
Fluoride Generating Compounds	Immediate (Acute)
Ammonium bifluoride (CAS#1341-49-7)	
Ammonium fluoride (CAS#12125-01-8)	
Friction Reducers	Immediate (Acute)
Acrylamide methacrylate copolymers	
Sulfonates	
Fuels	Fire, Sudden Release of Pressure, Immediate (Acute), Delayed (Chronic)
Acetylene gas (CAS#74-86-2)	
Diesel (CAS#68476-34-6)	
Fuel oil	
Gasoline (CAS#8006-61-9)	
Kerosene (CAS#8008-20-6)	
Propane (CAS#74-98-6)	
Gelling Agents	Immediate (Acute)
Cellulose and guar derivatives	

Hazardous Chemical Category (With Examples of Representative Chemicals)	Physical and Health Hazards
Gel Stabilizers	Immediate (Acute)
Sulfites	
Thiosulfates	
Heat Transfer Fluids	Immediate (Acute), Delayed (Chronic)
Ethylene glycol (CAS#107-21-1)	
Freon	
Herbicides	Immediate (Acute)
Hydraulic Fluids	Fire, Immediate (Acute)
Hydrogen Sulfide (CAS#7783-0604)	Fire, Immediate (Acute)
Inert Gases	Sudden Release of Pressure, Immediate (Acute)
Carbonate dioxide (CAS#124-38-9)	
Nitrogen (CAS#7727-37-9)	
Lost Circulation Materials	Immediate (Acute)
Cane Fibers	
Cedar fibers	
Cellophane fibers	
Corn cob	
Cottonseed hulls	
Mica (CAS#12001-26-2)	
Nut Shells	
Paper	
Rock wool	
Sawdust	
Lubricants, Drilling Mud Additives	Immediate (Acute)
Graphite (CAS#7782-42-5)	
Mineral oil formulations	
Organo-fatty acid salt	
Vegetable oil formulations	
Walnut shells	
Lubricants, Engine	Immediate (Acute)

Grease
Motor oil

Hazardous Chemical Category (With Examples of Representative Chemicals)	Physical and Health Hazards
Miscellaneous Drilling Additives	Immediate (Acute), Delayed (Chronic)
Diatomaceous earth (CAS#68855-54-9)	
Oxalic acid (CAS#144-62-7)	
Potassium acetate (CAS#127-08-2)	
Zinc bromide (CAS#7699-45-8)	
Odorants	Fire, Immediate (Acute)
Mercaptans, aliphatic	
Oil-Based Mud Additives	Fire, Immediate (Acute), Delayed (Chronic)
Amid polymer formulations	
Amine treated lignite	
Asphalt	
Diesel (CAS#68476-34-6)	
Gilsonite (CAS#12002-43-6)	
Mineral Oil	
Organophilic clay	
Organophilic hectorite	
Petroleum distillate (CAS#8030-30-6)	
Polyethylene powder	
Polymerized organic acids	
Sulfonate surfactant	
Paint and Paint Thinner	Fire, Delayed (Chronic)
Pipe Joint Compound	Delayed (Chronic)
Preservatives	Immediate (Acute), Delayed (Chronic)
Dithiocarbamates	
Isothiazions	
Paraformaldehyde (CAS#30525-89-4)	
Produced Hydrocarbons	Fire, Sudden Release of Pressure, Immediate (Acute), Delayed (Chronic)
Condensate	

Crude oil (CAS#8002-05-9)
Natural gas

Proppants	Immediate (Acute)
Bauxite (CAS#1318-16-7)	
Resin coated sand	
Zirconium proppant	

Hazardous Chemical Category (With Examples of Representative Chemicals)	**Physical and Health Hazards**
Resin and Resin Solutions	Fire, Immediate (Acute)
Melamine resins	
Phenolic resins	
Polyglycol resins	
Salt Solutions	Immediate (Acute)
Aluminum chloride (CAS#7446-70-0)	
Ammonium chloride (CAS#12125-02-9)	
Calcium bromide (CAS#71626-99-8)	
Calcium chloride (CAS#10035-04-8)	
Calcium sulfate (CAS#778-18-9)	
Ferrous sulfate (CAS#7782-63-0)	
Potassium chloride (CAS#7447-40-7)	
Sodium chloride (CAS#7647-14-5)	
Sodium sulfate (CAS#7757-82-6)	
Zinc bromide (CAS#7699-45-8)	
Zinc chloride (CAS#7646-85-7)	
Zinc sulfate	
Scale Inhibitors	Fire, Immediate (Acute), Delayed (Chronic)
Ethylenediaminetetraacetic acid (EDTA) (CAS#60-00-4)	
Inorganic phosphates	
Nitrilotriacetic acid (NTA) (CAS#139-13-9)	
Organic phosphates	
Phosphonates	
Polyacrylate	
Polyphosphates	
Shale Control Additives	Immediate (Acute)
Hydrolyzed polyacrylamide polymer	
Organo-aluminum complex	
Polyacrylate polymer	

Sulfonated asphaltic residuum

Silica Immediate (Acute), Delayed (Chronic)

Solvents Fire, Immediate (Acute), Delayed (Chronic)

1,1,1 - Trichloroethane (CAS#71-55-6)
Acetone (CAS#67-64-1)
Aliphatic hydrocarbons
t-Butyl alcohol (CAS#75-65-0)
Carbon tetrachloride (CAS#56-23-5)
Chloroform (CAS#67-6-3)
Diacetone alcohol (CAS#123-42-2)

Ethylene glycol monobutyl ether (CAS#111-76-2)
Kerosene (CAS#8008-20-6)
Isopropanol (CAS#67-63-0)
Methyl ethyl ketone (MEK)(CAS#78-93-3)
Methyl isobutyl ketone (MIBK) (CAS#108-10-1)
Methylene chloride (CAS#75-09-2)
Methanol (CAS#67-56-1)
Naphtha (CAS#8032-32-4)
Toluene (CAS#108-88-3)
Turpentine (CAS#8006-64-2)
Xylene (CAS#1330-20-7)

Spotting Fluids Fire, Immediate (Acute), Delayed (Chronic)

Non-oil base spotting fluid
Oil base spotting fluid (diesel oil base)
Oil base spotting fluid (mineral oil base)
Sulfonated vegetable ester

Sulphur Dioxide (CAS#7446-09-5) Sudden Release of Pressure, Immediate (Acute), Delayed (Chronic)

Surfactants - Corrosive Immediate (Acute), Delayed (Chronic)

Alcohol ether sulfates
Amines
Quaternary polyamine
Sulfonic acid

Surfactants - Ethylene Diamine	Fire, Immediate (Acute)
Ethylene diamine (CAS#107-15-3)	
Surfactants - Flammable	Fire, Immediate (Acute), Delayed (Chronic)
Amines	
Ammonium salts	
Fatty alcohols	
Isopropanol (CAS#67-63-0)	
Methanol (CAS#67-56-1)	
Oxyalkylated phenols	
Petroleum naphtha (CAS#8030-30-6)	
Sulfonates	

Hazardous Chemical Category (With Examples of Representative Chemicals)	**Physical and Health Hazards**
Surfactants - Miscellaneous	Immediate (Acute)
Amine salts	
Glycols	
Temporary Blocking Agents	Immediate (Acute)
Benzoic acid (CAS#65-85-0)	
Naphthalene (CAS#91-20-3)	
Petroleum wax polymers	
Sodium chloride (CAS#7647-14-5)	
Tracers	Fire
Ammonium nitrate	
Potassium nitrate	
Viscosifiers	Immediate (Acute)
Attapulgite	
Bentonite	
Guar gum (CAS#9000-30-0)	
Sepiolite	
Xanthan gum	
Weight Materials	Immediate (Acute)
Barite (CAS#7727-43-7)	
Calcium carbonate (CAS#1317-65-3)	
Galena	
Hematite (CAS#1317-60-8)	

Iron carbonate
Siderite

Welding Materials	Immediate (Acute)
Solder	
Welding Rods	

LIST OF REFERENCES

1. API Environmental Guidance Document; Onshore Solid Waste Management in Exploration and Production Operations, 1st Edition, American Petroleum Institute, Washington, DC (1989).

2. Developing Area-Specific Waste Management Plans for E&P Operations, 1st Edition, American Petroleum Institute, Washington, DC (1991).

3. Stilwell, C. T., "Area Waste-Management Plans for Drilling and Production Operations," Journal of Petroleum Technology 67-71 (Jan. 1991).

4. "Guidance to Hazardous Waste Generators on the Elements of a Waste Minimization Program," 58 Federal Register 31114-31120 (May 28, 1993).

5. "Environmental Management Systems: An Implementation Guide for Small and Medium Sized Organizations," NSF(2001).

6. Solid Waste Disposal Act of 1980, Section 3001(b)(2)(A); an amendment of RCRA of 1976.

7. "Regulatory Determination for Oil and Gas and Geothermal Exploration and Production Wastes," 53 Federal Register 25446-25459 (July 6, 1988).

8. "Clarification of the Regulatory Determination for Wastes from the Exploration, Development and Production of Crude Oil, Natural Gas and Geothermal Energy," 58 Federal Register 15284-15287 (Mar. 22, 1993).

9. "Generic Hazardous Chemical Category List and Inventory for the Oil and Gas Exploration and Production Industry," American Petroleum Institute and the Independent Petroleum Association of America (November 1988).

10. Principles of Drilling Fluid Control, 12th Edition, Petroleum Extension Service, University of Texas at Austin (1969).

11. *Drilling Fluids Reference Manual*, Milchem.

12. Field Handling of Natural Gas, 3rd Edition, Petroleum Extension Service, University of Texas at Austin (1972).

13. Plant Processing of Natural Gas, Petroleum Extension Service, University of Texas at Austin (1974).