CHAPTER 5

WASTE MINIMIZATION AND MANAGEMENT IN OIL AND GAS OPERATIONS

As discussed in Chapter 1, the goal of the Waste Minimization Plan is the elimination, reduction in volume and/or toxicity, or the recycling of generated wastes wherever possible. Numerous products, processes, and types of equipment have been shown to be effective in waste minimization.

This chapter presents waste minimization and management in oil and gas operations following the Waste Management Hierarchy presented in Chapter 1. The chapter begins with a general overview of source reduction and recycling and then provides a discussion of numerous opportunities for waste minimization in the various areas of oil and gas operations. The information provided in the chapter should help you in your waste minimization efforts.

SOURCE REDUCTION: AN OUNCE OF PREVENTION...

As noted in Chapter 1, source reduction (sometimes called pollution prevention) involves the use of processes, practices, or products to reduce or eliminate the generation of pollutants and wastes. In other words, source reduction is anything that acts to reduce the volume and or toxicity of waste that is generated. It includes, but is not limited to, changes in products (substitution and composition) and source control (process changes, equipment modification, increased automation, and material handling changes). Source reduction minimizes pollutants released to the environment and potential hazards to human health.

Opportunities for waste volume reduction in certain oil and gas operations may be limited. For example, volumes for some wastes such as produced waters, are primarily a function of activity level and age or state of depletion of a producing property. Nevertheless, every effort should be made to take advantage of those opportunities that do exist for source reduction.

Some source reduction opportunities are very simple. Others are extremely complex and may require a large capital outlay. Simple source reduction activities include product substitution, inventory control, reduction of water use, good housekeeping, equipment maintenance or replacement, in-process recycling, and careful selection of third party contractors. The section, "Waste Minimization Opportunities in Oil and Gas Operations" (below) provides a discussion of these various source reduction opportunities for each area of oil and gas operations. Also, a table of source reduction options for specific waste streams is provided as Appendix F.

RECYCLING: ONCE IS NEVER ENOUGH

There are many opportunities for recycling oil and gas waste. Industry has practiced recycling of some oil and gas wastes for years, such as the use of produced water in enhanced recovery projects and reclamation of oil-based drilling fluid. However, as recycling becomes more popular, recycling opportunities for other oil field wastes, such as solvents, metals, filters, and coolants, are also increasing. The table provided in Appendix F includes recycling options for specific waste streams. Also, Appendix G provides the 59 Federal Register 10550 (March 4, 1994), which addresses regulatory requirements for recycling of used lubricating oils (Note that the TNRCC has equivalent regulatory standards for handlers of used oil). Information on recycling resources is included on page 5-30.

WASTE MINIMIZATION OPPORTUNITIES IN OIL AND GAS OPERATIONS

The following sections provide discussions of source reduction and recycling opportunities for the various oil and gas operations. This section addresses source reduction and recycling in: drilling operations, production operations, natural gas treating and processing operations, and pipeline operations. In addition, waste minimization opportunities applicable to all oil and gas operations are discussed.

The Waste Minimization Program maintains, and continually updates, a list of technical papers and articles which address waste minimization opportunities. See Appendix H for program contact information.

DRILLING OPERATIONS

Source Reduction Opportunities in Drilling Operations

<u>Preplanning</u>

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 the other 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.

Drill Site Construction and Rigging-Up: A preplanning opportunity for a drilling operation is in the construction of the location and roads. The drilling 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.

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 discussed under the remaining opportunities. These waste minimization techniques should be integrated into the drilling fluid system portion of the drilling plan.

Pit Design: Another consideration in preplanning for a drilling operation is the design of the reserve pit (also see "closed-loop" drilling fluid systems under procedural changes). A major oil company has designed a V-shaped pit that provides advantages with respect to waste generation and operational costs. The open end of the "V" faces the drilling rig and the cross-sectional view looks like a squared-off funnel (about 10 feet deep with the upper 5 feet having slanted walls to a width of about 20 feet). This V-shape design prevents mud from channeling from the discharge point to the suction point, as it must travel the full length of the pit. Also, because the V-shaped pit is long and narrow (each leg is about 110 feet long), it is easier to construct and line, if necessary. In an actual comparison to a conventional reserve pit (for drilling similar wells using the same drilling rig), the company determined that pit construction time was reduced by about 40%, water costs for the well were reduced by about 38%, and the liner costs were reduced by about 43%. The total cost savings were about $10,800. Also, the use of water was minimized (which is applicable under the waste minimization opportunity "Reduction In Water Use"). The V-shaped pit also leaves a smaller "footprint."

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, such as the one featured in the case history on page 6-11, 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 drilling operations are provided below.

Drilling Fluids: Many companies have found that the substitution of low toxicity glycols, synthetic hydrocarbons, polymers, and esters for conventional oil-based drilling fluids is an effective drilling practice. The use of substitute drilling fluids eliminates the generation of oil-contaminated cuttings and other contamination by the oil-based fluid (e.g., reserve pit and accidental releases). Drill site closure concerns are also reduced. Drilling engineers have published numerous technical papers that describe the successful application of substitute drilling fluids. In many instances, this substitution has resulted in significant cost savings. Also, substitute spotting fluids are available for freeing differentially stuck drill pipe.

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.

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.

See also “Organic Solvents and Paints and Thinners” on page 5-24.

Equipment Modifications

Lubricating Oil Purification Units: The drilling rig’s diesel power plants typically generate large volumes of waste lubricating oil and lubricating oil filters. A lube oil testing program combined with extended operating intervals between changes is effective, as shown by the case history on page 6-2. 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. See “Lubricating Oil Purification Units” on page 5-25 for a description.

Process or Procedural Modifications

“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 and used, 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.

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.

Material Balance and Mud System Monitoring: Companies have found that diligent and comprehensive monitoring of drilling fluid properties is effective in reducing the frequency of water and additive additions to the system. Such a system is also referred to as “integrated drilling fluids management.” Monitoring devices at various points in the system allow the operator to immediately identify unwanted changes in the drilling fluid system and make the necessary corrections. This technique, in addition to the solids control described above can significantly reduce the costs of the drilling fluid system and the volume of drilling waste remaining at the end of the operation.

Closed-Loop Drilling Fluid Systems: Closed-loop drilling fluid systems provide many advantages over conventional earthen reserve pits. 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, such as the one featured in the case history on page 6-2, 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.

Mud Runoff From Pulled Drill String: Running drill pipe into and out of the hole can contribute to the volume of waste in the reserve pit. Lost drilling mud 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 mud does not run onto the rig floor (about 0.4 bbls of mud can be lost per 1,000 feet of pipe pulled). Thus, drilling mud losses and the need for rigwash are reduced.

Cementing "On-the-Fly": When conducting cementing operations, a significant volume of unused premixed cement may remain after obtaining returns. 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.

Reduction In Water Use

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 the water needs for the drilling operation. If feasible, collection and treatment of rigwash for reuse is a good waste minimization technique.

Drilling Fluid Systems: Improved design and operation of drilling fluid systems can also reduce the need for water. Waste minimization opportunities, such as solids control and detailed system monitoring, have been proven effective in reducing the amount of makeup water needed in a drilling operation (see “Process or Procedural Modifications” above).

Dewatering Waste Drilling Fluids: An operator can reclaim water from waste drilling fluids by using mechanical or chemical separation techniques. Large bowl centrifuges, hydrocyclones, and/or chemical flocculants may be used to dewater waste drilling fluids. The reclaimed water may then be reused, thus reducing the demand on, and cost of, new water sources. Proper application of dewatering can result in a reduction of the volume of drilling waste to be managed, thus saving waste management costs, easing site closure concerns and costs, and reducing future potential liability concerns.

Good Housekeeping and Preventative Maintenance

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.

See also “Drip Pans and Other Types of Containment,” “Preventive Maintenance,” and “Chemical and Materials Storage” on pages 5-26 and 5-27.

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. The case history on page 6-11 illustrates the impact an inventory control system can have on an operation. 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.)

<u>Selection of Contractors</u>

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 drilling rigs being considered for contract to appraise the general condition of the rigs. The contractor should be instructed to minimize maintenance operations on the drilling location (e.g., sand blasting and painting). Any oil and gas waste generated at the operator's drill 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 drilling contractor may be instrumental in implementing the waste minimization opportunities discussed above.

Recycling Opportunities in Drilling Operations

Drilling Fluids: Drilling fluids comprise the largest waste stream associated with a drilling operation. The cost of closing a drilling site is increased if waste drilling fluid in a reserve pit must be dewatered and/or stabilized prior to closure. A better alternative is to recycle or reuse the waste drilling fluid. If feasible, reuse the waste drilling fluid in another drilling project. One company designed a multi-well drilling project where the same drilling fluid was used for drilling each successive well. The result was significant cost savings and greatly reduced waste management concerns. If reuse within your company is not feasible, there are several companies in Texas who take waste drilling fluids for reconditioning and reuse. Another cost effective alternative for reuse of waste drilling fluid is in plugging or spudding of other wells.

Reserve Pit Water: A drilling operation should consider reclaiming water from the reserve 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.

See also “Paint Solvent Reuse” and “Commercial Chemical Products” on page 5-28 and 5-29.

PRODUCTION AND WORKOVER OPERATIONS

Source Reduction Opportunities in Production and Workover Operations

Preplanning

Production Site Design and Construction: One of the first opportunities for waste minimization is in the design and construction of the production site and lease roads. The site and the associated roads should be planned so that they are constructed such that stormwater runoff is diverted away from the site and that any 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.

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 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 and is discussed under "Selection of Contractors" on page 5-27.

Product Substitution

Organic Solvents: Solvents such as xylene and toluene, which may become hazardous wastes, have been commonly 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 xylene and toluene. Check with your service company or chemical vendor for these substitute solvents before purchasing aromatic solvents such as xylene and toluene. See also additional discussion of "Organic Solvents" and "Paints and Thinners" on page 5-24.

Pipe Dope: When running tubing, 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.

Equipment Modifications

Lubricating Oil Purification Units: In certain situations, production and workover operations use engines that typically generate large volumes of waste lubricating oil and lubricating oil filters. An equipment modification that can effectively reduce the volume of waste lubricating oil and filters is discussed under "Lubricating Oil Purification Units" on page 5-25.

Basic Sediment and Water, 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.

One operator in west Texas used an extra stock tank to collect tank bottoms from the regular crude oil stock tanks. The tank was painted black so that in the hot summer months the temperature would rise high enough to dissolve the paraffin and asphaltene, which would separate from the water. The heavy oil would then be transferred in appropriate amounts to the crude oil stock tank for sale. This simple solution reduced the ultimate volume of BS&W the operator had to manage as waste and added revenue from crude oil sales.

Vapor Recovery from Stock Tanks: The regulation of emissions of toxic air pollutants has become stricter since passage of the Clean Air Act Amendments in 1992. Many crude oil tank batteries may qualify as major sources, thus triggering Title V permitting, control, and monitoring requirements. A good way to avoid this situation is to install a vapor recovery system. Vapor recovery systems that use vacuum pumps are commercially available. One system has been designed and marketed that is simple and low-cost. That system uses only a pump and a venturi. The system pumps produced water from the tank through the venturi, which in turn draws a slight vacuum on the tanks. The vapors are entrained in the produced water which is sent to the separator. There the vapors are separated and returned to the production stream.

See also “High Energy Ion Plating,” “Chemical Metering, or Dosing, Systems,” and “Conventional Filters” on pages 5-24 and 5-25.

<u>Process or Procedural Modifications</u>

Cementing “On-the-Fly:” When conducting cementing operations, a significant volume of unused premixed cement may remain after completing the job. 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 salt water-contaminated soils, and dissatisfied crude oil purchasers. At the bottom line, the operator realizes reduced operating efficiency, reduced revenue, and increased regulatory compliance concerns.

Several techniques exist for reducing paraffin deposition and the related problems. One technique uses a device known as a magnetic fluid conditioner, or MFC. MFC's have been used in the oil field for some time, and not always successfully. However, in recent years, MFC technology has improved, and operators are finding success in their application (see the case history on page 6-3 for an example). An MFC may be installed in a producing oil well (e.g., on the downhole rod pump) for which it is specifically designed. Parameters such as pump dimensions, crude oil and water characteristics, and production parameters are accounted for in the design of the MFC. The MFC works by altering the properties of the crude oil and water as it passes through the intense magnetic field of the MFC's permanent rare earth magnet. As a result, the crude oil's pour point, yield point, and viscosity are reduced; and the temperature at which paraffin will deposit is lowered. Also, the MFC may also help inhibit scale formation.

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 210°F." Reports in that technical paper and in other technical papers indicate microbial control of paraffin deposition is effective.

See also the case history, "Drilling Rig Lubricating Oil," on page 6-2 for a lube oil testing program combined with extended operating intervals between changes.

<u>Control and Reduction of NORM Deposition</u>

Naturally occurring radioactive materials (NORM) that are produced with formation waters may cause troublesome waste management and regulatory compliance concerns. When NORM contaminates production equipment and sites, it poses a special waste management problem and falls under Rule 94 regulation. While much of the NORM contamination in the oil field is historical, future NORM contamination may be reduced using any of several techniques which apply the source reduction opportunity categories discussed above.

Deposition of NORM is primarily controlled by pressure and temperature changes and commingling of incompatible formation waters. Radon gas co-produced with natural gas is also a source of NORM. While the presence of NORM in reservoir water and gas cannot be eliminated, the volume of NORM-contaminated waste that is generated can be reduced through control of its deposition. Source reduction methods for NORM include: well completions or formation treatments designed to reduce water-cut and sand production; scale inhibitor squeezes that help control deposition of NORM-contaminated scale in the well and in surface equipment; chemical coating or high-energy ion plating of material surfaces at critical points in the production system to reduce the availability of nucleation points for scale formation; piping and equipment design that minimizes turbulent flow and pressure drops, thereby reducing the precipitation of scale; and segregation of incompatible formation waters that result in NORM-contaminated scale deposition (e.g., mixing of waters containing barium and sulfates will cause precipitation of barium sulfate scale).

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: As noted in the discussion “Selection of Contractors,” 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 (the Waste Minimization Program offers an example). 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. At least one firm offers a one-piece fiberglass model for about $800.

See also “Drip Pans and Other Types of Containment,” “Chemical and Materials Storage,” and “Preventive Maintenance” on pages 5-26 and 5-27.

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. The case history on page 6-11 illustrates the beneficial impact an inventory control system can have on an operation. 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. Contracted workover rigs are a good example of the need for waste minimization efforts by contractors. A producer can find himself dealing with unnecessary oil and gas waste if the service company's workover rig crew does not take steps to control sources of waste such as tubing runoff, spilled chemicals, and other associated waste (e.g., thread protectors, rubber seals and cups, and pipe dope containers). An operator should select workover rig contractors who use containment devices beneath the rig floor, exercise control over chemicals and products brought on-site, and collect all associated wastes for proper management. Also, the contractor will bring on-site well maintained equipment that will not leak fuel or lubricating oil and that will not need maintenance which may generate wastes.

Recycling Opportunities in Production and Workover Operations

Produced Water: Most produced water in Texas is injected in Class II wells. The largest proportion of produced water is injected in Class II wells that are permitted for disposal. Look for opportunities to redirect 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. (Also, see "Reduction in Water Use.")

Tank Bottoms: Tank bottoms, or BS&W, are best managed by sending them to a crude oil reclamation plant. An operator should contact nearby RRC-permitted crude oil reclamation plants to determine if an economically feasible arrangement is possible before considering disposal options. The Waste Minimization Program can help operators locate reclamation plants in their area. Some of these plants also specialize in reclamation of waste paraffin.

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 located in every area of Texas, so finding one is not difficult. The Waste Minimization Program will provide upon request a listing of these companies.

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 used oil) provide for this option. (Note that certain states' regulations may be stricter than federal regulations.) 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. Also, the Oklahoma Corporation Commission publication, "Oilfield Pollution Prevention," reports that one major service company has arranged to provide leftover cements to local governments for use in their construction projects.

See also "Sorbent Pads and Booms," "Spent Organic Solvents and Other Miscellaneous Spent Chemicals," "Paint Solvent Reuse," "Commercial Chemical Products," and "Scrap Metal and Drums" on pages 5-28 and 5-29.

NATURAL GAS TREATING AND PROCESSING OPERATIONS

Source Reduction Opportunities in Gas Treating and Processing Operations

Preplanning

The best place to start waste minimization efforts for natural gas treating and processing operations is in the planning stages. This is true whether you are preparing to build a new facility or preparing to work on smaller projects within an existing facility. An important component of the initial concept of the plan should be a discussion of the anticipated waste generation and waste management. As the project plan is developed it should be continually evaluated for potential waste generation and adjusted to take advantage of source reduction and recycling opportunities. This type of planning can significantly impact waste management requirements for the facility.

Site Construction: A preplanning opportunity for a new facility is the preparation of the site and the construction of associated roads. The site and roads should be planned so that they are constructed such that stormwater runoff is diverted away from the site and erosion is minimized. Stormwater runoff from the site itself, which may be contaminated, should be collected in an appropriate location on the site. These steps will help minimize the volume of contaminated stormwater runoff to be managed. Also, the site size should be only as large as absolutely necessary. Site 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.

Installation of New Equipment: When planning for the installation of new equipment (e.g., to replace old equipment, expand a facility, or modify a process), consider the potential for waste generation in your selection of the equipment. For example, design glycol dehydrators with vapor recovery to control VOC emissions. If possible the equipment should be installed with a containment structure appropriately located to contain any spills, leaks, or drips. Also, if waste generation cannot be reduced, try to select a process that generates waste amenable to recycling.

Product Substitution

Amine Process Sludges: Amine sludges can contain a high sodium content. To eliminate sodium in amine process waste substitute potassium hydroxide for sodium hydroxide to maintain high pH in the process. Amine sludges have also been shown to have elevated levels of nickel and copper, probably as a result of corrosion while gas is being processed. The addition of potassium hydroxide to maintain pH during the process also helps minimize corrosion and the presence of these metals in the sludge.

See also “Organic Solvents,” “Mechanical Cleaning,” and “Paints and Thinners” on page 5-24.

Equipment Modifications

Flash Tank Separators on Dehydrators: Dehydrators remove water from gas by bringing the gas into contact with a desiccant (e.g. glycol) which absorbs water in the gas. The glycol water mixture is then sent to a regeneration unit where it is heated to drive off the absorbed water. The glycol also contains quantities of volatile organic compounds (VOCs) which are driven off with the water and vented to the air. A flash tank separator (FTS) can be installed on the dehydrator to reduce the amount of VOCs released to the air. The FTS removes gas absorbed in the desiccant by a rapid pressure reduction which causes the gas to "flash out" of the desiccant. The gas may then be recovered and used to fuel the regenerating unit.

High-Bleed Pneumatic Control Devices: Many devices used throughout gas processing facilities use pneumatic devices such as valves and instruments to control and monitor the flow of gas. These devices need a pneumatic supply to drive their operating mechanisms. The most convenient supply is usually the natural gas in the line the device is monitoring or controlling. The typical pneumatic device uses a large volume of gas as a driving mechanism and then vents the gas to the atmosphere (thus the term "high-bleed"). There are two options to reduce the amount of gas which is vented. First, the supply could be changed to compressed air. This is not always a practical solution since supplying compressed air may not be feasible. The second option is to replace "high-bleed" devices with "low-bleed" devices to minimize the amount of vented gas. Generally, low-bleed devices operate slower than high-bleed devices; therefore, a replacement is not feasible in all cases.

See also "Lubricating Oil Purification Units," "Conventional Filters," "High Energy Ion Plating," and "Chemical Metering, or Dosing, Systems" on pages 5-24 and 5-25.

<u>Process or Procedural Modifications</u>

Lubricating Oil Reduction: The Alaska Health Project (partially funded by the U.S. EPA) conducted a program to study the feasibility of determining oil change intervals for diesel engines by using a portable field monitor. Incidents of normal and abnormal oil degradation were recorded and correlated between field and laboratory tests. The result of the study indicated that oil change intervals can be extended with analysis and monitoring. The study concluded that one facility in the study could save over 2,000 gallons of lubricating oil per year, based on a 5,000 hour/year operational period. The case history on page 6-2 supports this procedural change.

VOC Emissions: Operators can reduce the VOC emissions from a glycol dehydration unit by optimizing the operation of the unit. In many cases, glycol dehydration units are over-sized, and the glycol circulation rate is too high. Many of these units can be optimized by reducing the glycol flow rate, though in some cases a glycol pump may need to be replaced with a smaller pump. A study conducted in Louisiana found that a dehydration unit with a glycol flow rate of 0.90 gal/min was too high for the gas flow through the unit. The glycol flow rate was reduced to 0.23 gal/min and the VOC emissions in the unit decreased proportionally to the reduction in the glycol rate.

<u>Reduction In Water Use</u>

Cooling tower blowdown generates large volumes of wastewater. In many instances, an operator can make modifications to the operation of the cooling water system that will reduce blowdown frequency, thus reducing the need for make-up water. As seen in the case history on page 6-6, one operator reduced the volume of cooling tower blowdown by using a substitute scale inhibitor and installing a chemical metering system.

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

See “Drip Pans and Other Types of Containment,” “Preventive Maintenance,” and “Chemical and Materials Storage” under “Good Housekeeping and Preventative Maintenance” on pages 5-26 and 5-27.

<u>Inventory Control</u>

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. The case history on page 6-11 illustrates the impact an inventory control system can have on an operation. 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.)

<u>Selection of Contractors</u>

Operators should choose contractors who recognize the value of waste minimization and make efforts to apply it in their service. Any oil and gas waste generated at the operator’s facility 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.

Recycling Opportunities in Natural Gas Treatment and Processing Operations

Reuse of Spent Natural Gas Liquid Sweetening Solutions: Many gas plant facilities use sour gas fuel in their operations. These facilities use exhaust gas scrubbers to control sulfur dioxide (SO_2) emissions from units burning sour gas. SO_2 scrubbing units can use partially spent caustic solutions from natural gas sweetening processes as a reagent. A major oil company conducted a study in which partially spent caustic natural gas liquid sweetening solution was used in place of soda ash solution as a reagent in a SO_2 scrubber. To achieve acceptable performance using partially spent caustic solutions, they found that necessary changes to the scrubber operation were reagent feed rate, scrubber liquid pH and specific gravity, and blowdown rate. A cost savings was realized due to reduced off-site disposal and purchases of reagent. It was demonstrated that the SO_2 scrubber could be operated without negative effects on performance, compliance, or operating costs.

See also "Recycling Opportunities Applicable to All Oil and Gas Operations" on page 5-28.

PIPELINE TRANSPORTATION OPERATIONS

Source Reduction Opportunities in Crude Oil and Natural Gas Pipeline Operations

<u>Preplanning</u>

Preplanning the siting, construction, operation, and maintenance of pipeline used in crude oil and natural gas pipeline operations is an important time to consider waste minimization techniques. Preplanning the pipeline construction should include consideration of pipeline location and access roads to minimize storm runoff and erosion. If possible, locate the pipeline along an existing line to reduce construction of new access roads.

<u>Product Substitution</u>

See "Organic Solvents," "Mechanical Cleaning," and "Paints and Thinners" on page 5-24.

Equipment Modifications

Replacing High-Bleed Pneumatics: Many devices used throughout pipeline operations use pneumatic devices such as valves and instruments to control and monitor the flow of gas. These devices need a pneumatic supply to drive their operating mechanisms. The most convenient supply is usually gas in the line the device is monitoring or controlling. Many of these devices are high-bleed which use a large volume of gas as a driving mechanism and then vent it to the atmosphere. Replacement with a low-bleed device can minimize the amount of gas vented, thus the loss of valuable natural gas. Generally low-bleed devices operate slower than high-bleed devices; therefore, a replacement is not feasible in all cases.

Replacing Natural Gas with Compressed Air for Operating Pneumatic Devices: Many pneumatic devices in pipelines are controlled by gas in the line. During operation of the devices gas is vented to the atmosphere. Compressed air should be used as the driving force for pneumatic devices when feasible.

Replacing Reciprocating Engines with Turbines: Turbines are more efficient in their use of natural gas than are reciprocating (e.g., internal combustion) engines. Replacing a reciprocating engine with a turbine unit can reduce the emission of natural gas to the atmosphere. Also, turbines are more efficient than reciprocating engines in driving pumping units. When feasible, consider replacing reciprocating engines with turbines at sites such as compressor stations or pump stations.

Basic Sediment and Water, or Tank Bottoms: Many operators have used simple techniques to minimize the volume of BS&W that accumulates in tanks. Devices such as circulating jets, rotating paddles, and propellers may be installed in crude oil 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.

See also “Lubricating Oil Purification Units,” “Chemical Metering, or Dosing, Systems,” and “Conventional Filters” on pages 5-25.

Reduction in Water Use

Large amounts of water are used when hydrotesting lines. To reduce water use and water disposal costs operators should, when feasible, reuse hydrotest water to test as many lines as possible. In some instances, reuse of hydrotest water can result in the reduction of significant waste management costs and water purchase costs.

Also, some pipeline operators have found the use of ultrasonic ("smart") pigs may reduce the need for hydrotesting. Smart pigs can assess the condition of pipe and, thus, may help in more efficient planning of hydrotesting.

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

See "Drip Pans and Other Types of Containment," "Preventive Maintenance," and "Chemical and Materials Storage" on pages 5-26 and 5-27.

<u>Inventory Control</u>

See "Inventory Control" on page 5-27.

<u>Selection of Contractors</u>

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 potential 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.

Recycling Opportunities in Crude Oil and Natural Gas Pipeline Operations

The next preferred waste management option is recycling. Recycling is becoming a big business and more recycling options are available every day. The following discussion offers some recycling tips.

Tank Bottoms: Nonhazardous, nonexempt pipe line system tank bottoms (BS&W) are best managed by sending them to a crude oil reclamation plant. An operator should contact nearby RRC-permitted crude oil reclamation plants to determine if an economically feasible arrangement is possible before considering disposal options. The

Waste Minimization Program can help operators locate reclamation plants in their area. Many of these plants also specialize in reclamation of waste paraffin.

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 located in every area of Texas, so finding one is not difficult. The Waste Minimization Program will provide upon request a listing of these companies.

Also, an operator can recycle his waste lube oil by adding it to a crude oil pipeline or storage 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 suffer damage to catalysts and other processes.)

Compressor Lubricating Oil: One inventive operator devised a procedure to optimize the use of lubricating oils in compressor units. According to the operator, used lubricating oil from the drive engine was of adequate quality to serve as lube oil in the compressor. So, the operator established a procedure where the used lube oil from the drive engine would be recovered and directed to the compressor. The result of this reuse option was reduced waste lube oil generation and reduced new lube oil purchases, making this a cost-effective waste minimization technique.

See also “Recycling Opportunities Applicable to All Oil and Gas Operations” on page 5-28

WASTE MINIMIZATION APPLICABLE TO ALL OIL AND GAS OPERATIONS

Source Reduction Opportunities Applicable to All Oil and Gas Operations

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, such as the one featured in the case history on page 6-11, 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.

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 140^{O}F, which is a characteristically ignitable hazardous waste when spent, some suppliers may provide a "high flash point Varsol" with a flash point greater than 140^{O}F. 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.

<u>Equipment Modifications</u>

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 a 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, as shown by the case history on page 6-2. (Even though the case history is from drilling operations, the concept may be applied anywhere.) 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 filters that typically comprise 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. The case histories on pages 6-7 and 6-8 are good examples of filter reduction.

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. The case history provided on page 6-6 proves this point.

Reduction in Water Use

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.

Good Housekeeping and Preventative Maintenance

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.

Preventive Maintenance: The companion of good housekeeping is preventive 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. 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 sheets (MSDSs) 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.

<u>Inventory Control</u>

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. The case history on page 6-11 illustrates the beneficial impact an inventory control system can have on an operation. 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.)

<u>Selection of Contractors</u>

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.

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. Also, the RRC offers inexpensive Waste Minimization Workshops at various locations across the state.

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 located in every area of Texas, so finding one is not difficult. The Waste Minimization Program will provide upon request a listing of these companies.

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. See "Recycling Resources" on the next page to learn how to find these companies.

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, scrap metal is subject to hazardous waste regulation. 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. (Also, see the discussions in "Good Housekeeping" and "Inventory Control.")

RECYCLING RESOURCES

The Railroad Commission maintains a list of permitted crude oil reclamation plants. See Appendix H for more information.

The Texas Natural Resource Conservation Commission (TNRCC) offers Recycle Texas and RENEW on their web site at www.tnrcc.state.tx.us. Recycle Texas lists companies that recycle a wide variety of wastes. This service is helpful in finding options for recycling oil and gas wastes. RENEW (Resource Exchange Network for Eliminating Waste) is a waste exchange network.

The TNRCC also maintains a list of registered facilities that transport, store, process, and/or market used oil and used oil filters for recycling.

See Appendix H, page H-2, for TNRCC contact information.

If you have difficulty finding a company who will recycle your specific waste, call the Waste Minimization Program for assistance.

TREATMENT

Treatment can be employed to reduce the volume or relative toxicity of waste that has been unavoidably generated. Treatment is anything that changes the physical, chemical, or biological character of a waste. Stabilization, neutralization, precipitation, evaporation, incineration, and scrubbing are all examples of treatment activities. Land treatment using methods such as landfarming with proper mixing and/or management of nutrients, moisture, and oxygen as necessary, is a process that is an effective means of management of certain oily wastes.

Unlike source reduction, treatment does not eliminate the creation of pollutants. However, treatment can render the waste less hazardous and, therefore, safer to transport, store, and dispose of. Also, in some circumstances, treatment may render the waste recyclable. Operators are encouraged to investigate treatment options to decrease the potential long-term environmental and human health impacts of wastes that are generated.

DISPOSAL

As we noted in Chapter 1, disposal is the discharge, deposition, injection, dumping, spilling, leaking, or placing of any waste into or on land, water, or air. For purposes of the waste management hierarchy, disposal is the final placement of wastes into the environment; obviously the least preferred option. It does not include recovered materials from leaks or spills that do not reach the environment. It also does not include the storage, treatment, or recycling of such wastes.

Many times the generation of a waste is unavoidable. The choice of a disposal option for a particular waste that has been unavoidably generated should be made only after careful consideration of the type of waste, applicable state and/or federal regulations impacting disposal options for the waste, the volume of the waste, the disposal environment, and short- and long-term liabilities. If a commercial disposal facility is used, the waste generator is encouraged to audit both the disposal facility and the oil and gas waste hauler to determine if they have the proper permits, good compliance histories, and environmentally sound waste management practices.

A NOTE ON THE IMPORTANCE OF SEGREGATING WASTES

Failure to segregate certain waste streams may lessen waste management options. In general, waste streams that are more regulated should be segregated from those that are less regulated. Hazardous oil and gas wastes should be segregated from exempt and nonexempt oil and gas wastes as explained in Chapter 3. For example, cleaning wastes, unused or unusable chemical products, and other nonexempt wastes should be segregated from exempt wastes where there is the potential of causing the exempt waste to become hazardous. Effective waste segregation can increase the volume of waste that is easily recycled and minimize the volume of waste that must be managed as hazardous oil and gas waste. In other words, the segregation of wastes allows an operator to follow the Waste Management Hierarchy to a greater degree, which can result in decreased waste management costs.

NOTES