POLLUTION PREVENTION CONSIDERATIONS FOR LARGE-SCALE FUEL HANDLING FACILITIES AND RELATED OPERATIONS

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ABSTRACT

Pollution prevention (P2) is the reduction, to the maximum extent feasible, of generated hazardous wastes prior to treatment, storage, or disposal. The United States Environmental Protection Agency (US EPA) encourages P2 and waste minimization as the preferred practice in an integrated waste management system. Pollution prevention focuses on source reduction and recycling activities to reduce either the volume or toxicity of hazardous waste generated as well as air emissions and effluent discharges.

As with most innovative solutions to waste management problems, P2 requires careful planning, creative problem solving, changes in attitude, potential capital investment, and most important, a firm commitment. The rewards for this commitment, however, can be great. Pollution prevention can enhance the efficient use of resources, reduce waste treatment and disposal costs, and decrease hazardous waste-related financial liabilities.

This work investigated P2 considerations for large-scale fuel handling facilities and related operations. The site studied receives, stores, and issues petroleum fuel products in addition to handling hazardous materials and chemicals used to perform regular maintenance and housekeeping tasks. A variety of hazardous materials are handled on site, with associated generated hazardous wastes.

Pollution prevention opportunities described herein consider applicable hazardous material substitutions, process and equipment modifications, hazardous material management and administrative changes, and non-point source pollution minimization. Potential barriers to P2 efforts are outlined.

Keywords: Pollution prevention (P2), hazardous material and waste (HM and HW), fuel handling facilities, HM substitution, equipment, management and administrative, non-point source

INTRODUCTION

Pollution prevention consists of all activities that reduce the generation of hazardous and non-hazardous wastes. Pollution prevention involves applying source reduction and other practices to decrease or eliminate the generation of pollutants to the maximum extent feasible. Examples of P2 techniques include:

- Integrated management strategy
- Material substitution

- Process redesign/modification
- Waste exchange programs
- Chemical segregation
- Reuse and recycling

Pollution prevention includes a comprehensive life-cycle approach to reduce HM use and HW generation. Pollution prevention includes the reduction of pollution through increased efficiency in the use of materials, energy, water, or resources, and conservation and protection of natural resources. A further advantage of instituting a P2 program is that numerous regulatory compliance requirements may also be fulfilled or facilitated as a result of the associated decrease in HM/HW and emissions. An effective P2 program will integrate all of the site's environmental and safety plans and procedures.

The purpose of this work is to investigate P2 opportunities for large-scale fuel handling facilities with an annual product throughput of more than 10 million barrels. The work described herein addresses P2 as defined by the Pollution Prevention Act of 1990 and subsequent federal, state, and local regulatory requirements. A large-scale fuel handling facility and related operations are used as a case study. The facility studied receives, stores, and issues petroleum fuel products in addition to handling hazardous materials and chemicals used to perform regular maintenance and housekeeping tasks. A variety of HM is handled on site, with associated generated HW. The specific objectives of this work are to:

- Identify major installation processes that use toxic chemicals or generate HW.
- Identify current and proposed measures and procedures to comply with federal, state, and local P2 directives, standards, and regulations.
- Provide technically and economically feasible options to reduce the generation and off-site transfer of toxic chemicals and HW.
- Recommend additional P2 actions.

PROBLEM DEFINITION AND SITE DESCRIPTION

This section describes processes and operations with potential environmental impact.

The site has approximately 60 aboveground and underground storage tanks (ASTs and USTs) for petroleum product handling. The total storage capacity is 2.5 million barrels (105 million gallons). The site handles approximately 15 million barrels (630 million gallons) of fuel annually. There are 10 runoff discharge outfall points to receiving bodies of water adjacent to the site. These outfall points are regulated by National Pollutant Discharge Elimination System (NPDES) permits that mandate effluent limitations, monitoring requirements, and other conditions for operations.

The facility maintains an oily waste treatment plant (OWTP) and manages a fuel oil recycling (FOR) program to reclaim used oil. The OWTP accepts bilge and tank-bottom water generated both on- and off-site as well as stormwater from the oil/water separators at permitted site outfall points. A master petroleum laboratory performs quality assurance (QA) testing on fuels and determines the acceptability of sources of FOR and bilge water for processing at the OWTP and FOR reclaim tanks.

Hazardous material handled and sources of hazardous waste at the site include: kerosene, ethylene glycol monomethyl ether, diethylene glycol monomethyl ether, napthalene, and other common fuel additives, lube oils, hydraulic oils, grounds fuels (low-sulfur diesel and reformulated gasoline), antifreeze, solvents (acetone, toluene, xylene), coagulants, acids, motor oils, brake fluids, cleaners/degreasers, paints, thinners, and sealants.

Hazardous waste generated on-site includes: tank bottoms, HM spills and associated materials, contaminated soil, oil and grease, contaminated solvents, skimmings/sludge, and effluent wastestream regulated under NPDES.

METHOD OF INVESTIGATION

Three methods of comprehensive research were performed to formulate the P2 plan. The first included interviews with all division managers, various “line” personnel, and those employees responsible for HM/HW. Concurrently, standard operating procedures, waste manifest files and databases, and all existing environmental plans and studies were reviewed. Last, a site assessment was conducted to observe site operations and evaluate field conditions. The site survey focused on all processes that use toxic chemicals or generate HW. Site facilities and operations were surveyed to determine current HM usage, HW generation rates, disposal procedures, required training levels, and waste minimization practices.

The data gathered provided a complete understanding of the site activities and requirements for improvement with regard to pollution prevention. To determine critical wastestreams, material balance theory and process flow diagrams were utilized to analyze throughput data such as HM inventory records and waste generation records. Baseline waste generation rates were finalized, from which pollution reduction goals were established. Based on these goals and suggestions from site personnel, P2 opportunities were identified. These ranged from the implementation of new procedures or training to the purchase of equipment or replacement of chemicals. A priority was assigned to each opportunity based on factors such as reduced risk to personnel/environment, ease of implementation, urgency of regulatory compliance deadlines, and economic feasibility.

RESULTS AND DISCUSSION

Pollution prevention goals address HM management, training and awareness programs, and reduction of HW, solid waste, and ozone depleting substances (ODSs). The establishment of a reference baseline for quantities of waste generation is essential in planning and implementing P2 goals. Typically, documentation such as EPCRA Section 313 Form R reporting, or permit applications, are useful in establishing the baseline for toxic chemical releases.

Pollution prevention opportunities are categorized as follows:

- Hazardous material substitutions
- Process and equipment modifications
- Hazardous material management and administrative changes
- Non-point source pollution prevention

Hazardous Material Substitutions

The site uses moderate quantities of HM, toxic chemicals, and ODSs listed by EPCRA and targeted for P2. The chemicals are used for cleaning, painting, lubricating, pest control, testing, and other basic maintenance tasks. Hazardous chemicals such as chlorinated solvent degreasers, ODSs, methylene chloride, methylethylketone, cresylic acid, dichlorobenzene petroleum distillates, lacquer washes, TCA, CFC-113, methanol, toluene, acetone, and ethylene glycol can be replaced with less hazardous, less toxic substitutes currently available on the market. Although many replacements may be available, not all of them may be suitable for the intended site application. It is necessary to study material characteristics and understand the requirements of the application before choosing a replacement product.

Process and Equipment Modifications

Process and equipment modifications that provide P2 opportunities at the site are described below. Operations such as fuel handling, housekeeping, cleaning, degreasing, painting-depainting, and equipment servicing were studied.

Used Oil and Oily Wastewater Management

Waste oil and off-specification oil constitute the largest portion of the hazardous wastestream at the facility studied. Recycling/reuse of used oil and oily wastewaters is an attractive option, since it is easy to implement and offers immediate economic return. Practices and technologies for used oil and oily wastewater management include used oil recycling, water quality inlets (WQIs), and sand filters.

Programs to recycle used oil and reuse it as fuel are a common practice for managing non-hazardous wastes with high heat value. Proper storage and segregation are essential to avoid contamination of the waste oil by solvents, cleaners and degreasers, water, dirt, or HW.

Waste oils that meet the definition of a used oil under the CFR for zero hazardous waste content and allowable total halogen concentrations are candidates for recycling and reuse. Otherwise, strict regulations for storage, handling, transportation, and disposal are applicable to used oils that do not meet RCRA standards and are classified as HW.

If waste oil products, such as grades of fuel, can be strictly segregated, collected product can often be reused for its originally intended purpose. Mixtures of used oil products are best suited for heating applications, such as in boilers. If the waste oil cannot be reused on site, it can often be sold to a local recycler.

Water quality inlets are used for treatment of oil-contaminated stormwater runoff. These structures include oil/water and oil/grit separators. Stormwater runoff is treated to meet NPDES permit effluent requirements prior to final discharge. Typical WQI structures employ a series of chambers that provide quiescent flow conditions to allow gravity separation of oil and grit from the wastestream. They remove free oil and grease that are not in the dissolved or emulsified phase. Proper maintenance of these units is essential for successful operation. WQI efficiency is a function of flow rates and unit surface area.

Finally, sand filters are another method that may be used to treat stormwater runoff to meet NPDES permit effluent requirements. These filters typically include sedimentation and filtration chambers. The sedimentation chamber removes floating debris and heavier sediments. The filtration chamber contains a sand bed for removal of colloidal suspended solids, metals, fecal coliform bacteria, BOD, nitrogen, and phosphorous. Sand filter operations can be modified to include biological treatment. The filters need periodic back washing to remove accumulated debris and media regeneration.

All these technologies will minimize wastestream generation and assist in meeting regulatory requirements for the site.

Drum and Oil Filter Management

Used 55-gallon drums and spent oil filters constitute a significant portion of a typical wastestream for facilities similar to the one studied. Current management practices include landfilling used drums and incinerating oil filters without any prior treatment.

Drum and filter crushing processes, as well as drum reconditioning technology, reduce the volume of the wastestream and extracts residual liquid HW content. Drum crushers use hydraulic pressure to compact 55-gallon drums, as well as smaller drums, down to less than 12-inch thick disks. Crushed drums may be recycled or disposed of properly. Hazardous residue problems can be avoided by using units that perform drum cleaning and crushing. Similarly, oil filter crushers reduce wastestream volume. Oil effluent collected from this process may be recycled.

Drum reconditioning processes use multiple rinsing, both internally and externally, followed by touch-up painting to minimize the effects of corrosion. The wastewater collected during this process requires proper treatment and disposal. The reconditioned drums may be reused to store HM and HW for later disposal.

These technologies reduce the volume and toxicity of wastestreams associated with used drums and filters.

Paint Stripping Processes

Typical paint stripping processes involve the use of chemical stripping agents that generate toxic sludge containing heavy metals and solvents. Abrasive blasting methods, such as sandblasting, generate large quantities of waste due to the blast media that must be disposed of, often as HW. "Wet" abrasive blasting technologies also have the potential to generate considerable quantities of contaminated wastewater that must be contained. Innovative paint stripping processes that have P2 potential include bicarbonate of soda stripping, plastic media blasting, and ultra-high-pressure water blasting.

Sodium bicarbonate stripping processes use this agent as the blasting media. The media are mixed with water, which dissipates heat and controls dust emissions. Although the blast media used are not toxic and can be solubilized, the resulting wastewater may contain HW. Solids, paint, debris, oil, grease, and other contaminants can be separated from the blasting media through filtration equipment. Special filters for removing lead may be necessary, if lead paint removal is anticipated. The remaining wastestream meets conventional sewer water discharge requirements.

Plastic media blasting is another alternative for replacing chemical stripping solvents and other dry blasting media. These media can be recycled repeatedly before requiring disposal as HW.

Finally, ultra-high-pressure water blasting technology uses a water jet stream at extreme pressures, thereby minimizing the quantity of blast water required. The collected wastestream is treated to remove all contaminants. Resulting sludge requires proper disposal as HW. The filtered blast water is recirculated through the system, eliminating the requirement for disposal of wastewater.

All of these technologies will minimize waste, reduce labor, and provide a safer work environment for paint removal operations compared with conventional processes.

Glycol and Hydraulic Oil Management

Used antifreeze may contain dissolved heavy metals such as lead, tin, zinc, copper, aluminum, silver, and iron. Proper containment, treatment, and disposal of glycol contaminated with these metals are required to prevent soil and groundwater contamination. Glycol recycling technology reconditions and purifies spent antifreeze from engine-driven pieces of equipment. The collected spent antifreeze is filtered, aerated, purified, and reconditioned using chemical additives. The recycled antifreeze is then fit for engine use. Contaminated filters have favorable leachate retention and are suitable for land disposal.

Spent hydraulic oil may contain impurities and contaminants such as particulates, water, air, and chlorinated solvents. Hydraulic oil purification technology strips undesirable contaminants from the oil to create a reusable product. Continuous and batch treatment processes are available to treat hydraulic oil. This technology extends the life of hydraulic oil by maintaining the intended viscosity. It is also applicable to other types of oil including synthetics. Resulting contaminated filter elements may be recycled or incinerated.

A significant advantage of these technologies is the reduction in the amount of antifreeze and hydraulic oil purchased, as well as the resulting wastestream. Such automated processes require minimal labor to implement.

Cleaning and Degreasing Operations Management

Cleaning and degreasing operations are to recondition equipment and parts.

Typical parts washing operations use hazardous solvents such as 1,1,1 TCE and MEK. Manual scrubbing is used in dip tanks, exposing workers to those chemicals. New aqueous parts washing technology employs a closed-loop automated cleaning cabinet using non-hazardous, water-based, biodegradable aqueous detergents to wash parts. The resulting sludge, consisting of oil particulates, and other contaminants, is collected and must be disposed of as HW. The rinse water is recycled rather than disposed of. Fresh water must be added to the system due to evaporation.

The advantages of this process include eliminating worker exposure to hazardous solvents and reducing labor time for parts cleaning, as well as the quantity and toxicity of the wastestream.

Washrack operations are employed to clean and degrease vehicles and other engine-operated equipment. Resulting wastewater typically contains detergents, degreasers, metals, oils, fuels, and other contaminants. Enhanced closed-loop washrack technology contains and treats wastewater generated from cleaning/degreasing operations. Typical closed-loop washrack units treat wastewater utilizing solids-liquids separators, absorption filters, flow baffles, and oil skimmers. The removed contaminants are collected and require proper disposal.

This technology allows for complete recycling and reuse of wastewater, significantly reducing the volume and toxicity of the wastestream.

Emergency Spill Management

Current emergency spill response practices include allowing the wastestream to discharge into the sanitary sewer collection system or using absorbent material, which subsequently has to be handled as HW.

Opportunities for enhanced spill response include making facility design improvements to optimize spill collection and employing safe, efficient technologies for spill recovery such as wet/dry vacuums. This technology decreases the volume of spill debris such as rags and petroleum product-absorbent material.

Hazardous Material Management and Administrative Changes

Pollution prevention opportunities in this area include:

- Hazardous material shelf-life management
- Hazardous waste containers, labeling, storage, and transportation
- Spill prevention techniques
- Recycling/reuse programs

In light of the new regulatory emphasis on P2 and HM minimization, shelf-life management is a valuable resource for reducing unnecessary disposal of HM, accurately reordering additional supplies to replace expired HM, and eliminating overstocking practices.

Hazardous waste generated by site activities must be carefully handled to minimize hazards to personnel, regulatory violations, and releases of hazardous substances to the environment. This entails proper selection, labeling, storage, and on-site transportation of HW containers. Standard operating procedures (SOPs) should be developed and implemented for HW handling, including container selection, labeling, storage, and transportation.

Releases of HM due to spills result in loss of usable product as well as generation of waste material such as contaminated soil, contaminated absorbent material, and the HM itself. In certain cases, such as spills or releases of ammonia, the HM is released to the atmosphere, frequently violating the Clean Air Act. In any case, disposal and clean-up costs are incurred. In addition, appropriate regulatory paperwork must be completed and the proper regulatory officials notified if the spill has the potential to affect the environment beyond the facility fenceline. A structured plan is recommended to prevent spills of all sizes, whether from bulk storage failures or improperly stacked packages. Spills are most often caused by mechanical failure, personnel error, and material handling deficiencies, but fires, explosions, and power failures also must be considered.

In addition, there are certain measures for reducing spill hazards specifically associated with ASTs, USTs, and piping systems, many of which are required by regulations. These include programs for regular inspection and maintenance of valves and pipelines. Most facility spill prevention control and countermeasure (SPCC) plans concentrate on measures for bulk storage of HM in tanks. These plans must also address the storage of smaller containers of HM (e.g., those stored on racking systems) and the unique material handling procedures required to ensure their integrity.

Finally, various vendors offer recycling/reuse services for special HW, which often require separate treatment and handling within the hazardous wastestream. These services are environmentally sound alternatives to off-site disposal and effectively reduce overall site waste generation rates. Recycling/reuse programs are available for printed electronic circuit boards, photographic and x-ray processing and printing chemical wastes, and fluorescent light tubes and high-intensity discharge lamps. Specific vendors must be contacted in advance to determine and meet their criteria for acceptance and proper handling of these items.

Non-Point Source Pollution Prevention

The presence of impervious surface areas on-site causes a high proportion of rainfall to be converted to stormwater runoff. The resulting wastestream contains pollutants such as suspended solids, oil, grease, metals, and undesirable nutrients. Best management practices (BMPs) to handle this wastestream include both structural and nonstructural controls. Generally, structural controls include containment areas for ASTs, structures that enclose or cover material handling and storage areas, and oil/water separators. Nonstructural controls include practices such as preventive maintenance, SPCC plans, housekeeping, and prevention or minimization of potential pollutant releases. Formal stormwater management plans and review of non-point sources of pollution are recommended.

Implementation of non-point source pollution control practices is essential to successful P2 efforts and meeting facility regulatory requirements.

POTENTIAL BARRIERS TO POLLUTION PREVENTION EFFORTS

Any new or developing program must overcome potential barriers to ensure successful implementation. Pollution prevention is no exception. Pollution prevention barriers identified throughout this case study include:

- Resistance to change in mind-set
- Unexpected changes in regulatory requirements
- Lack of available funding sources
- Insufficient P2 training and awareness programs

Pollution prevention is a relatively new approach in environmental protection. The switch from pollution control (i.e., what should be done to wastes and pollution once they are produced) to P2 is a major paradigm change. As with any change, skepticism can greatly affect the success of implementing a new approach. However, once the change has been implemented and proven worthwhile, skepticism is transformed to support. The key to the success is to start small, and through proven performance, build upwards, one step at a time.

Recent changes in regulatory requirements may impede P2 implementation in various ways such as:

- Providing conflicting media-specific goals or P2 mandates.
- Imposing cumbersome permitting requirements on P2 technologies.

- Mandating best available control technologies rather than promoting the most feasible technologies optimized on a site-specific basis.

Establishing a relationship built on “good will and faith” with local regulators and demonstrating commitment to P2 may ease some regulatory burdens caused by conflicts between P2 philosophy and current regulations.

Initial capital investment is required for certain P2 measures. Funds to procure P2 supplies and equipment may be available from several different sources. Obtaining sufficient funding for proposed P2 process modifications can be challenging. Therefore, P2 efforts should be considered during all budgetary exercises, and innovative approaches should be used in combination with other environmental projects.

Finally, many P2 procedures involve changes in operation or equipment. Hence, proper personnel training and awareness are essential. Individuals must understand the benefits of P2 and be provided with incentives to implement changes and recommended P2 improvements.

SUMMARY AND CONCLUSIONS

This work investigated P2 considerations for a large-scale fuel handling facility and its related operations. The site investigated receives, stores, and issues petroleum fuel products, in addition to handling hazardous materials and chemicals used to perform regular maintenance and housekeeping tasks. A variety of HM is handled on site, with associated generated HW.

Pollution prevention opportunities described herein consider applicable HM substitutions, process and equipment modifications, HM management and administrative changes, and non-point source pollution minimization. These opportunities will help to achieve P2 goals. Investigation of potential barriers to P2 is essential to successful implementation of P2 programs.

The methodology for developing a successful P2 program are universal to all types of industrial facilities. The essential elements are to:

- Survey site operations.
- Interview personnel
- Research HM/HW records, environmental plans, and associated documents.
- Establish baselines and goals.
- Identify opportunities.
- Implement opportunities most effective for site.
- Educate personnel.
- Integrate all environmental programs.

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