Waste Minimization
Requirements and Options for Generators

What every waste generator should know in order to reduce or eliminate waste.

The U.S. Resource Conservation and Recovery Act (RCRA) provides a systematic structure for managing hazardous waste within a cradle-to-grave regulatory system. Hazardous waste generators are, as identified by the U.S. Environmental Protection Agency (EPA), any person, or site, whose processes or actions create hazardous waste. EPA separates generators into three categories based on the quantity of hazardous waste they produce: large quantity generators (LQGs), small quantity generators (SQGs), and conditionally exempt small quantity generators (CESQGs).

What Is Hazardous Waste?
Hazardous waste is a solid waste (i.e., discarded solid, liquid, or gas) and is hazardous if it meets EPA’s rule definitions:

- It is a “listed” hazardous waste in Subpart D of 40 CFR 261 (which includes acute waste and other waste EPA determined to be toxic or of concern to human health and or the environment); or
• It is a characteristic hazardous waste and exhibits one or more of four defined properties: ignitability, corrosivity, reactivity, or toxicity.

The types of toxicity characteristic wastes are broad and range from metals (e.g., lead) to specific organic wastes (e.g., benzene) with each type having a concentration level at which the waste is hazardous. There are 40 different toxicity characteristic wastes from D004 to D043, each one having an individual number. The other three types of characteristic wastes are numbered D001 (ignitable), D002 (corrosive), and D003 (reactive). EPA “listed” wastes are known as F-listed, K-listed, P-listed, and U-listed, and number well over 400 wastes from specific sources.

Obviously, the more hazardous waste a generator produces, the more costly it is to manage the waste while onsite, and transport and dispose of the waste offsite. It is through this generation process that waste minimization becomes a goal.

Waste Minimization
The regulatory framework for waste minimization stems from RCRA since RCRA mandates, where feasible, that the generation of hazardous waste is to be reduced or eliminated as expeditiously as possible (RCRA § 1003(b)). A waste minimization program is required for LQGs, while all generators are also included in the mandate to reduce the amount of hazardous waste that has to be treated and disposed of in the United States.

A generator who initiates a shipment of hazardous waste to a treatment or disposal facility certifies to one of the following statements in Item 15 of the uniform hazardous waste manifest, in accordance with 40 CFR §262.27:

(a) “I am a large quantity generator. I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment;” or

(b) “I am a small quantity generator. I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and that I can afford.”

Some states, such as New York, require large-quantity generators to prepare, implement, and submit to the Department of Environmental Conservation (DEC), a Hazardous Waste Reduction Plan (HWRP). The HWRP is reviewed and approved by the DEC, updated biennially, and a status report is submitted annually on the waste reduction technological or process reduction changes. The state has a guidance document and checklist available online to assist generators in the implementation of a program and in the required items to be tracked in reducing acute and non-acute hazardous waste that is reported to the state.

Efforts to reduce waste and use chemicals with fewer toxic properties in order to generate less toxic wastes are part of the waste minimization goal of the State of New York in its requirements for generators. Generators in New York State must:

• identify the amount and type of hazardous waste;
• identity the point of generation or the source (acute and non-acute hazardous waste);
• submit block diagrams of the processes generating the waste (including raw material inputs, major process steps and equipment, and product and waste outputs); and
• provide an activity/production index for each identified wastestream. This is a measure of changes in economic or other factors that affect the quantity of hazardous waste generated in a specific year, compared to the previous year. The
Examples of Waste Reduction and Minimization

Below are some examples of waste reduction and minimization from different industrial and mining sectors.

Eliminating Lead from the Wastestream

One example is the gold mining industry, where hazardous waste was generated as a result of using a chemical in one of the associated processes in producing gold. The name of the specific mine in this example is withheld, as the company prefers to remain anonymous; however, the situation of large quantities of hazardous waste was occurring at one western mine as of 2008. The hazardous waste, in this case, was lead and cost the company thousands of dollars every two to three months for its disposal.

Metallurgy is an exact science in the beneficiation and mineral processing of gold as the recipe for maximum extraction of the mineral varies from property to property. One of the processes typically used at a gold property is assaying the gold mineral, both for determining the quantity in a sample as well as determining the purity of the gold. The fire assay process at the mine used a toxic chemical that resulted in generating a large quantity of hazardous waste.

Gold ore is subjected to grinding, milling, and flotation processes to enhance the recovery of gold. Other processes used in recovery include: leaching, electrowinning, use of activated carbon in various chemical washes, carbon stripping, and heating in a furnace. Gold is removed from other minerals during the heating or melting process in an assay laboratory. The cupellation process uses lead litharge (lead monoxide powder) in the cupel or crucible (i.e., containers that can withstand high temperature) to pull the gold particles from the other minerals/salts present in the mineral stream during a fire assay. The cupel/crucible becomes contaminated with lead and these articles, as well as the slag generated during the melting process, require disposal as hazardous waste. Lead is one of the characteristic wastes that when produced in a quantity that fails EPAs test for toxicity characteristics is identified as a hazardous waste and has to be disposed of as such.
The fire assay process was reviewed, a possible substitute was identified, and analytical testing ensued to see if the substitute (a nontoxic chemical) could be used for the same purpose during the assaying of the gold. The metallurgical process was essentially the same, with modifications in the recipe to try to duplicate the effectiveness of lead litharge with the substitute chemical in the assay. Each time the recipe changed, analytical testing and evaluations were made of the less toxic substitute to assure that the quantification of the gold was as effective as the lead litharge in the assay process. The chemical substitute testing was part of the waste minimization assessment program at the mine property.

The gold mine company in our example identified that there were less toxic chemical substitutes for lead litharge, such as bismuth, that might perform the same function as lead litharge during the mineral recovery in the fire assay. The company performed analytical testing using bismuth to recover the gold in the fire assay. The basis of the quantity and quality of the gold depends on the effectiveness and reliability of this process at each mine property. It should be understood that each mine property has a particular natural, mineral complex that requires understanding the mineral properties to effectively remove and quantify the gold. The chemical processes involved are complex and the melting process is one of the last steps involving the right recipe to measure gold, and document the gold production. So the testing of a substitute chemical, such as bismuth for the lead litharge, involved multiple analytical testing trying different amounts of bismuth to achieve the maximum gold recovery in the cupel/crucible.

The use of bismuth in the assay laboratory of the facility was successful in achieving gold recovery and eliminating the use of lead in the process. As a result, lead was eliminated from the wastestream. The use of bismuth, not known to be a human carcinogen, and not one of the EPA listed hazardous wastes or considered hazardous for toxicity characteristics, eliminated the hazardous waste stream. Although bismuth, as a laboratory reagent, is more expensive than lead litharge, the cost of the
reactant did not exceed the cost of the hazardous waste disposal. Without this lead wastestream, there was also less cost associated with handling and storage of the resulting solid waste and less recordkeeping associated with the solid waste.

**Recycling Flux and Heavy Metal Waste**

Our second example is Nucor Steel Texas’ steel bar mill production facility in Jewett, TX, which generates a hazardous waste on EPA’s list of hazardous waste in 40 CFR 261: emission control dust (K061) from the primary production of steel in the electric arc furnace (EAF). The company uses EAF technology to annually recycle approximately 1 million tons of scrap steel into new steel products. The primary raw material is steel scrap, which typically includes old cars, appliances, and other scrap steel removed from the wastestream. Heavy metals found in this steel scrap causes the emission control dust to be identified as the listed hazardous waste K061.

A drop out chamber (DOC) is located beneath the EAF and is part of the direct evacuation control system leading to the baghouse. A review of the handling process as part of the company’s waste minimization plan determined that the EAF operations personnel could reclaim fluxes and metal collected in the DOC by charging the material into the EAF rather than loading the material out with the baghouse dust as a K061 hazardous waste. Reclamation of the flux and metal resulted in a significant reduction of hazardous waste generated and provided the additional benefit of reduced transportation and disposal costs associated with the waste reduction. In 2007, Nucor Steel Texas sent 1,974 tons (or approximately 4.0 lb) per ton of steel offsite as hazardous waste. Today, the company is recycling 100% of this DOC material as a beneficial additive in the furnace.

**Replacing Toxic Cleaning/Degreasing Chemicals**

Both of the above examples involved a review of an industrial process that was an integral part of production—a mainstream process for the entities involved. However, the associated or auxiliary processes of a company can also be reviewed to identify where they might reduce or eliminate hazardous waste.

A small-quantity generator evaluated waste generation in 2007 to see if there were chemicals or methods that could be used to minimize hazardous waste generation. Since most of their hazardous waste generation actually originated in the heavy equipment shop—a support function to the product produced at the site—the heavy equipment shop was the area assessed for chemicals used in generating hazardous waste.

The company initiated an evaluation of the chemicals used during the cleaning and degreasing of equipment at the heavy-equipment shop. Products were evaluated for ingredients that resulted in the waste generated being hazardous (products can contain chemicals that are solvents, meeting the definition of EPA’s F-listed wastes, such that prior to use, the generator knows the waste is hazardous). Products were identified for elimination based on the chemical solvents listed as ingredients. The first option was to find products without toxic chemicals or no “listed” solvent chemicals or toxic chemicals in the product. The second option was to investigate other methods for cleaning of parts.

The first option was initiated and, as a result, products with less toxic chemicals were used in the shop. This option was successful, in part, because the substitute degreasing and cleaning products had to be ordered through a single department; products purchased by employees from vendors outside the property, such as during a visit to the auto parts store, were not allowed to be brought onsite. The establishment of a standard purchasing method contributed to eliminating multiple sources of waste. The second option was implemented when the company found a large, steam cleaning machine on which parts can be placed within the machine and steam cleaned with soap and water. This has worked with most parts that needed cleaning and has cut down on the use of chemicals and the quantity of hazardous waste that is generated overall. Products with F-listed solvents were substituted with products not having a “listed” chemical in the ingredients.

**Successful Recycling of ‘Waste’**

Other generators are finding there are exciting options occurring in the recycling and reuse of spent materials that would be waste otherwise.
Companies such as Heritage-Crystal Clean, offer a reuse program for used solvents. The company sells a solvent to the customer, then samples and analyzes the used solvent from the customer for the characteristics and concentrations in the material (normally the waste). If the spent material meets the specifications as a substitute for a commercial raw material in a manufacturing process, it is used as a product in the manufacture of another product. The used solvent is no longer considered a waste, since it is legitimately reused directly in a manufacturing process and, thus, the waste disposal cost is eliminated. Generators considering this option would need to review the RCRA obligations associated with the recycling of the waste-like materials in 40 CFR 261.2(e) and any similar state requirements as well as other subsections of 40 CFR 261.2 to assure that the reuse activity is in compliance onsite as well as offsite.

### Conclusion

All the examples above utilized a small team of individuals from different departments and perspectives within the organization to assist with identifying a wastestream for reduction or elimination, identifying improvements in chemical use, and investigating and implementing the new approach or chemical. A systemic approach was used in finding solutions to hazardous waste reduction. 

### Five Steps for Initiating Waste Reduction

1. Identify wastes by the generating process.
2. Select a chemical or process to investigate with reduce (or eliminate), recycle, or reuse goals with input from people directly involved (assessment of product or chemical effectiveness, financial cost, ease of use or changing process).
3. Prepare a plan of what the entity intends to implement for waste minimization (i.e., document program).
4. Implement the substitute or change in the process on a trial basis.
5. Follow-up/track effective minimization, including measurement of reduction and potential cost savings.