It is time for you to consider putting the EHS principles and tactics to work! This section was included to help you do just that.

The keystone of your efforts to make the business case for EHS will hinge on your ability to use **Tactic 1**. This is a very important way to put together an EHS management system and to get the employees and management communicating about ways to add business value.

**Tactic 1** was selected by EPA for its “Nothing to Waste” Program in 1995. This program promoted the use of these quality management tools with a large number of micro-businesses (i.e., defined as a business with between 1 and 10 employees). Because of its success, the state of New Mexico adopted the Nothing to Waste Program as part of its Green Zia Environmental Excellence Award Program. **Tactic 1** was also included in an EPA publication, “An Organizational Guide to Pollution Prevention.”

Having said this, **Tactic 1** requires that you develop some skill in order for you to be able to use it effectively. The three cases not only show you how to use this important tactic, but they will also provide you with some practice using the tactic before you tackle your own processes. It is good to get a feel for what you will be doing before you actually try it out.

The first case is for a very typical small business. A medium-sized business case is also presented. Finally, a larger-sized business case is presented. All sizes of businesses have main processes and supporting processes. Only the amount of in-house information available on these processes will differ with the size of the company. The Internet is a treasure-trove of information about all manufacturing and service sectors because of the U.S. EPA funding of pollution prevention efforts over the past 18 years. OSHA also has sector-specific information on the health and safety side. **Tactic 1** can be used to help you make some sense of this information and to use it to better understand the processes in your business.

At the end of the cases, a series of “lessons learned” are presented. These tips for more effective use of the tools in **Tactic 1** come from hundreds of implementations of these quality management tools.

Take the time to work out the cases. Get some of your fellow employees involved in working with these cases as an exercise. The practice will help you better use the **Tactic** in your own business.
Case Study 2: Mid-Sized Paint Manufacturing Business

The U.S. paint and coatings industry is comprised of approximately 1,500 establishments engaged in mixing pigments, solvents, and binders into a wide variety of products that preserve, protect and beautify the objects to which they are applied. Paint and coating products are commonly grouped into three categories:

- **Architectural coatings** include interior and exterior paints, primers, sealers, varnishes and stains that are applied on-site to new and existing residential, commercial, institutional and industrial buildings.
- **Industrial coatings** are coatings that are factory-applied to manufactured goods as part of the production process. They are used to decorate and protect a wide variety of products, including motor vehicles, appliances, beverage cans, furniture, machinery and electrical equipment.
- **Special purpose coatings** include marine paints, high performance maintenance coatings, automotive refinish paints, transportation markings and aerosol paints. Such coatings are generally used where durability is a key objective.

In 2002 the U.S. paint and coatings industry sold 1.46 billion gallons of product, valued at $17.2 billion.

Along with other businesses, paint and coatings companies are held increasingly responsible for the effect their processes and products have on the environment. Combined with the genuine concern of most companies, this has led to a slew of new initiatives on behalf of environmental improvement, as well as the continued development of more environmentally friendly products.

Wastes generated at paint manufacturing facilities include equipment cleaning wastes, spills and area wash down, off-specification paint, bags and packages, air emissions, filter cartridges, obsolete products, and customer returns. In recent years, the paint and coatings industry has worked diligently to address concerns in almost every one of these areas. The success of these initiatives has not escaped the radar of many environmental watchdog groups, which have maintained that while there is still room for improvement, the paint and coatings industry is making great strides regarding its impact on the environment.

Non-waste-water generation at these facilities ranged from 300 pounds to 450 pounds per 1,000 gallons of paint produced. However, paint companies have improved their relationship with the environment in recent years. “Reducing the amount of paint that is wasted or thrown away, making sure our plants do not adversely affect the communities in which they operate, and working efficiently to avoid waste of materials and energy are primary concerns,” said Carl Minchew, Benjamin Moore’s director of technical services and environmental affairs. “Knowledge is the key. Knowing the correct processes and procedures and ensuring they are followed by everyone involved is the best way to minimize adverse impacts. A lot of damage is done, not by accident or lack of concern, but through lack of knowing what matters and what to do about it.”

This case description was prepared to describe the process in a typical mid-sized paint manufacturing business.

**Tip:** Manufacturers of adhesives, cosmetics, beverages, processed foods, and food processing equipment all have processes similar to this paint manufacturer.
The Case Studies

For the purposes of the case, the management has formed a team of approximately five people to use the Systems Approach in Tactic 1. It is important that people use the tools a minimum of four times before they can become sufficiently adept in their use.

**Tip:** An alternative is to use an outside facilitator who is more familiar with the tools or have someone trained in the use of these tools. Many community colleges and continuing education programs offer training in the use of quality management tools and methods. Typically, a 2-day training course in the use of the Systems Approach will provide the basic skills necessary to use the tools. After the course has been completed, the participants are encouraged to facilitate the use of the tools with small teams using Tactic 1.

There are seven steps in this case:

1. Process Mapping
2. Accounting
3. Rank Ordering With Pareto
4. Root Cause Using a Cause and Effect Diagram
5. Generating Alternatives With Brainwriting
6. Selecting Alternatives With Bubble-up/Bubble-down
7. Preparing for Implementation with an Action Plan

Figures, tables, and other information are provided within each of these sections to help the team use the tools. A sample of a team product is provided in the Attachment to this case.
Step 1. Process Mapping

Instructions

The information on the process is provided in the box below. Please read this information and prepare a process map using the flip chart paper placed in a “landscape” position. It is all right to mark it up and cross things out. The process map is just a tool to help the team focus its discussion on understanding the process before it is studied in greater detail. Make sure the perspective in the process map is consistent. Make sure you agree on the boundaries that are placed on the process by the work steps. As you are working on the process map, you should start preparing a listing of supporting processes associated with paint manufacture.

Latex Paint Manufacturing Process

The paint ingredients for the grind step are added into the paint-mixing vessel following the order of ingredient listing (see Resource Accounting). These ingredients are mixed using a high-speed mixer with a high-power electric motor and a long vertical rotating shaft with a specially designed mixing blade. The pigments are the ingredients that require the most energy to disperse, wet out, and keep separated so that they do not agglomerate in the paint. Once all the materials are added to the mixing vessel, the high-speed mixing should continue for 15 to 20 minutes to ensure complete dispersion of the pigments.

The paint is then pumped through pipes to the let-down tank to finish making the paint. Ingredients are added (see Resource Accounting) in this tank that do not require high shear mixing to disperse. There is a smaller electric motor and a long vertical rotating shaft and mixing blade. The contents are mixed until the paint has been tested by quality control.

After the let-down step, the paint is pumped through paint filters into the filling line where it is put into cans. These cans are sealed and labelled by this filling line.

The filled paint cans are then sent to packaging where they are placed in boxes, put onto pallets, and sent to shipping.

The first and last steps have already been added to the process map below.

Figure 1. Latex Paint Manufacturing Process Map Template

It doesn’t appear that any of the work steps can be described in three to six steps at the next lowest level.
Step 2. Accounting

Instructions

Prepare Resource Accounting Sheets for the work steps in your process map. A listing of the resources used in the process is provided in the box below. Formulation processes do not plan to have waste in the grind and let-down portions. However, there will be spills and leaks and materials left in the system before cleaning. In this case, you will not have to fill out the Activity Accounting Sheets. However, you could do this at a later time. As you are filling out the Resource Accounting Sheets, be sure that all the supporting processes have been captured.

Figure 2. Grind Work Step

<table>
<thead>
<tr>
<th>Resources for Grind Portion</th>
<th>Volume (L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>144.1</td>
</tr>
<tr>
<td>Propylene glycol</td>
<td>69.2</td>
</tr>
<tr>
<td>In-can preservative</td>
<td>2.0</td>
</tr>
<tr>
<td>Cellulosic thickener, 100%</td>
<td>2.5</td>
</tr>
<tr>
<td>Dispersant, 25%</td>
<td>13.3</td>
</tr>
<tr>
<td>Surfactant</td>
<td>2.2</td>
</tr>
<tr>
<td>Defoamer</td>
<td>2.6</td>
</tr>
<tr>
<td>Titanium dioxide</td>
<td>52.5</td>
</tr>
<tr>
<td>Zinc oxide</td>
<td>5.3</td>
</tr>
<tr>
<td>Extenders</td>
<td>80.7</td>
</tr>
<tr>
<td>Electricity</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3. Let-down Work Step

<table>
<thead>
<tr>
<th>Resources for the Let-down Portion</th>
<th>Volume (L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latex emulsion, 53.3%</td>
<td>365.8</td>
</tr>
<tr>
<td>Polymeric opacifier</td>
<td>76.7</td>
</tr>
<tr>
<td>Texanol</td>
<td>12.4</td>
</tr>
<tr>
<td>Defoamer</td>
<td>2.4</td>
</tr>
<tr>
<td>Mildewcide</td>
<td>2.3</td>
</tr>
<tr>
<td>Polyurethane thickener, 25%</td>
<td>12.5</td>
</tr>
<tr>
<td>Aqueous ammonia, 28%</td>
<td>2.9</td>
</tr>
<tr>
<td>Water</td>
<td>150.4</td>
</tr>
<tr>
<td>Electricity</td>
<td></td>
</tr>
</tbody>
</table>
**Figure 4. Sample Resource Accounting Sheet**

<table>
<thead>
<tr>
<th>RESOURCE ACCOUNTING SHEET</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description of the Work Step:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WORK STEP</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>SUPPORTING PROCESSES:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Each supporting process is a “process” with its non-product inputs and non-product outputs. It can be one step or multiple work steps.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>OTHER INFORMATION:</th>
</tr>
</thead>
</table>

Figure 5. Sample Activity Accounting Sheet

**ACTIVITY ACCOUNTING SHEET**

**Description of the Work Step:**

**INDIRECT LABOR FOR WORK STEP (NON-VALUE ADDED)**

**DIRECT LABOR**

**PREVIOUS STEP**

**WORK STEP**

**CYCLE TIME**

**NEXT STEP (THROUGHPUT)**

**INDIRECT LABOR TO MANAGE LOSSES (NON-VALUE ADDED)**

**Supporting Processes:**

*Each supporting process is a “process” with its indirect labor for work step management and indirect labor for the management of the losses. It can be one step or multiple work steps.*

**Other Information:**
### Figure 6. Resource Accounting Sheet – Mix the Paint Ingredients

<table>
<thead>
<tr>
<th>RESOURCE ACCOUNTING #1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description of the Work Step:</td>
</tr>
</tbody>
</table>

- PALLETS
- RAGS
- WATER
- ENERGY - MOTOR (electricity)
- PPE
- RAW INGREDIENTS (Grind Portion)

**STORE THE INGREDIENTS**

**GRIND THE INGREDIENTS**

- CONTAINERS AND PACKAGING (shrink wrap)
- SPILLS AND LEAKS
- DUST - particulates
- PPE
- RAGS
- HEAT LOSS
- PALLETS

**MILL THE INGREDIENTS [2.2]**

**Supporting Processes:**
- Recycle
- Laboratory
- Air Emission Control
- Solid Waste Handling
- Laundry of Uniforms
- Maintain Transport of Equipment
- Process Water Treatment
- PM Tank and Piping and other equipment
- Clean Equipment
- Storage

**Other Information:**
- Blade and shaft
- Motor
- Tank
- Piping
- Valves
- Instruments (level, temp., and revolution)
Step 3. Rank Ordering with Pareto

Instructions

Take a look at all the uses and losses of resources in the paint manufacturing operation. Be sure to include the uses and losses of resources from the supporting operations as well. Remember that all the tanks and lines must be cleaned between batches. Cleaning is probably the most wasteful of all the supporting operations. Don’t forget container management, pallets, packaging, and other similar wastes from the operations. You will find even more items during your site verification procedure.

Using the collective knowledge of your team members, what are the 20% of the total list of uses, losses, and activities that cause the operation to spend 80% of the money for dealing with these items? Be sure to recognize linkages by taking into account the cost of the lost resource as well as a person’s time cost associated with managing the waste. Try not to double count. The y-axis on the Pareto chart could be “relative” costs (i.e., like the dollar symbols on restaurant reviews: $$$$$, $$$$, $$, $ categories). If you want, you could look at the operations from three different perspectives: resource usage, resource loss, and indirect labor requirements.

For a look at a sample Pareto Chart, see Chapter 4, Case Study 1, Attachment 2.

Determine: What are the biggest losses of resources in the operation from a cost perspective?

The Systems Approach Training covers several ways to address the selection of opportunities for process improvement. For the purposes of this exercise, we are just trying to have you get a sense of how the information in the sections above can be used for rank ordering.

Step 4. Root Cause with Cause and Effect Diagram

Instructions

Your team will need to select a problem that you identified as being important in the Pareto analysis. You should consider the following problem:

Dispersing the paint components takes a lot of energy. The facility you are working with mixes the components of the grind phase into a mixer. These mixed materials are then pumped through a ball mill – a horizontal cylinder that contains the liquid vehicle and pigments to be dispersed, along with many ceramic balls. As the cylinder rotates, the balls tumble and create shear forces on the pigment agglomerates that disperse the pigment particles. Since this process takes a relatively long time, many manufacturers have opted to go with a one step add-grind process. How can electricity be conserved in this operation?

What is it in the grind work step that is causing the use of electricity? The team should go back over the Resource Accounting Sheet for this work step. You might wish to prepare an Activity Accounting Sheet for this step. Remember that the client is doing this work step in TWO work steps. You need to focus on the client’s process. Some information on this problem was obtained from some interviews of the employees working in the plant. Remember, do not try to solve the problem at this point!

Elect a scribe (i.e., someone who did not draw the process maps or Pareto chart) to take the marker and draw a large cause and effect diagram on the paper. Write the problem in the box on the right. Pick your cause categories (you might wish to stick with materials, machines, methods, and people).

On a separate piece of paper, list all the things from that work step that would fit under each of these categories. One at a time, place these items on the cause and effect diagram while asking the
question: “What is it about _____ that causes the problem (written in the box on the right)? Write the answer on a side “bone” that is perpendicular to the cause bone. Continue until the fishbone is complete. Take a look to make sure nothing was overlooked. If you have time, the diagram should sit for a day or two before it is revisited. Could you use this diagram to explain causes to the owner of the paint manufacturing operation? What would you say?

When your team has completed the diagram, count the total number of causes. Circle 20% (i.e., one-fifth) of the most probable causes. Can the team agree to eliminate one of these circled causes as being much less significant than the others as a likely cause of the problem? Can the team agree to eliminate another one? Can you find the root cause of your problem? In the next step, you will begin to find ways to solve the problem.

Ideas from Interviews with Employees

◆ There have been a number of vendors that sell equipment for completing the grinding (i.e., dispersion) in a single step instead of the two-step process currently in use.

◆ The U.S. Department of Energy has a motor management program that helps companies use less electricity (http://www.oit.doe.gov/bestpractices/motors/)

◆ It is known that the selection of the mixing blade used to disperse the pigments in the liquid vehicle is the key component choice for proper pigment grinding when using this type of equipment. A common design for mixing blades is a flat disk having metal teeth on the outer edges of the disk that point up and down perpendicular to the horizontal plane of the disk. The purpose of this design is that a spinning disk creates shear forces in thick liquids due to the inertial drag of one layer of material moving over another. The higher viscosity of the liquid surrounding the disk, the higher the shear forces being generated. The circulation provides fresh liquid material for the spinning disk surface and ensures that all the liquid in the missing vessel comes in contact with the spinning disk and is effectively sheared. This combination of strong shear forces and good circulation results in efficient pigment dispersion in this grind portion.

◆ One employee was wondering if the order of adding the components has ever been optimized with energy efficiency in mind.

◆ What considerations could be made regarding the speed of the motor and the depth at which the blades are located? Can these be varied throughout the process?

◆ Can the raw materials be purchased in other forms or pretreated in a way to lessen the amount of energy used in the grind phase?

◆ Grind temperature is an important factor to monitor. A low grind temperature sometimes indicates that no friction is developing from shearing the ingredients or that too much liquid has been added for the amount of pigment being dispersed. A grind temperature that is too high may indicate a high grind viscosity that can lead to an unsafe work environment and can even burn out the motor.

◆ Pumps also use electricity.

◆ Electric energy can come from a variety of different sources.
The Case Studies

Step 5. Generating Alternatives with Brainwriting

Instructions

With the process map and cause and effect diagram in view, your team is ready to search for alternative solutions using the brainwriting tool. You might wish to re-read the information provided from some interviews with employees in the root cause exercise.

When you are ready, remove a brainwriting sheet form from the back of this training packet. Put it into a pile that all team members can reach. One of the team members should place a second sheet in the pile so that there is one more sheet than there are people on the team. The sheets can be face up in the pile. Each person should pick up a brainwriting sheet and write a way to solve the problem or make it less severe in box #1. Write another way to solve the problem or make it less severe in box #2.

Take your time.

Then place your sheet back into the pile and take another sheet and repeat the process in the lowest numbered boxes available to you. Don’t forget to be provocative! When you cannot think of any more alternative solutions to the problem, read what the others have written and see if it triggers another idea. You can build on other peoples’ alternative solutions by adding things to what they said. Keep the sheets moving until you have read everything and just do not have any more ideas. It is all right to talk during the exercise and ask questions when you do not understand an alternative solution on one of the pages.

When activity has stopped, elect a team member to use the flip chart paper to write down the alternatives as read by the team members who have divided the sheets among themselves. Make sure the scribe captures the idea as read. Leave space between the items because the sheets will be cut into strips for the next exercise. Once an item is placed on the flip chart, the members of the team should check their sheets to see if there is a similar item listed. It should be read aloud and the team will decide if it is the same or if it is slightly different. If it is different, it should be added to the flip chart list. Cross off all items that have been considered.

Tip: Do not try to combine alternatives now. Keep going until all the alternatives are listed. Cut them into strips, with one alternative on each strip.

Step 6. Selecting Alternatives with Bubble-up/Bubble-down

Instructions

Take the strips containing the alternative solutions from the brainwriting exercise and place two of them on the table or floor and ask the question, “Which is best?” Take cost, ability to implement, and effectiveness into account as the team makes a decision. Only a majority is needed to bubble-up or stop. This tool helps you discuss all the alternatives. You can ask questions of the person that recommended the alternative solution. Do not try to reach consensus on every item. Remember that you can combine items as they are moved up the list. You can simply tape them together or write the combined alternative solution on a blank slip of paper. Do not take short cuts by moving alternative solutions up the list without considering all the other solutions. It is good to have discussions so each team member learns what the others think about each alternative. This discussion will help write a better action plan for the alternative solution(s) selected for implementation.
**Tip:** Here is an important consideration for you to keep in mind during this exercise: Alternative solutions that are cheap and easy to implement usually win out over effective ones that are more expensive or take a long time to implement. Remember how important it is to show progress in this and every program conducted within the organization using the Systems Approach for process improvement.

Once the prioritization has been completed, the team members should feel free to do some shuffling of the order (i.e., move nothing more than two places unless agreed to by a consensus of the team). The *quick wins* should be at the top of the list. What is the alternative solution that is closest to the top that is not a quick win? This is probably your highest-rated *crown jewel* or effective alternative solution. You should consider writing an action plan for that alternative solution as well as for the one that ended up on top since it will take time to get it implemented.

**Step 7. Preparing for Implementation with an Action Plan**

**Instructions**

You should now try to prepare an action plan just as if the team were going to implement the alternative selected in the step above. While this may be difficult to think about if you do not actually manufacture paint, it is instructive to take a look at how you would perform the baseline survey (i.e., resource use and loss, activities conducted, and the financial costs) in the first work task. Without a baseline survey, it will be impossible to assess the success of the activity. You will have to determine the best way to assess the same information at the end of the project.

The second work task will describe what the first step will be for implementing this activity. It is important to have a clearly written *performance standard* for each of these tasks. The audit at the end of the year will assess the work items and their ability to meet these performance standards. The sum of all the performance standards will become the objectives and targets in any conformance program in effect (e.g., ISO 14001).

The team will need to prepare a report on the project at the end of the reporting period. This report must contain the *lessons learned* and some recommendations for leveraging these lessons in other work steps or in other future projects. This work task should take place as the last item right after the data assessment discussed above.

An Action Plan Form is provided on page 132.
Possible Outcomes from Using the Systems Approach Tools
(See Attachment 1)

Ideas for Adding Business Value

The literature offers many “best practices” for manufacturing paint. The National Paint and Coatings Association is also a source of best practices to its member companies. Some of the industry best practices are provided below. You should try to determine how each of these practices could
help add business value to this mid-sized company. When using the Systems Approach, the employee
teams are not provided with best practices until just before they prepare the draft action plan. At
that point, they are able to take some of these initiatives and compare them to the alternative solu-
tions that were just prioritized using the quality management tool, bubble-up/bubble-down.

**Raw Material Pollution Prevention (P2) Checklist**

- Substitute raw materials to minimize health and environmental effects.
- Inspect, repair, and reuse pallets received with purchased raw materials, or return to ven-
dor.
- Rinse and crush damaged metal containers and ship to scrap metal recyclers.
- Establish product certification and/or physical property checks for raw materials.
- Establish laboratory procedures for quality control of new products.
- Return corner boards on can shipments to supplier.
- Purchase dry pigments in 1,000–2,000-lb reusable “superbags” that can be discharged
directly into mixing tanks. This avoids waste pigment being left in 50-lb bags, which are then
landfilled.
- Eliminate dry bags by converting to the TiO₂ slurry system pumped directly to mixer.
- Purchase pigments in the form of a slurry or paste in place of powder form to reduce the
amount of dust generated by the waste.
- Purchase raw materials in tote tanks when possible. These tanks, when empty, are returned
to the supplier, cleaned, and reused.
- Where volume warrants, purchase colorants in 15, 30, or 55-gallon reusable drums rather
than 5-gallon pails.
- Install dust collectors to collect dust generated during dry pigment incorporation; recycle
back into batches as raw material.
- Where volume warrants and regulations allow, replace use of 55-gallon resin drums with
bulk tank system.
- Institute production planning that eliminates inventories on-site and reduces the potential
for outdated inventory and spills.
- Use deposit drums. The supplier will take back the drums (be sure to completely empty
the drums to avoid any residue cleaning charges).
- Ensure that raw material containers are thoroughly emptied.
- Fabricate or purchase raw material container residual removal tools.
- Repair or fix any leaking water faucets or valves that could generate wastewater.

**Filtering Wastes P2 Checklist**

- Improve pigment dispersion.
- Wash and reuse filters and straining bags.
- Replace bag-type filters with stainless steel mesh filters to eliminate the disposal of
spent filters.
Cleaning Wastes P2 Checklist

- Streamline piping to eliminate long runs, and varying sized piping, elbows, and valves that cannot be pigged or cleaned.
- Note on the batch ticket which solvent is used for cleanup, so the solvent can be used in future batches.
- Limit the amount of solvent used for cleaning.
- Use mechanical wipers on mix tanks.
- Use high-pressure, low-volume wash systems.
- Install Teflon liners on mix tanks.
- Use foam/plastic pigs to clean lines.
- Reuse equipment cleaning wastes.
- Schedule production to minimize need for cleaning.
- Clean equipment immediately.
- Use counter-current rinse methods.
- Use alternative cleaning agents.
- Increase spent rinse settling time.
- Use de-emulsifiers on spent rinses.
- Recycle wash solvent whenever possible.
- Use the recycled wash solvent in the production of solvent-based paint batches.
- Use, if feasible, un-recyclable wash solvent as supplemental fuel in cement kilns.
- Schedule batches of like colors consecutively through same process equipment.
- Segregate or dedicate process equipment to certain colors.
- Let wash water settle, and use the supernate as tank washing liquid.
- Consider dedicated lines where feasible to reduce flushing.
- Require contract carriers to provide clean, dry trailers to eliminate need for flushing.
- Set up holding tanks for recovered wash water and wash solvent, segregated by color and/or product line, to facilitate recycling.
- Use the water wash from the grinding mill as part of the batch formula.
- Use hot caustic solution instead of solvents for cleaning solvent paint tubs and tanks.
- Eliminate equipment that is hard to clean or that generates large amounts of cleanup waste.
- Redesign stand tanks to minimize clinging.
- Make use of natural gravity flow in transfer lines where possible.
- Utilize an industrial shop towel recycling program.
- Clean with “like” solvents (i.e., water for water, solvent for solvent).
- Use nitrogen or other gas to purge solvent-based vents and piping to recover product.
- Hold out part of the letdown solvent after each batch is completed. As soon as the batch is completed, the letdown portion is used to clean the tank and mill. This material can then be pumped through the equipment and used as part of the batch.
Install an enclosed hot caustic cleaning system. This system heats a caustic/water solution in an enclosed holding tank to a temperature of 180°F.

Implement a waste tracking system that tracks disposal and raw material cost of waste back to its exact point of origin.

Wring out or launder solvent rags.

Use cleanup solvent in the next compatible batch by removing that solvent from the upcoming batch.

Implement a caustic-solution wash-water storage and reuse program rather than using the caustic solution one time for cleaning.

Change formulations so that they are lead and chromate-free.

**Emission Reduction P2 Checklist**

- Install vents on process tanks that operate only when the tank lid is open.
- Install duct work on top of process tanks to passively capture emissions as opposed to collecting vapors directly from the tank headspace.
- Install conservation vents on process tanks.
- Institute a facility goal to get below the EPA major source threshold.
- Cover tanks.
- Use pigment pastes.
- Install a dedicated baghouse system.
- Equip bulk storage tanks with vapor return lines (vapor recovery).
- Consider the use of nitrogen blankets to reduce the release of vapors in thin-down tanks.
- Install timers on thin-down tank agitators so that they only run when necessary.
- Install storage tank supply lines below the normal liquid level so that all solvent fills are submerged.
- Utilize completely enclosed filters to reduce VOC emissions.

**Spill Waste P2 Checklist**

- Replace dry absorbents cleanup methods with water-based cleanup methods to eliminate solid waste generation.
- Vacuum spills for reuse.
- Recycle spill material back into process.
- Implement better operating practices.
- Use appropriate cleanup methods.
- Place drip containers under all piping connections that have potential to drip and add back into batches from which they were collected.
- Do not install floor drains in new plants; remove floor drains in existing plants.

**Waste Solvent P2 Checklist**

- Recycle wash solvent.
- Reuse wash solvent in next batch (at the grind stage).
The Case Studies

- Install a solvent distillation unit.
- Contract with contractor to come on-site to distill solvents.
- Schedule compatible solvents in sequence to reduce truck loading and drum flushing needs.
- Increase drum inventories of high-volume products to reduce changing of products in the drumming line.
- Segregate line and pump flushings to produce low-grade thinners suitable for cleaning purposes, or hydrocarbon blends suitable for cement kiln fuel.
- Use solvent used to rinse mills or grinding tubs as part of the batch formula.
- Allow waste solvent to settle, and use supernate as primary wash for equipment clean-out.
- If solvent cannot be reused, send to a cement kiln for fuel use.

Paint Sludge P2 Checklist

- Use solvent still-bottoms in the manufacture of industrial primers.
- Keep oil-based and waterborne paints segregated to keep nonhazardous product from being contaminated with hazardous product.
- Consider shipping sludges in bulk (i.e., via a vacuum truck) to eliminate disposing of drums and to reduce the cost for disposal.
- Investigate possible uses of wastewater treatment sludge in other products (e.g., cement, asphalt).

Packaging P2 Checklist

- Reuse 4- and 6-gallon cardboard shipping cartons.
- Reuse plastic pails.
- Recycle cardboard.
- Recycle metal containers (drums and cans), metal bands, used balls from mills.
- Recycle waste paper, including obsolete labels and draw-down cards, or use for covering QC benches, or setting adjustments on spray guns.
- Use shredded paper for packing material.
- Recycle drums through drum re-conditioners.
- Recycle fiber drums.
- Allow drums to drain completely before sending off-site.
- Use slightly dented or damaged cans for the collection of samples. Recycle badly dented cans or return to supplier.
- Switch from paper labels to lithograph cans on high-volume items.
- Recycle plastic wrap.
- Repair and reuse pallets instead of buying new pallets.

Employee Participation P2 Checklist

- Provide an incentive bonus program - each employee becomes an active part of the waste reduction program.
- Implement an employee suggestion program.
Enlist employee support for waste minimization/pollution prevention efforts.
Train all employees in the proper methods of filling out batch tickets.
Train employees on how to properly remove residual raw materials from containers.

Management Practices P2 Checklist
- Increase preventive maintenance to reduce waste.
- Include waste minimization, good housekeeping, and safety practices in employees’ performance evaluations.
- Use computerized metering systems and flow meters to allow for more exact measurements in formulation, thereby reducing waste.
- Review and update operating and quality control procedures to prevent bad blends.
- Document mistakes and review to prevent recurrence.
- Evaluate each product line as to the amount of waste generated per gallon of production of that line and the cost of disposal of that waste. Does the manufacturing cost for a particular product line or product reflect the cost of the disposal of this waste generated during its manufacture?

Quality Control P2 Checklist
- Send used aluminum and steel paint test panels to metal recycler.
- Use washable or reusable metal or plastic containers for sampling intermediates and finished products.
- Reuse samples of raw materials and finished goods.
- Collect laboratory sink drainage for incorporation into batches.
ATTACHMENT 1. Preparing an Action Plan Using the Systems Approach Tools

**Rank Ordering – Cause-Effect Diagram**

[ Mixing/Grind/Dispersion – Work Steps 2.1 and 2.2 ]

<table>
<thead>
<tr>
<th>People</th>
<th>Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operators</td>
<td>• Adding ingredients</td>
</tr>
<tr>
<td>Maintenance</td>
<td>• Add Water</td>
</tr>
<tr>
<td>Monitoring People</td>
<td>• Time of Mix</td>
</tr>
<tr>
<td>Quality Control</td>
<td>• Quality of Mix</td>
</tr>
<tr>
<td>Supervisor</td>
<td>• Time of Mill</td>
</tr>
<tr>
<td></td>
<td>• Quality of Mill</td>
</tr>
<tr>
<td></td>
<td>• PM of Mixing</td>
</tr>
<tr>
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<td>• PM of Milling</td>
</tr>
<tr>
<td></td>
<td>• Calibration of Temperature Monitor</td>
</tr>
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<td>Operators (Methods)</td>
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<th>Materials</th>
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<tbody>
<tr>
<td>Water</td>
<td>• Glass beads</td>
</tr>
<tr>
<td>All other liquids ingredients</td>
<td>• Mixing tank</td>
</tr>
<tr>
<td>Titanium Dioxide</td>
<td>• Mixing stirrer and motor</td>
</tr>
<tr>
<td>All other solid ingredients</td>
<td>• Mill (structure)</td>
</tr>
<tr>
<td>Glass bead</td>
<td>• Mill motor</td>
</tr>
<tr>
<td>Extenders</td>
<td>• Pipes</td>
</tr>
<tr>
<td></td>
<td>• Pumps</td>
</tr>
<tr>
<td></td>
<td>• Temperature Monitor</td>
</tr>
</tbody>
</table>
In work step 2.1 and 2.2 we are using too much energy (electricity); costs too much money.

- **Glass beads**
  - May not be optimal for mixing
- **Mix Motors**
  - May not be optimal (variability)
- **Mill Motor**
  - May not be appropriate
- **Mixing Stirrer & Motor**
  - Temperature motor may not be optimal for milling
  - Diameter may not be optimal for viscosity of paint
- **Glass beads**
  - Does not adsorb energy as much as metal
  - Requires energy to hydrate with water
- **Titanium Dioxide and All other liquid ingredients**
  - Requires energy to dispense non-solubles
  - Thick and difficult to disperse
- **Mill (structure)**
  - May not be appropriate
  - May not be optimal
- **Mix Motors**
  - May not be optimal for milling
- **Mixing Tanks**
  - May not be appropriate (variability)
- **Shape or symmetry**
  - May not be optimal for mixing
- **Order for energy use**
  - May not be often enough
- **Time for production or energy**
  - Time
- **Methods**
  - Timing of Milling and Mixing
  - Add water
  - Add ingredients
  - Calibration
  - Quality Mill and Mix Supervisor
  - Not sufficiently aware
  - May not report observation
  - May not take proper sample

- **People**
  - Operators
  - Monitoring People
  - Maintenance
  - Quality Control
  - Lack of funding for PM
  - May not have SPC
  - May not report observation
  - May not take proper sample

- **Materials**
  - Thick and difficult to disperse
  - Extenders
  - Requires energy to wet solids and disperse
  - Water
  - Requires energy to disperse non-solubles
  - All other liquid ingredients
  - Requires energy to hydrate with water
  - Titanium Dioxide and All other liquid ingredients

- **Machines**
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**Brainwriting (Generating Solutions)**

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<th>“Red Flag” communication mechanism between/linking QC people, maintenance, and operators.</th>
</tr>
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<tr>
<td>Make sure ingredients are not clumped or caked (requiring additional energy to break-up/mix).</td>
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<tr>
<td>Size pipes so pumps don’t need to work so hard (determine ideal/most energy-efficient size).</td>
</tr>
<tr>
<td>Make supervisor responsible for reducing energy use (performance review).</td>
</tr>
<tr>
<td>Use a sensor to determine when the product is ready (eliminate lab analysis step).</td>
</tr>
<tr>
<td>Precisely follow the procedure for adding ingredients to tank.</td>
</tr>
<tr>
<td>Provide incentive to equipment vendor to design way to lower energy use (of their equipment).</td>
</tr>
<tr>
<td>Review operational methods with vendors to make sure they are the most energy-efficient.</td>
</tr>
<tr>
<td>Change out motors to more/most energy-efficient models.</td>
</tr>
<tr>
<td>Source of electricity/energy should be changed to solar battery.</td>
</tr>
<tr>
<td>Analyze pumps to make sure they are energy-efficient, and if not, optimize or replace as necessary.</td>
</tr>
<tr>
<td>Look to development of variable-frequency pumps and see if they are more energy-efficient.</td>
</tr>
<tr>
<td>Optimize tank shape and size.</td>
</tr>
<tr>
<td>Optimize stirrer geometry.</td>
</tr>
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<td>Determine reasoning behind order of adding ingredients if adding in different order, or combining some, if possible, can save energy in grinding/mix/mill stages.</td>
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<td>Take Quality Samples more frequently to shorten mix time to reduce energy use.</td>
</tr>
<tr>
<td>Provide training to operators on ways to reduce energy use.</td>
</tr>
<tr>
<td>Hire energy conservation consultants to provide ideas for reducing energy consumption.</td>
</tr>
<tr>
<td>Recirculate the mixture toward the blades to supply the mixer with fresh material to increase efficiency.</td>
</tr>
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<tr>
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</tr>
<tr>
<td>Eliminate the mixing tank itself: Perform mixing and dispersion in the same tank.</td>
</tr>
<tr>
<td>Add water with pressure spray to lower the amount of mixing energy that is needed.</td>
</tr>
<tr>
<td>Pre-wet the solids so that the mixing energy required is lower.</td>
</tr>
<tr>
<td>Have vendor provide pre-mixed ingredients.</td>
</tr>
<tr>
<td>Use ultrasonic energy to assist the mixing and lower energy use.</td>
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**Brainwriting (Generating Solutions) cont.**

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</tr>
<tr>
<td>Replace grind process with freeze dry process (more-efficient ingredient break-down).</td>
</tr>
<tr>
<td>Constantly monitor energy use by individual machine, and post usage charts on wall.</td>
</tr>
<tr>
<td>Provide pay incentives to workers to find successful energy-reduction techniques.</td>
</tr>
<tr>
<td>Replace glass beads with a mixer machine (research energy-efficiency comparison).</td>
</tr>
<tr>
<td>Make management aware of relationship between PM and energy-efficiency.</td>
</tr>
<tr>
<td>Can extender be warmed (or use ultrasonic) such that it has a greater degree of fluidity (to reduce energy use in mixing stage)?</td>
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</table>
The Case Studies

**Bubble-Up/Bubble-Down (Selecting Solutions)**

**Rules!! :**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td><strong>COST</strong></td>
<td>Lower Cost is Best</td>
</tr>
<tr>
<td><strong>ABILITY TO DO</strong></td>
<td>Cost is Best</td>
</tr>
<tr>
<td><strong>EFFECTIVENESS</strong></td>
<td>More energy conserved is Best</td>
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Precisely follow the procedure for adding ingredients to tank.  
(Done quickly with ability to follow with #2)  
Make sure ingredients are not clumped or caked (requiring additional energy to break-up/mix)

Review operational methods with vendors to make sure they are the most energy-efficient.  
Pre-wet the solids so that the mixing energy required is lower.  
Determine reasoning behind order of adding ingredients if adding in different order, or combining some, if possible, can save energy in grinding/mix/mill stages.

Make management aware of relationship between PM and energy-efficiency.  
Make supervisor responsible for reducing energy use (performance review).  
Provide training to operators on ways to reduce energy use.  
Constantly monitor energy use by individual machine, and post usage charts on wall.  
Provide pay incentives to workers to find successful energy-reduction techniques.

PM on milling or mixing should be altered/adjusted according to energy-efficient needs.  
Hire energy conservation consultants to provide ideas for reducing energy consumption.  
Size pipes so pumps don’t need to work so hard (determine ideal/most energy-efficient size).

Use a sensor to determine when the product is ready (eliminate lab analysis step).  
Take Quality Samples more frequently to shorten mix time to reduce energy use.  
Change out motors to more/most energy-efficient models.  
Analyze pumps to make sure they are energy-efficient, and if not, optimize or replace as necessary.  
Look to development of variable-frequency pumps and see if they are more energy-efficient.  
Optimize tank shape and size.  
Optimize stirrer geometry.

Provide incentive to equipment vendor to design way to lower energy use (of their equipment).  
Eliminate the mixing tank itself: Perform mixing and dispersion in the same tank.  
(Performance contracting – we pay if total cost is lower)

Can extender be warmed (or use ultrasonic) so that it has a greater degree of fluidity (to reduce energy use in mixing stage)?

Recirculate the mixture toward the blades to supply the mixer with fresh material to increase efficiency.
**Bubble-Up/Bubble-Down (Selecting Solutions) cont.**

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1. **Lower the energy used in Work Steps 2.1 and 2.2.**

   **Purpose:** To find ways of conserving energy in the two most energy-intensive operations of the paint manufacturing.

   **Project:** Seek short-term energy use conservation by examining the form and order of addition of the paint ingredients and longer-term improvements by seeking changes in the equipment.

   **Benefits:** Lower the cost and environmental impact of energy use and reduce cycle time of the dispersion step.

<table>
<thead>
<tr>
<th>WORK TASKS</th>
<th>PERSON/TEAM RESPONSIBLE</th>
<th>COMPLETION DATE</th>
<th>PERFORMANCE GOAL</th>
<th>RESOURCES REQUIRED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Perform a baseline survey of energy use for work steps 2.1 and 2.2 and determine the cost of that energy.</td>
<td>Team</td>
<td>+1 month</td>
<td>Provide a reputable baseline survey for helping to determine final results at the end of the project.</td>
<td>Purchase energy metering equipment Time</td>
</tr>
<tr>
<td>2. Work with plant chemist to ensure that the form and adding sequence of ingredients are optimal.</td>
<td>Team Leader Chemist</td>
<td>+3 months</td>
<td>Ensure form and sequence that are used are optimal in terms of energy use.</td>
<td>Access to chemical suppliers and literature Lab testing Time</td>
</tr>
<tr>
<td>3. Plant chemist will work closely with chemical supplier and equipment vendors to make further improvement to optimize form and adding sequence.</td>
<td>Team Leader Chemist Vendors</td>
<td>+6 months</td>
<td>Ensure continuous improvement from energy use reduction via form and adding sequence of ingredients.</td>
<td>Time Some equipment</td>
</tr>
</tbody>
</table>
## WORK TASKS

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| **4.** Talk/interview vendors and consultants to determine change management and communication programs that will further the continuous improvement.  
  a. Make management aware of relationship between preventative maintenance and energy efficiency.  
  b. Make supervisor responsible for reducing energy and link the responsibility to that person’s performance review.  
  c. Provide training to operators on ways to reduce energy use.  
  d. Constantly monitor the use by individual machines and post energy use charts on the wall.  
  e. Provide pay incentives to workers to find successful energy reduction techniques.  
  f. Develop a means of communicating between QC people, maintenance, and operations. | *Entire Team* | +9 months | Make sure that a viable program of continuous improvement (kaizen) is in place to keep reducing energy use in the long term. |
| **5.** Perform baseline survey at the end of the project and calculate the savings in energy and the cost savings of the project. | *Entire Team* | +11 months | Ensure that the results of the efforts for the first year are recorded. |

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