ATTACHMENT 2

HIERARCHICAL PROCESS MAPPING

1. Select a Process

- The first step is to Select a Process (see Attachment 1 for a checklist) in the facility. The process results in a product or service that supports the mission of the organization.
  - The initial process improvement efforts should focus on a process that involves the manufacture of a part or a product or offers a service that uses and loses resources.
  - Try to find information on the “inputs and outputs” of the process. If the company has a materials resources planning (MRP) system, it might have this information. Purchasing is another source for this information. If applicable, review the information that the facility used to search for “aspects” in its ISO 14001 program or “risks” in its OHSAS 18001 program.
  - The process selected should include sustainable development issues that you wish to address. Remember by changing the process, you might be able to conserve resources or eliminate the loss of resources.

- You should not focus only on the main process, but you should also consider all “supporting processes” associated with that process.
  - For example, if the use of water is a concern because of local water use restrictions, you should not focus, for example, just on the parts washers. You should also evaluate the process of producing a part as it goes through the various steps including the parts washer. The answer to using less water may lie in a work step “up-stream” of the parts washer; e.g., how did the part get dirty and require this cleaning.

- Another way to select a process is to look at the volume of waste that it creates when compared to other processes at the facility or the amount of health and safety risk that it poses. Maybe it is a process that has already been selected for improvements in the company’s process improvement programs (e.g., Lean or Six Sigma).

Note:

There is no single way to select the first or best process to focus on. However, you will need to select a process to have a starting point for preparing the hierarchical process map. Refer to the checklist under the Select a Process in the attachments.
2. Prepare the Preliminary Hierarchical Process Map

Notes: You will have to develop some skill to become proficient at hierarchical process mapping. Under normal conditions the above effort can take 1 month from the time the process is selected until all items are completed.

- A sustainable development oversight committee should be formed to provide the resources and provide the management oversight for this important effort. See the Oversight Committee (Attachment 2). The oversight committee should authorize someone to initiate the process mapping activity. This person should meet with the operations staff and obtain a process flow diagram or process flow chart for the selected process.
  - Typically a facility process flow chart is several pages long.
  - Value stream maps may be available from the lean program.

- Using the basic rules of hierarchical process mapping (see Attachment 3) develop a preliminary process map (see Attachment 4) from this information.
  - Have the people who maintain the facility process flow charts or value stream maps review the information with you to make sure it is correct.
  - Next, you should identify each process work step at the lowest level using the process mapping instructions.

- Prepare a resource accounting sheet (see Attachment 5) and resource accounting sheet template (see Attachment 6) for each of these work steps. Complete each accounting sheet at the lowest level in the hierarchical process map (i.e., highest level of detail). Make sure you capture all the resources that are used in the work step and all of the resources that are lost in that work step.
  - List all of the supporting processes (see Attachment 7) that are required in order to make that work step operate.
  - Be very careful with the nomenclature of work steps, supporting processes and resources. Use the same terms that the workers use or as listed on the flow charts.
  - Create a glossary (see Attachment 8) to make sure that you are always using the correct term and that you are not using different terms in different places.

- Preparing these hierarchical process maps should be a repetitive process using the rules of process mapping. The initial process maps should be reviewed with the production staff.

- Once the process maps have been completed, move on to complete the preliminary resources accounting sheets.
Also, link all of the work steps to the supporting processes that support the work found in the work steps.

- It is important for the oversight committee to make sure that the hierarchical process mapping effort is consistent with the manner in which the ISO 14001 aspects and the OHSAS 18001 risks were selected (if applicable).

### 3. Verify the Preliminary Hierarchical Process Map

- Once this preliminary information has been completed, it must be verified by visiting the process area with the process maps in hand. Refer to the [verification checklist](#) (see Attachment 9).

- Two questions should be asked at each work step in the process:
  - What improvements have been made to this work step in the past 2 years that have led to conservation of resources or the reduction of losses (waste)?
  - If there were no rules and money was not an object, what further improvements would you initiate on the process to improve or increase its efficiency and effectiveness?

- It is also important that all of the supporting processes that are linked to the work step be identified.
  - The supporting processes also need standard and consistent names.
  - Allocate the resources used and lost by the supporting processes to the work step in the main process in proportion to its use or loss.

- Upon verification of the process map, a revised set of hierarchical process maps and their resource accounting sheets should be completed, verified by the workers, and agreed to by the supervisors of those work areas.

**Notes:**
- In some cases, this will be the workers’ first exposure to the Systems Approach. Therefore, it is important that they be provided with an opportunity to help modify the hierarchical process maps and add to the uses and losses of resources on the resource accounting sheets.
- All the uses and losses of resources should have standard names.
- Typically, the process verification activities can be conducted by using a facilitator trained in the Systems Approach in a period of approximately three days to one week.
1. **Select a Process – Checklist**

- Make a list of all the manufacturing and supporting processes responsible for each of the EHS compliance issues. This listing may already exist as part of your facility’s EHS management program if one exists.
- Make a list of all of the pollution control processes (e.g., air pollution control, dust control, oil/water separators, wastewater treatment/pretreatment, hazardous waste storage).
- Make a list of all of the safety controls (e.g., process guards, safety showers, first-aid stations). These will all be supporting processes in the process characterization.
- Make a list of departments that are responsible for the preparation of parts for products assembled at the facility. Processes are usually sorted by department at the facility level.

Next, using this list of processes, consider each of the following items:

- Does quality or operations use value stream maps, work flow diagrams, or work descriptions to describe work processes?
- Has facility management targeted any processes for improvement in the next year?
- Is facility management expecting to add new processes or expand existing processes in the coming year?
- Is facility management expecting to curtail or reduce the use of any existing processes during the coming year?
- Which processes, if any, are presently being examined by company process improvement efforts?
- Which processes use the most expensive and largest quantities of material and other supplies?
- Which processes generate the most solid and hazardous waste or are more highly regulated from an environmental perspective?
- Which processes have the greatest number of rejects?
- Which processes have the greatest health and safety issues?

Now, select a process to work with that has sustainable development issues and a product, family of products or service associated with it.

2. **Oversight Committee**

It is important to have top management support and direct the sustainable development effort. The EHS coordinator (sometimes the responsibility is split between an environmental coordinator and a health and safety coordinator) should meet with the top management of the facility and explain what is involved in this process characterization effort. It is best to select a management committee that already exists. Often the facility manager has an operations committee that meets on a regular basis. This committee would have many of the senior managers on it including people from accounting, purchasing, quality, maintenance management, operations, and human resources. This committee would be asked to dedicate only four (4) of their meetings per year to the management oversight of this sustainable development effort.
The major requirement of the committee is to review the resources that are requested by the employee teams and find some way to provide the level of support that they deem adequate to complete the work. They will also review the cost and benefit of each improvement project during the year.

3. Hierarchical Process Mapping

Once a candidate process has been selected, a small team should be assembled to prepare a hierarchical process map. The process mapping activity should be facilitated by someone who has training in the use of the hierarchical process mapping technique and experience using this tool. Ideally the team should consist of the following people:

- An operator or supervisor involved in the process.
- An employee involved in the EHS activities.
- A maintenance person familiar with the process.
- An employee from operations management or quality
- An employee who is not familiar with the process.

A copy of the value stream maps, process flow charts and/or work instructions for the process are obtained and reviewed by the team. It is important that the processes be defined as the work steps (i.e. the work performed by the operator as described in the work instructions) for the production process or service using and losing resources. Processes should not be limited to unit operations (e.g., five stage washer) that are used in the processes as described here.

The team should take the “perspective” of the actual product being manufactured or the service that is being provided. They should follow the product or service through its journey from start to finish. Using the available information, the team should next create a complete set of work steps necessary to describe the full process. Only work steps directly experienced by the product or service should be included.

- For example, a product never “sees” the air compressor, wastewater treatment system and other supporting processes. We will be accounting for these “supporting processes” later.

This listing of work steps in the MAIN PROCESS needs to be expressed in 3 to 6 work steps. If there are only 2 work steps, the team needs to consider whether it has defined the process correctly (Is it really a unit operation in a process or is it a “supporting process?”). Often time-dependent activities take place within a unit process (e.g., a five stage washer) that adds additional work steps (i.e., not simply “wash the part” in the case of the five stage washer).

- If there are more than 6 work steps, the team needs to determine how to express this process in three to six work steps. These steps will constitute what is called the “top level” (i.e., least detailed) of the hierarchical process map.
- If there were more than six steps in the first step, the extra steps will provide more detail at the second level of the hierarchical process map. Make sure that each of the work steps is expressed as a “verb phrase.” This phrase needs to be familiar to the operators of the process. Each work step will be placed in a box and will have a single numeric number under the verb phrase (e.g., 1, 2, 3, 4, etc.).

As the process mapping team looks at the top level map, it should ask the question, “Can we describe what is happening in this work step in three to six sub-work (more detailed) steps?

- If the answer is yes, these work steps are mapped as the second level and numbered with two numbers as in an outline (e.g., 1.1, 1.2, 1.3, etc).
- If there are only two work steps at the second level, the team can either express the two steps as one step at the top level or try to see if there is something they have missed that would provide a third sub-work step and the opportunity to detail the second level.
- Once again, if there are more than six sub-work steps at the second level, the team will have to express the work in three to six work steps and provide additional detail at the third level of the process map.

This procedure is repeated at the second level to see if there are any third level sub-work steps. The mapping teams should be careful never to go below the fourth level. In most cases, going below the third level is more detail than is necessary to explain the work.

Upper managers are typically concerned with the top level of the diagram. Supervisors are most concerned with the second level. In many cases, the workers need to know what is happening at the second or third level of the hierarchical process map.

4. Preliminary Process Map Checklist

☐ Select a process using the checklist in Attachment 1.
☐ Obtain the value stream maps, work flow diagrams, and work instructions for that process.
☐ Assemble a process mapping team using the guidance provided in Attachment 3.
☐ Prepare a top-level process map for the MAIN PROCESS after selecting a “perspective” and making a complete list of all the work steps that occur using the perspective selected.

Note: Make sure that the steps are named with a verb phrase familiar to the workers and that each work step is numbered in order with a single number from 1 to 6.
☐ Prepare the second- and third-level process maps as directed in Attachment 3.
☐ Review these preliminary draft process maps with people familiar with the operations after double-checking them against the process documentation. Make corrections as necessary.
☐ The preliminary process map is now ready for verification.
☐ Collect a preliminary listing of processes that are required to support the MAIN PROCESS from the original list in Attachment 1.
☐ Create a glossary in alphabetical order of all the “verb phrases” used in the process map. Be certain that the phrases are not used multiple times for different work steps.
5. Resource Accounting Sheets Checklist

- Determine the work steps in the MAIN PROCESS that are at the “lowest levels” (i.e., more detailed).
- If there is a 1.1, 1.2, 1.3, etc., you eliminate 1 from consideration because the former are at a lower level. If there are 1.2.1, 1.2.2, 1.2.3, etc., you eliminate 1.2 from consideration since there is a lower level.
- Prepare a resource accounting (RA) sheet for each work step at the lowest level (see the template).
- The top portion of the RA sheet is used to describe the work being performed in that step. This description can come from the process documentation or the work instructions.
- The center portion of the RA sheet provides a 360-degree look at the work step. Be sure to use the same verb phrases in the featured work step (center box) and the work step that occurs before and after the featured work step.
- All the resources used in the work step are placed above the center box.
- All of the resources lost in the work step (i.e., wastes, discharges, emissions, noise, odors, spills/leaks, accidental losses) are placed below the center box.
- Each resource used and lost should have a unique name that is familiar to the workers. A glossary should be kept for each of these categories.
- The bottom portion of the RA sheet provides a listing of all the supporting processes that are necessary in order for the featured work step to be properly used. Each of the supporting processes should have a unique name and these names should be kept in a separate glossary.
- Allow people familiar with the work step to review the information and look for major omissions. Make any changes necessary in these work sheets.

6. Resource Accounting Sheet Template

RESOURCE ACCOUNTING SHEET

Description of the Work Step

Describe the activity in the work step.
7. Supporting Processes List

- Create an alphabetical listing of the supporting processes from the RA Sheets and your initial listing of pollution and safety controls. Be sure that similar processes are arranged in a hierarchical manner (e.g., air pollution control – dust filter; air pollution control – fume hood; air pollution control – wet scrubber; etc.).

- Check to see that all supporting processes that were used to bring the resources to the work step are included. This would include receiving, storage, transportation within the facility, mixing, cleaning the use storage vessels, air compressors, providing steam, deionized water systems, etc.

- Check to see that all the supporting processes that were used to collect and manage the losses (wastes) are included. This would include pollution control equipment, cleaning, handling reject parts, waste handling systems, recycling, contractor and vendor services, etc.

- All parts provided by suppliers should be considered to be supporting processes.

- Note: There can also be processes that support the supporting processes.
- For example, cutting swath is collected at the machining operation. In another location, the swath is centrifuged or pressed to remove excess cutting fluids before the swath is sent to a metal recycling company. The collection of the cutting swath is a supporting process. The removal of the cutting fluids supports the collection process.

- The handling and disposition of the cutting fluids and the swath support the removal process. Once again these can be arranged in hierarchical fashion. Supporting processes can be numbered with a letter: A1, A2, A3, etc. The second level supporting processes could be AA1, AA2, AA3, etc. The third level supporting processes could be AAA1, AAA2, AAA3, etc.

**Note:** Typically only 20% of the total number of supporting processes (at all levels) account for about 80% of the resources consumed by the supporting processes and the losses (wastes) generated by the supporting processes. This is referred to as “rank ordering.” If some of these noteworthy supporting processes are to be included in the selection of opportunities for sustainable development, hierarchical process maps should be prepared using the numbering sequence described above.

### 8. Glossary Checklist

- The use of a glossary helps the process mapping team ensure that consistent and familiar terms are used throughout the documentation of the processes. Multiple names for the same term are avoided when a glossary is prepared.

- Four glossaries are necessary to sort through the information collected in the process mapping and RA sheets:
  - Process work step names – verb phrases
  - Resources Used
  - Resources Lost (wastes)
  - Supporting Processes

- Once the hierarchical process map is computerized, there will be links that can be used to see what other work steps have the same resources used or lost. Whenever there has been a success involving the conservation of a resource use or the minimization of a waste, the resource can be tracked to every other work step with this resource to see if the success can be used at that point.

### 9. Verification Checklist

At this point the process mapping team has completed and checked each of the following items:

- Hierarchical Process Map of the MAIN Process
- RA Sheets for each of the work steps at the lowest level in the process map
- An alphabetical listing of the supporting processes
- A draft glossary.
The process mapping team will then visit each work step of the process and make certain that the information that has been gathered is complete and understandable to the operator.

The team should ask the operator about improvements that have been made at their work step that have led to EHS improvements during the past 2 years. This information will be recorded and documented as an Appendix in the EHS Process Improvement Program Plan.

The team should ask the operator how they would change the work step if given the opportunity to further improve the EHS aspect of the work. This information will be recorded and documented as the list of opportunities for the Opportunity Selection Process described below in Attachment 10.

When the verification of the MAIN PROCESS has been completed, the process mapping team should visit each of the supporting processes listed on the RA sheets.

They should both confirm that their list is complete and try to get a sense of the percent of the total capacity of the supporting processes viewed that is dedicated to each of the work steps where it is listed on the RA sheet. In other words, they should try to find the 20% of the supporting processes that use 80% of the resources and lose 80% of the waste that the resources use supporting the MAIN PROCESS work steps. This is called rank ordering, or the 80/20 rule.

**Note:** Given the fact that some supporting processes are more important to the main process and contribute to the “significant aspects” or “risks” as defined in ISO 14001 and/or OHSAS 18001 (if applicable) of the main process, the process mapping teams needs to make a decision as to whether they should prepare hierarchical process maps and RA sheets for these important supporting processes. The reasoning behind this decision is to help them prepare a complete listing of the opportunities for waste min that will be used for the Opportunity Selection Process described below in Attachment 10.

- Some facilities choose to attribute the resources used and lost by the supporting processes to the work step in the MAIN PROCESS that is demanding this support. In this manner, the main process is required to be responsible for the EHS process improvement activities in the supporting process. The theory is that is you use less compressed air, it will cost the facility less money to generate the compressed air. You cannot control this at the supporting process.