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Guidelines for Classifying Production Units

Introduction

The Toxics Use Reduction Act (TURA) was established in 1989 to promote environmental protection, worker safety, and public health through reductions in the use of toxic and hazardous substances. This law requires that firms report on toxic use and develop toxic use reduction plans for the individual "production units" (or production processes) employed at their facility.

MassDEP is required to develop regulations for classifying similar production units into "user segments." These guidelines describe how firms should identify production units at their facilities.

Toxics use reduction encompasses a range of techniques such as product reformulation, changes in raw materials, or improved operation and maintenance. These techniques are designed to eliminate/reduce "wastes" before they are produced.

TURA has certain reporting, and in later years, planning requirements designed to help businesses identify toxics use reduction opportunities within their firms. The law's provisions incorporate approaches used by companies that have successfully implemented toxics use reduction.

Typically, these companies began their efforts by taking a close look at individual products and processes used to make the products. With that focus, a firm can identify different or more efficient production methods that eliminate/reduce toxic chemical byproducts or the use of toxic substances, and save money.

TURA incorporates that thinking by establishing the PRODUCTION UNIT (the combination of a product and process) as the arena for achieving reductions and as the basic unit of reporting, planning, and technical programs.

What Is A Production Unit & Why Is It Important?

TURA defines a "production unit" as: "a process, line, method, activity, or technique, or a combination or series thereof, used to produce a product (or family of products)."

A production unit is **not** the process **or** the product. It is the **combination** of the process and the products produced by that process.

PRODUCTION UNIT = PROCESS + PRODUCT

Here are some examples of processes and products designated as production units:

Dry Cleaning Machine #1 used to **Clean Clothing**
Assembly, Primer Coating of **Desks**
Plating Line #2 used to plate **Chrome Fixtures**

TURA requires that firms examine their activities and establish such combinations of processes and products as production unit(s). A production unit - focus helps establish a connection between the chemicals used/the wastes produced and the products/activities involved.

That connection is reinforced by TURA's reporting requirements. In the annual toxics use reports, regulated firms identify the production unit(s) in which a TURA-regulated chemical is manufactured, processed, or otherwise used.

For each production unit, the information to be provided includes calculations of a **byproduct reduction index** and an **emissions reduction index**, which are ratios expressing year-to-year progress in reducing byproducts and emissions per unit of product.

With regard to future planning, TURA calls on regulated firms to establish a process for identifying/evaluating toxics use reduction opportunities for each such unit.

Designating production units is key to other aspects of TURA as well. As the Act directs, MassDEP will issue regulations on grouping production units with similar products and processes into "user segments" -- based on a number of considerations, including a review of the production units identified by firms identify in the first annual toxics use report.

The user segment groupings will then be used to set priorities for technical assistance (provided by the Office to Technical Assistance), and research and demonstration projects (sponsored by the Toxics Use Reduction Institute at the University of Lowell).

While these GUIDELINES focus on designating production units for reporting and planning, it is important to keep in mind the larger role the concept has in TURA.

How Do I Classify My Production Units?

Classifying or, more accurately, designating production units is somewhat like drawing boxes around the activities and products in your firm. You could, for example, draw a box around one machine, link that machine to a product, and call that combination a production unit. You could draw a box around a process line, around a number of process lines, or conceivably around your whole plant.

While your approach must be consistent with TURA, its regulations and policies, firms have flexibility in designating production units. Firms are encouraged, moreover, to classify production units in a way that is most useful for identifying toxics use reduction opportunities and documenting progress in reducing toxic byproducts.

MassDEP has developed a procedure for designating production units. This procedure is not a requirement -- it is presented to be helpful to technical and non-technical staff alike.

While the steps in this process are listed sequentially below, the concepts involved -- and the decisions you will be making -- are actually intertwined.

Step One: Identify the Processes at Your Facility

Step Two: Identify Your Facility's Products

Step Three: Designate Process/Product Combination(s) as a Production Unit(s)

After discussing the steps in this procedure, these **GUIDELINES** will provide examples of how the choices you make in designating **production units** relate to TURA reporting requirements.

Step One: Identify the Processes at Your Facility

The first step in classifying production units is to identify the discrete process steps or activities conducted at your facility, sometimes referred to as "unit operations" or "unit processes."

Then you should identify the unit operations in which a TURA-regulated chemical [Endnote 1] is: (1) manufactured, processed, or otherwise used, or (2) generated as a byproduct or an emission.

TURA allows you to group unit operations together for the purpose of designating production units. Note, however, that: **Generally, every unit operation involving a TURA-regulated chemical must be accounted for in at least one production unit.** [Endnote 2]

It is important here that you be as thorough and methodical as you can, particularly in identifying the unit operations involving TURA-regulated chemicals. The following example illustrates this point.

EXAMPLE:

An airline company built a wastewater treatment plant to handle discharges containing chromium substances. When the plant failed to work as expected, the company further analyzed chromium use. They found that they could have **eliminated the chromium byproduct** by switching from aqueous to abrasive methods of removing paint from airplanes being reconditioned. Had they discovered this sooner, the treatment plant would not have been built.

This example underscores the need to focus on **all** the activities associated with the making of a product (not just the direct manufacturing activities). To identify your processes look broadly to: (a) storage/handling of input materials, (b) processing/use of materials in production, and (c) assemble/packaging of final products.

You should also consider intermittent processes such as equipment maintenance, tank clean-out and solution make-up.

Process flow diagrams are a useful source of information on the unit operations at a firm. Below is a much-simplified diagram showing **some** of the unit operations in paint manufacturing. (A complete diagram would obviously have much more information.)

BLENDING --> FILTRATION --> PACKAGING --> Paint

Your firm may have prepared much more elaborate process flow diagrams to estimate annual toxic chemical releases and off-site transfers for FORM R reporting under EPCRA. If not, such diagrams may have been prepared in the course of:

- Developing management systems (e.g., designating cost centers);
- Planning facility upgrades;

- Responding to other environmental reporting/permitting requirements;

  or

- Conducting toxics use reduction activities.

If process flow diagrams are available, you should make sure that production steps/processes have not changed since the diagrams were prepared. If process flow diagrams are not available, a plant tour and discussions with production personnel will help you identify your firm's processes so you can prepare such diagram(s).

Good process flow diagrams will be useful not only for designating production units but also for future toxics use reduction planning.

The flow diagrams should depict all the unit operations in your facility processes or activities that occur to at least the level of detail that is acceptable for production planning in your industry. You then should focus on identifying those operations "associated" with a TURA-regulated chemical.

To do so, the process flow diagram should be drawn (as is common) to depict the flow of materials (particularly the chemicals regulated by TURA). With a diagram depicting material streams and discussions with technical personnel and production staff, you can identify the specific unit operations which involve a TURA-regulated chemical -- as an input, output or throughput. You should also identify valves and other junctures where fugitive emissions of TURA-regulated chemicals occur.

As stated earlier, TURA allows you to group unit operations for the purpose of designating production units, as long as every operation involving a TURA-regulated chemical is accounted for in at least one such unit.

Many times, final decisions on grouping unit operations may not be made until you begin to designate product/process combinations (STEP THREE in these GUIDELINES). Initially, you may attempt to aggregate unit operations, but you should then ask, "Should a given operation be treated separately?" Sometimes there are very good reasons to do so.

EXAMPLE:

A manufacturer makes and sells painted and unpainted appliances. One TURA-regulated chemical is used in various cleaning steps for both types of appliances but the painted ones undergo an additional cleaning step involving another chemical.

The manufacturer could group the steps common to all appliances into a single process. The cleaning step for painted appliances might be treated as a separate production unit. This approach depicts the product mix and usage of chemicals at the facility more accurately than grouping all the steps for all the appliances together would.

Generally, parallel process lines MAY be grouped together unless they involve different technologies, chemical usage, or they produce different products. If significant differences exist, they should be treated separately. Again, final decisions on aggregating or disaggregating unit operations will probably be made at STEP THREE, after you have identified the products produced by your firm as described below.

Step Two: Identify Your Products

Under TURA, a "product" is:
"a product, a family of products, an intermediate product, a family of intermediate products, or a desired result or a family of results."

In some ways, the TURA definition of product is broader than the common understanding of the term. Intermediate products are considered "products" under the statute, as are certain "results." Also, the definition of "intermediate product" may encompass "outputs" other than those considered as such in your industry.

Asking the following questions will help you identify and classify your firm's PRODUCTS for TURA reporting and planning.

QUESTION 1: What products or intermediate products did the firm produce during the reporting year?

QUESTION 2: Can/should these products be treated as separate products or grouped into families?

What products or intermediate products did the firm produce during the reporting year?

As a first step in determining what products your firm produced, you should assume -- at least initially -- that any product or intermediate product that is identified as such in your accounting, inventory or manufacturing information systems is a product.

After you identify products (and intermediate products) from existing information sources, you should consider whether does your firm produces any <u>other items</u> that might meet the broad TURA definition of "product."

Consider whether there are any "outputs," not commonly considered intermediate products that might be classified as intermediate products. Note that under TURA, a chemical substance or other product can be considered an intermediate product if it is:

Produced to be used intentionally in the manufacture of another product OR

Taken out of the production process and transferred off-site, to another production unit, to storage, or through a finishing process.

Common examples of intermediate products include: (1) a chemical (phenol) that is sold as a product and used to produce another chemical product (aniline), or (2) unpainted appliances shipped off-site by a manufacturer that makes and sells painted and unpainted appliances.

Phenol and the unpainted appliance would probably be considered intermediate products within their respective industries. The following example illustrates a case where something that is not usually viewed as an intermediate product might be treated as such.

EXAMPLE:

An electronics component manufacturer produces deionized water that is used (for cleaning) in the production of printer circuit boards. Under the TURA definition, the manufacturer could call deionized water an intermediate product. In that case, the unit operations associated with the production of deionized water could be grouped together, linked with that "product" and called one PRODUCTION UNIT.

Similarly, there are some results that a firm might usefully consider to be products. In the non-manufacturing sector, a result might include a service or something less concrete like the production of electricity. Even in manufacturing, there may be certain results that could be treated as products.

The option of treating results as products is something to keep in mind. At this point in your analysis, however, your major effort should be identifying the products and intermediate products produced by your firm. Having done so, the next question is:

Can/should these products be treated as separate products or grouped into families?

If your firm produces one, truly homogeneous product, this question is not an issue. Many firms, however, have different, varying products and product lines.

Under TURA, similar products may be classified into a "family of products," so that the process used to produce them can be considered one production unit.

To determine if products can be grouped or should be treated separately, you need to have a sense of how similar (or different) they are. Are the same (or different) processes used to produce the products? Are the products similar (or different) in terms of the usage of a TURA-regulated chemical(s) or in the production of regulated chemical(s) as byproducts or emissions?

Often, judgment is called for in deciding whether to group products into families or treat them separately. Some simple principles that might be useful are set forth below, with examples. (While the examples refer to similarities or differences in chemical usage, it is equally important to consider the processes used to create products, and the byproducts/emissions generated by those processes.)

You can group products into families if there are no significant differences in the technologies used to produce them, the usage of chemicals, or the creation of byproducts/emissions.

EXAMPLE:

A battery maker produces lead acid batteries of the same size/shape, using the same production processes and involving the usage of the same amounts of lead compounds, a TURA-regulated chemical.

The various batteries have certain internal elements made of differing materials, such as silicon, clay or paper -- none of which are listed chemicals.

Although sales records list and price the batteries as different "products,", the manufacture could group them into a family for TURA purposes.

You may group products into families if you are assured any differences are minor or statistically insignificant.

EXAMPLE:

A firm mass-produces 500,000 transformers a year. While these products are uniform in every way, the firm also makes 50 special order transformers. The special orders involve usage of a listed chemical that varies considerably from that of the mass produced items.

This firm has a decision to make. The firm might decide to group all the transformers into a family of products, especially if the special orders are expected to remain a constant, and statistically insignificant, part of its business.

You should treat products as separate production if significant differences exist.

EXAMPLE:

A firm produces two types of microfilm on one process line. The steps in the process are the same for each type of microfilm *except* that in one of the process steps a TURA-regulated chemical is used to produce one and not the other. The two types of microfilm should be treated as separate products and not grouped into families

While these three principles may not cover every situation, you should use them to guide your thinking on how your final products should be treated. Once you have identified the products produced by your facility, you can then link them to the processed identified earlier. The next section describes how to combine these "building blocks" to make **production units** useful for TURA reporting and planning.

Step Three: Designate Product/Process Combination(s) as Production Unit(s)

TURA affords firms flexibility in designating product/process combinations as production units. Here are some examples of possible combinations:

1 Production Unit = 1 Process + 1 Product : A facility with a single product and a single production process has one production unit.

For example, the production of car batteries through one process.

1 Production Unit = 1 Process + A Family of Products : A facility with similar products may group these into a family, so that the process used to produce them can be considered one production unit.

For example, the production of miscellaneous engine parts through one process.

2 Production Units = 1 Process + 2 Products: A facility with a single production process making two distinct products (not the same family) should designate these process/product combinations as two production units.

For example, the production of unpainted appliances (intermediate product) and painted appliances through one process.

These examples reflect the combinations possible as a result of whether products are treated separately or grouped into families. The examples are based on situations where a firm has one process. Additional combinations are possible depending on the number of processes in a facility and how those are treated.

The more products and process steps you treat separately, the more production units you will have. On the other hand, if you group products into families and aggregate process steps, you will have fewer production units.

Your main concern, however, should be to designate production units in a manner that most accurately reflects the activities and products of your facility. Keep in mind that products and processes can change over time. If, for example, your firm has one stable product line and another that is expected to change, you might want to put each into a separate production unit.

You should take into account the availability of information and its reliability. If, for example, relevant information on separate production lines is kept separately, it might be simpler to treat the lines as separate production units, rather than combining them.

Finally, and most importantly, a collaborative approach to designating production units could be useful because a range of personnel might have relevant information. These include environmental managers, production supervisors, people doing equipment maintenance, process/product engineers, and fiscal managers.

Discussions with personnel from different disciplines will help inform your decisions on designating production units. This might also be of assistance in completing the final task associated with these designations -- assigning to the production units an output measure or measures for reporting and planning under TURA.

For some firms this will be as easy as keeping track of the number of products produced annually (e.g., a chair manufacturer could use the number of chairs).

For other firms, however, this might not be a simple issue and other measures of production levels should be used. Some examples are:

- Pounds of Plastic Resin Produced
- Square Yards of Paper Coated
- Gallons of Chemical Produced

Under TURA, such an output measure is called a "unit of product," and it serves the following functions.

Regulated firms report their progress in reducing byproducts and emissions on a per unit-of-product - basis. This approach to reporting is designed to "normalize" year-to-year changes in production levels that might increase or decrease chemical usage. [Endnote 3] With regard to planning, regulated firms will probably use the unit of product to evaluate the costs/benefits of alternative toxics use reduction techniques.

In choosing a unit of product, you should try to pick a measure of facility productivity that most closely reflects all activities involving the listed chemical. The measure must increase/decrease in a consistent way as chemical usage (or the generation of byproducts) increases or decreases.

In addition, the unit of product should be one that is as free from nonproduction influences as possible. Dollars sales, for example, are affected by a variety of factors that are unrelated to production levels or chemical usage: market share, pricing decisions, inflation, etc. Direct labor hours is another example of this.

Please note that the regulations previously required that the unit of product be a physical measure, disallowing the use of dollar sales or direct labors hours, for example.

After discussions with our Advisory Committee, MassDEP amended its regulations to allow firms to use non-physical measures if developing a physical measure is not feasible.

If you chose a non-physical unit of product, however, you must explain in a letter why a physical measure cannot be used and you must state how the non-physical measure has been adjusted to accurately reflect production levels rather than changes in costs, prices, inventory, productivity or other factors.

For example, a repair facility handles so many different kinds of products that designating a single physical measure (e.g., number of pieces repaired) would be inaccurate. The firm might choose to use direct labor hours but it would have to develop a mechanism for correcting for changes in worker productivity per type of product.

The following example illustrates some of the considerations involved in picking a unit of product.

EXAMPLE: A copper forming firm produces extruded copper products. Some of the alternative UNITS OF PRODUCT for this firm include:

- Number of finished products manufactured
- Surface area of copper processed
- Mass of copper produced

The firm rejects the first two measures for the following reasons.

Number of products produced fails to account for the wide range of sizes and shapes of the extruded products, which affect the amount of chemicals used.

Information on the **Surface area** of copper processed was not available and would be very difficult to collect.

Mass of copper produced was chosen as the UNIT OF PRODUCT because the firm's production records are expressed in those terms and the mass of copper processed through the plant is directly related to the amount of byproduct/emissions generated.

Up to this point in the discussion, the GUIDELINES have focused on presenting a framework for the decisions you will be making concerning production units. In the next and final section, the GUIDELINES will provide examples of how the choices you make relate to certain aspects of TURA reporting.

Production Unit(s) & TURA Reporting

Some of the information called for in the Annual Toxics Use Reports involves facility-wide usage of TURA-related chemicals. These GUIDELINES, however, focus on the reporting requirements related specifically to production units. In this report, regulated firms identify the production unit(s) in which a TURA-regulated chemical is manufactured, processed, or otherwise used.

For each production unit, chemical usage is then reported in terms of a range, and indices are calculated to report progress in reducing byproducts and emissions, attributable to that production unit. Finally, the methods of achieving those reductions have to be indicated in a matrix form.

The choices made in designating production units can affect your reporting under TURA, as the tables below illustrate. Note that these tables focus on *one* aspect of TURA reporting -- calculating the byproduct reduction index ("BRI"). Note that the BRI is not necessarily the most important aspect of TURA reporting, and that reporting is not necessarily the most important aspect of TURA.

The examples based on BRI calculations do, however, illustrate the principles set out in these GUIDELINES.

The formula for the byproduct reduction index is: 100 x ((A- B)/A)

WHERE:

A = the quantity of toxic byproducts generated in base year divided by the units of product produced in base year

B = the quantity of toxic byproducts generated in reporting year divided by the units of product produced in reporting year

The following examples illustrates a BRI calculation:

A widget manufacturer's production unit generates a TURA-regulated chemical (nitrobenzene) as a byproduct. In the base year, (1987), 30,000 lbs. of nitrobenzene byproduct is generated for 180,000 widgets produced. In the reporting year, 1990, 48,000 lbs. of nitrobenzene byproduct is generated for 360,000 widgets produced.

A = 30,000 lbs. nitrobenzene/180,000 widgets = 0.166

B = 48,000 lbs. nitrobenzene/360,000 widgets = 0.133

Byproduct reduction index = 100 x ((0.166 - 0.133)/0.166) = 100 x 0.198 or 20

The BRI of 20 indicates that the widget manufacturer has reduced the nitrobenzene byproduct per widget by 20%. An index of 100 would represent the highest possible reduction, which means that the chemical was totally eliminated from the production unit. [Endnote 4]

This example takes the firm's designation of the production unit as a given. The examples depicted in the following tables illustrate the impact of the following:

TABLE #1: Decisions Concerning Products

TABLE #2: Decisions Concerning Units of Product

By giving these examples, MassDEP intends to illustrate the principles discussed previously in the GUIDELINES. The examples are based on discussions with industry, environmentalists and other government officials. The facts in these examples have been simplified.

TABLE #1: DECISIONS CONCERNING PRODUCTS

Assumptions: A paper maker produces assorted colors of paper, of which TURA-regulated chemical A is produced as a byproduct from the production of dark blue and light blue papers.

In 1990 (the base year) and 1991 (the reporting year) production remained the same at 10,000 lbs. (5,000 lbs. of dark blue and 5,000 lbs. of light blue).

1990 BYPRODUCTS 1991 BYPRODUCTS Dark Blue 100 lbs 80 lbs Light Blue 30 lbs 30 lbs TABLE #1: Decisions Concerning Products

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As the information above indicates, this firm reduced the byproduct from the production of dark blue paper from 100 lbs. in 1990 to 80 lbs. in 1991.

Approaches to Grouping Products

Option #1:
A = 100 lbs. of chemical A/5,000 lbs of paper = 0.020

B = 80 lbs. of chemical A/5,000 lbs of paper = 0.016

BRI = 100 x ((0.020 - 0.016)/0.020) = 100 x 0.2 = **20**

Option #2:
A = 130 lbs. of chemical A/10,000 lbs of paper = 0.013

B = 110 lbs. of chemical A/10,000 lbs of paper = 0.011

BRI = 100 x ((0.013 - 0.011)/0.013) = 100 x 0.153 = **15**

SUMMARY: The BRI for dark blue paper as a separate product is 20, expressing a 20% reduction in the byproducts. The BRI for dark and light blue papers was 15. Combining the papers means that the byproduct reductions were averaged over all of them.

TABLE #2: DECISIONS CONCERNING UNITS OF PRODUCT

Assumptions: An electronics component manufacturer makes printed circuit boards. To clean the boards, the firm produces deionized water. TURA-regulated chemical C is a byproduct of the deionization unit.

In 1990 (the base year), the firm produced 9500 circuit boards. In 1991 (the reporting year), 7500 boards were produced. The amount of deionized water produced remained the same at 10,000 gallons/year. The firm reduced the byproducts from the deionization unit as shown below.

1990 BYPRODUCTS 100 lbs
1991 BYPRODUCTS 90 lbs

Approaches to Selecting a Unit of Product

Option #1:
The firm chooses gallons of deionized water as the unit of product for the deionization unit. (See p. 7 on treating this water as an intermediate product.)

Option #2:
The firm chooses number of printed circuit boards as the unit of product.

Byproduct Reduction Indices for the 2 OPTIONS.

Option #1: A = 100 lbs. of chemical C/10,000 gals of water = 0.010

B = 90 lbs. of chemical C/10,000 gals of water = 0.009

BRI = 100 x ((0.010 - 0.009)/0.010) = 100 x 0.1 = **10**

Option #2: A = 100 lbs. of chemical C/9,500 boards = 0.011

B = 90 lbs. of chemical C/7,500 boards = 0.012

BRI = 100 x ((0.011 - 0.012(/0.011) = 100 x -0.09 = **-9**

CONCLUSION: The BRI for the deionization unit as a separate production unit with gallons of water produced as the unit of product is 10, expressing a 10% reduction in the byproducts. The BRI for deionization unit, treated as part of the other manufacturing processes (with # of circuit boards as the unit of product) was a negative 9, suggesting a 9% increase in byproducts.

Endnotes

1. In the first TURA reporting year, the Act regulates the same chemicals that are regulated under Section 313 of the federal Emergency Planning and Community Right to Know Act (EPCRA), which requires toxic chemical release inventory reporting on a "FORM R." Over time, however, the list of TURA-regulated chemicals will be expanded to include the chemicals regulated under CERCLA (the federal Comprehensive Environmental Response, Compensation, and Liability Act).

2. Certain processes and activities are exempt from production unit reporting. These include pilot plants and waste treatment units. An exempt processes should not be considered a production unit or part of one. See the Instructions for Completing the Toxics Use Report for more detail.

3. This reporting method also allows firms to keep certain information on production levels confidential.

4. The formula for the emissions reduction index is the same as the BRI formula, except that the quantity of emissions generated appears in the numerator of the two ratios, A and B.