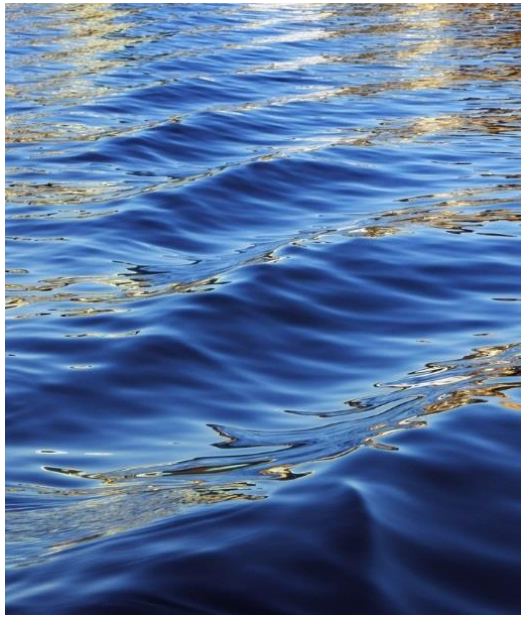
Massachusetts Toxics Use Reduction

Math for TUR Planning and Reporting

June 17, 2025



Welcome!

- Today's webinar agenda
  - Basic concepts for materials accounting
  - Breakout discussion
  - Math for materials accounting
  - Breakout worksheet
  - More challenges and final thoughts

- Be sure to sign up for TURI's newsletter to learn about upcoming training events
  - Scroll to the bottom to sign up: www.turi.org

- Consider joining our next TUR planner certification course
  - Online asynchronous class starts mid-August
  - In-person practicum classes in October
  - MassDEP certification exam in December

- Contact TURI's training team at any time!
  - Pam Eliason, TURI Training Director: pamela_eliason@uml.edu
  - Agnes Cheng, TURI Training Associate: agnes_cheng@uml.edu
  - General training questions: training@turi.org

OTA OFFICE OF TECHNICAL ASSISTANCE & TECHNOLOGY
TURI TOXICS USE REDUCTION INSTITUTE
MassDEP

Math for TUR Planners

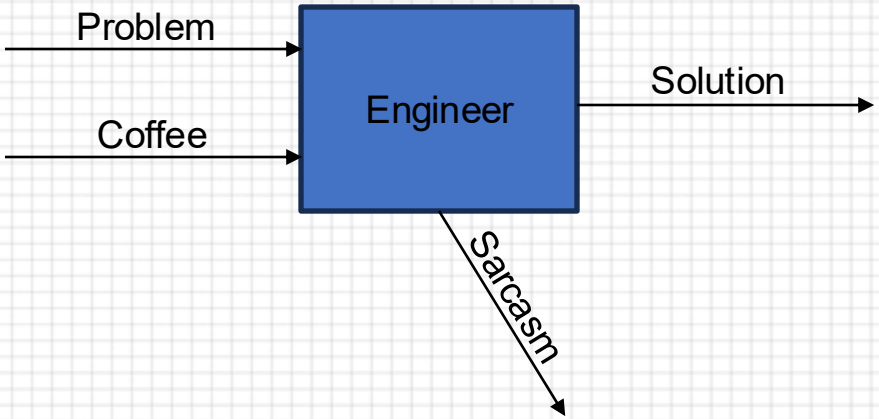
A deep dive into Sections 1 and 2 of the Form S

Presented by Mel Kenerson – GZA

June 17, 2025 – 12-1:30 pm

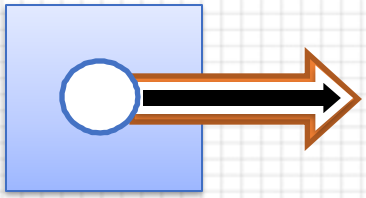
Agenda

- Process Characterization & Data Collection
- Form S Section 1
- Form S Section 2



Manufacture, Process or Otherwise Use?

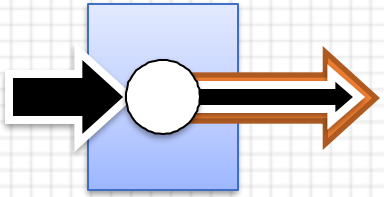
Manufacture



<u>Create</u> a toxic substance:

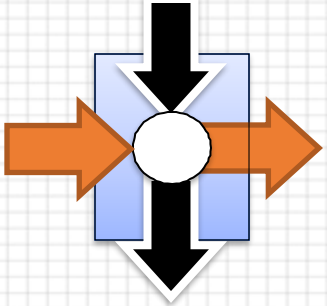
- *Intentionally* – to incorporate into the product (e.g., paint)
- *Unintentionally* – either as part of the product, or as byproduct
- *Import* the substance

Process



<u>Prepare</u> a toxic substance
after its manufacture.
Toxic chemical is <u>intentionally incorporated</u> in the product.

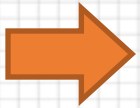
Otherwise Use



<u>Use</u> a toxic substance in a way that it is **<u>not</u>** intentionally incorporated into the product (e.g., degreasing a machine)

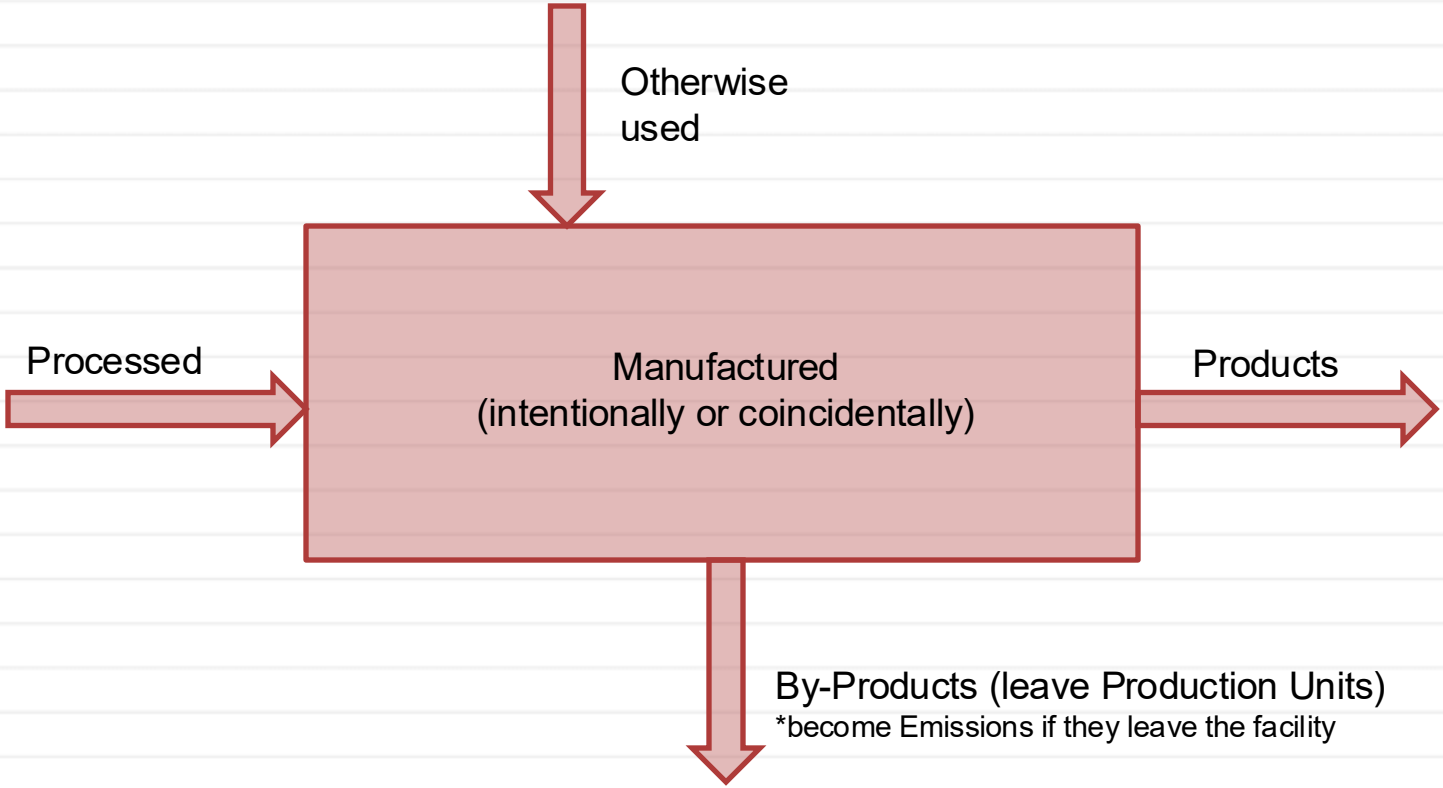
Production Unit

Toxic substance
inputs and outputs



Product
inputs and outputs

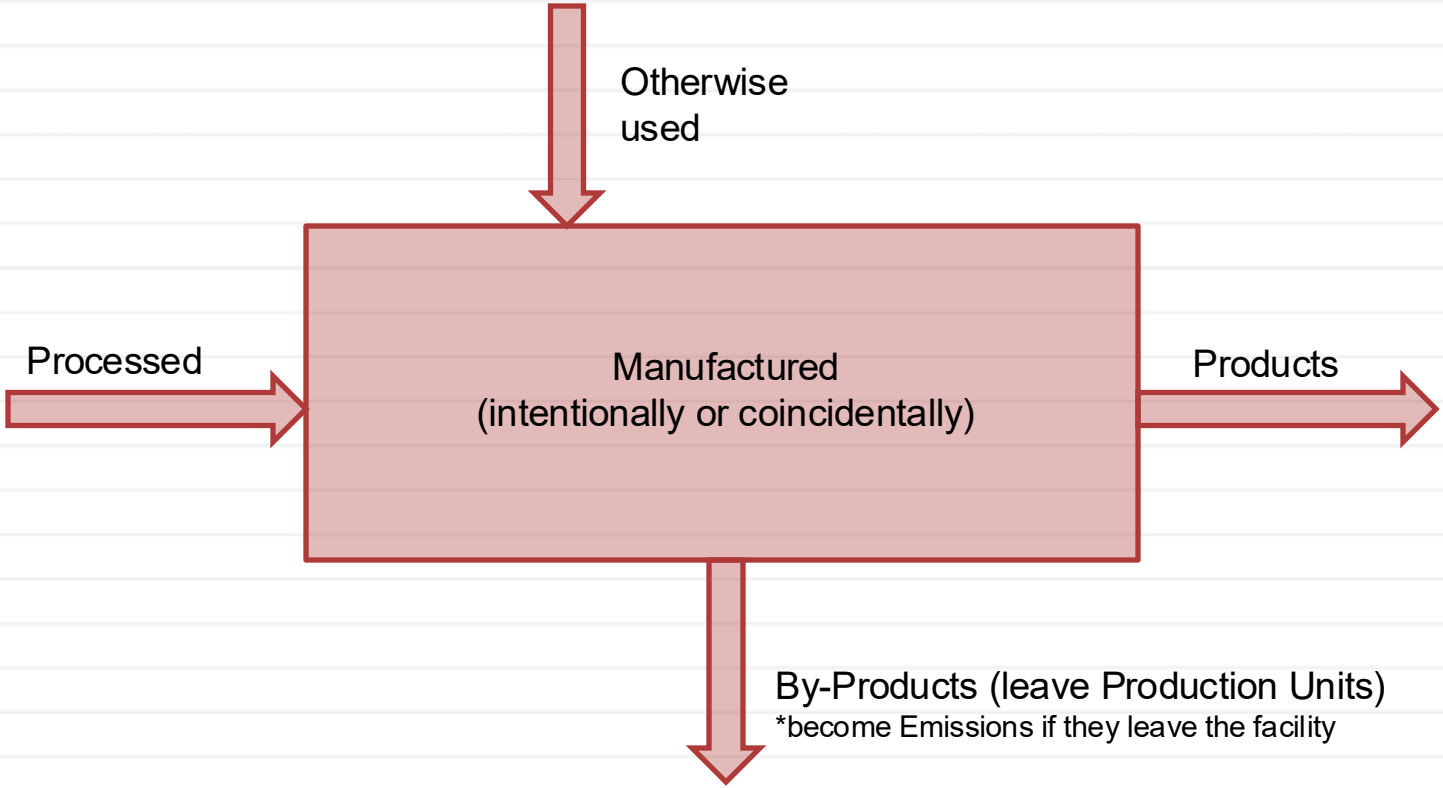
Process Flow Diagrams & Data Collection



Process Flow Diagrams & Data Collection
Common Data Sources

- Production Reports (batch sheets, outputs of tracking systems)
- Shipping/Sales Records
- Inventory Reports
- Waste disposal/Management Records
- Maintenance Records (esp for Otherwise Used materials)
- Analytical data (stack test reports, waste profiles, stormwater monitoring)
- Safety Data Sheets/Technical Data Sheets
- Other Regulatory Reports (Air Emissions Statements)
- Purchasing Records**

Process Flow Diagrams & Data Collection



Data Collection
Common Red Flags and Best Practices

Given purchasing records – compare against inventory and production if available

Handwritten data/Data out of context – request backup

Materials with multiple common names – Use the CAS to be sure!

- MEK - butanone, 2-butanone and methyl acetone
- Formaldehyde – formalin, methanol, formol, methylene glycol/oxide/aldehyde

Assumptions……well, you know the saying – use supporting data wherever possible (waste profiles/analysis, batch sheets)

Trusting prior work if done by others – talk to them if available, redo it yourself if you have time

The Importance of a Complete Mass Balance

This year (a Reporting Year), ensuring a Form S that completely represents the facility and each production unit

- Nothing missed
- Nothing under- or over- reported

Next Year (a Planning Year), knowing where listed chemicals are used or created

- Gives you the whole picture to help lead your TUR Options evaluation
- Can inform decisions for where to focus on equipment changes (for modification or modernization)
- Can help prioritize input substitution or internal recycling/reuse efforts

Always, Employee Health concerns

- Knowing where chemicals are located in the facility can inform employee exposure or spill response concerns
- Coincidentally manufactured compounds can have significant health concerns that need to be addressed

Breakout Session #1

Please enter a breakout room and discuss the following questions:

- What Red Flags do you typically see or expect to see in the data you receive?
- What data gaps have you seen in your data and how have you resolved them?

Section 1: Facility-Wide use of Listed Chemical

c. Amount Manufactured

d. Amount Processed

e. Amount Otherwise Used

f. Amount Generated as Byproduct

g. Amount Shipped In Or As Product

h. Production or Activity Ratio

Section 2: Materials Balance and Other Reporting Anomolies

a. Amount of Chemical Recycled OnSite

b. Amount of Chemical Consumed Or Transformed

c. Amount of Chemical(Product) Held In Inventory

d. Amount of Chemical Compound

e. Other Amount

If needed, can add explanation in Section 5 on page 3 of the Form S

Production Ratio (PR)

$$\frac{\text{Product Made Reporting Year}}{\text{Product Made Previous Year}}$$

Based on unit of product, NOT chemical used!!

$$\frac{\text{2,576 widgets (2024)}}{\text{2,123 widgets (2023)}} = 1.21$$

PR>1
Production increased

$$\frac{\text{1,568,245 \# widgets (2024)}}{\text{2,314,547 \# widgets (2023)}} = 0.68$$

PR<1
Production decreased

$$\frac{\text{0 gallons (2024)}}{\text{2,700 gallons (2023)}} = 0$$

PR=0
No Production Current Year

Dimensional Analysis (review)

Gallons x Specific Gravity x Density$_{H_2O}$ = Mass

750 gal	0.96	8.34#
		gal

= 6,005 #

Used when:

- Converting between units, such as metric to empirical
- Using provided data, such as density or analytical data, to determine a specific quantity, such as pounds of material used

Coincidental Manufacturing

Common concerns from a TURA perspective

- Water dissociable nitrate compounds from nitric acid
- Chromium VI compounds from the combustion of fuel or welding operations
- Formaldehyde from combustion of fuel
- Hydrogen fluoride from the mixture of dry ammonium bifluoride with water and from combustion of fuel
- Metal salts from electroplating

Items to watch for

- New material may be a Higher Hazard Substance (HHS) (such as HF)
- New material may be a waste (by-product) from the process, but is considered manufactured in TURA terms
- Chemistry dictates how much is created, it may be more than you'd think!

Coincidental Manufacturing Water-Dissociable Nitrate Compounds

Nitric acid (HNO_3) neutralization can manufacture water dissociable Nitrate Compounds above reporting thresholds even though <25,000 pounds of HNO_3 treated

$$HNO_3 + NaOH \rightarrow NaNO_3 + H_2O$$

19,000 lb HNO_3	84.9947 g $NaNO_3$	1 mol $NaNO_3$
	63.01 g HNO_3	1 mol HNO_3

= 25,629 lb $NaNO_3$

Even though nitric acid was used at less than the 25,000-pound threshold, the facility coincidentally manufactured water-dissociable nitrate compounds above the threshold.

Reporting Metal Compounds for TURA

For metals reported as compounds, the total weight of the compound in the amount manufactured, processed or otherwise used is counted. However, only the weight of the parent metal being reported is counted in calculating byproducts. (TURA Reporting Instructions)

- **297 pounds of lead oxide manufactured and disposed as scrap**

Use molar mass ratio to create conversion: _____#Pb/# PbO

$$\frac{207.2 \text{ g/mol (Pb)}}{223.199 \text{ g/mol (PbO)}} = 0.928 \text{ \#Pb/\#PbO}$$

297 # PbO (0.928 #Pb/#PbO) = 276 pounds Pb (By-Product – Section 1)

297 # PbO – 276 # Pb = 21 # O (Chemical is a Compound – Section 2)

Calculation Summary

297 # Lead Oxide manufactured

297 # Lead Oxide as by-product

276 # of lead
&
21 # of oxygen

Section 1: Facility-Wide Use of Listed Chemical

1026	Lead Compounds
a. MA DEP CAS #	b. Chemical Name (Dioxin should be in grams, decimal points may be used)

Facility-wide use of chemical identified in a. Enter the total amount (in POUNDS, except for dioxin) for each applicable category. **NOTE:** 'Generated as byproduct' (item f.) means all waste containing the listed chemical before the waste is handled, transferred, treated, recycled or released. Please refer to the reporting instructions before completing this section.

297 Entire Compound	
c. Manufactured	d. Processed
	276 regulated metal only
e. Otherwise Used	f. Generated As Byproduct
g. Shipped In Or As Product	h. Production or Activity Ratio

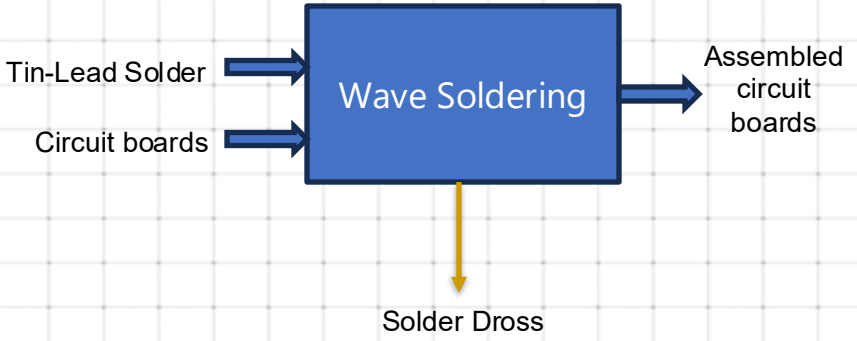
Section 2: Materials Balance

When the amounts reported in c, d and e in Section 1 are added together, the sum will in many cases equal the sum of f and g. In other words, lines c, d and e will often form a "materials balance." If lines c, d and e are not in approximate balance, you must use this section to explain why. Indicate all the reasons that apply by entering the number of pounds on the appropriate line below (e.g., 4,000 Chemical was held in inventory).

a. Chemical Was Recycled On Site	b. Chemical Was Consumed Or Transformed
	21 non-metal portion of compound
c. Chemical Was Held In Inventory	d. Chemical Is A Compound
e. Other	

Lead & Lead Compounds

Boards Etc. is a contract circuit board assembler. The company attaches components to customer-supplied circuit boards via wave soldering. In reporting year 2023, the company used tin-lead solder that contained **3,436 pounds of lead**. That same year they sent 6,090 solder dross (containing **1,715 pounds of reportable lead compounds**) off-site for recycling and received a statement back from its recycler that **1,585 pounds of lead** were recovered from the dross. The amount of **lead that was shipped out with the customer product** was **1,766** pounds.

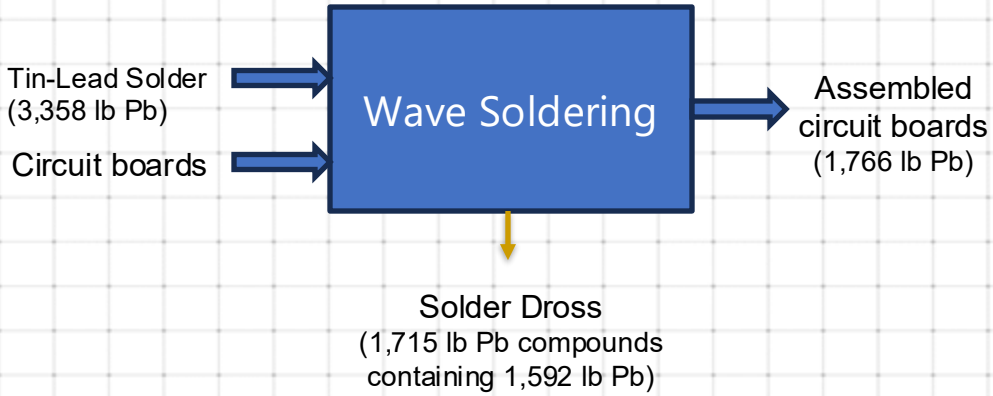


Lead & Lead Compounds

Processed tin-lead solder:
3,358 pounds of lead.★

Solder dross waste:
1,715 pounds of lead oxide,★
containing **1,592 pounds of lead**

Shipped as product:
1,766 pounds.



If Lead and Lead Compounds are BOTH used in excess of the 100-pound reporting threshold, report both lead and lead compounds on the same Form S (and pay only 1 fee)

1,715 # lead oxide manufactured

3,358 # Lead Processed

1,766 # lead shipped as product

1,592 # Lead in Dross as by-product

123 # of oxygen in lead oxide

Section 1: Facility-Wide Use of Listed Chemical

a. MA DEP CAS #	b. Chemical Name (Dioxin should be in grams, decimal points may be used)
1026	Lead Compounds

Facility-wide use of chemical identified in a. Enter the total amount (in POUNDS, except for dioxin) for each applicable category. **NOTE:** 'Generated as byproduct' (item f.) means all waste containing the listed chemical before the waste is handled, transferred, treated, recycled or released. Please refer to the reporting instructions before completing this section.

c. Manufactured: 1,715 (lead oxide in dross)	d. Processed: 3,358 (lead in solder)
e. Otherwise Used	f. Generated As Byproduct: 1,592 (lead in dross)
g. Shipped In Or As Product: 1,766 (lead in product)	h. Production or Activity Ratio

Section 2: Materials Balance

When the amounts reported in c, d and e in Section 1 are added together, the sum will in many cases equal the sum of f and g. In other words, lines c, d and e will often form a "materials balance." If lines c, d and e are not in approximate balance, you must use this section to explain why. Indicate all the reasons that apply by entering the number of pounds on the appropriate line below (e.g., 4,000 Chemical was held in inventory).

a. Chemical Was Recycled On Site	b. Chemical Was Consumed Or Transformed: 1,592 (lead → lead oxide)
c. Chemical Was Held In Inventory	d. Chemical Is A Compound: 123 (other compounds in dross)
e. Other	

Breakout Session #2

Please work with your group to identify data gaps and complete the calculations

Section 2 – Mass Balance Assistance

If c. + d. + e. ≠ f. + g. → explain in Section 2

Section 1: Facility-Wide use of Listed Chemical

c. Amount Manufactured

d. Amount Processed

e. Amount Otherwise Used

f. Amount Generated as Byproduct

g. Amount Shipped In Or As Product

h. Production or Activity Ratio

Section 2: Materials Balance and Other Reporting Anomolies

a. Amount of Chemical Recycled OnSite

b. Amount of Chemical Consumed Or Transformed

c. Amount of Chemical(Product) Held In Inventory

d. Amount of Chemical Compound

e. Other Amount

Inventory Considerations

Shipped ≠ Processed and/or Manufactured

Items may be processed and/or manufactured and left in a warehouse

Section 1: Facility-Wide use of Listed Chemical

c. Amount Manufactured	d. Amount Processed
e. Amount Otherwise Used	f. Amount Generated as Byproduct
g. Amount Shipped In Or As Product	h. Production or Activity Ratio

Section 2: Materials Balance and Other Reporting Anomolies

a. Amount of Chemical Recycled OnSite	b. Amount of Chemical Consumed Or Transformed
c. Amount of Chemical(Product) Held In Inventory	d. Amount of Chemical Compound
e. Other Amount	

Section 2, Item c.

+ value → more items made than shipped

- value → more items shipped than made (implies excess inventory from prior year was shipped this reporting year

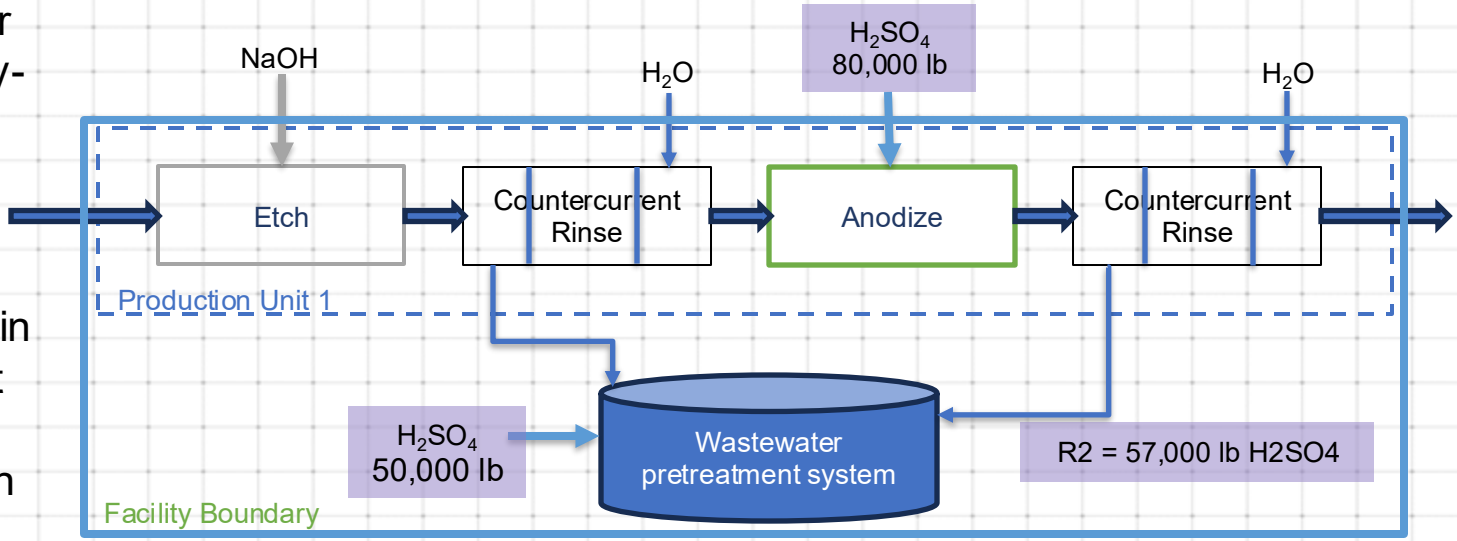
Consumed or Transformed

130,000 # Other wise used facility-wide

80,000 # Otherwise Used in Production Unit

50,000 # used in Wastewater treatment

57,000 # by-product



130,000 # Other wise used

57,000 # by-product

(80,000-57,000) 23,000 # Consumed or Transformed

50,000 # used in Wastewater treatment

Section 1: Facility-Wide use of Listed Chemical

c. Amount Manufactured

d. Amount Processed

130,000

e. Amount Otherwise Used

57,000

f. Amount Generated as Byproduct

g. Amount Shipped In Or As Product

h. Production or Activity Ratio

Section 2: Materials Balance and Other Reporting Anomolies

a. Amount of Chemical Recycled OnSite

23,000

b. Amount of Chemical Consumed Or Transformed

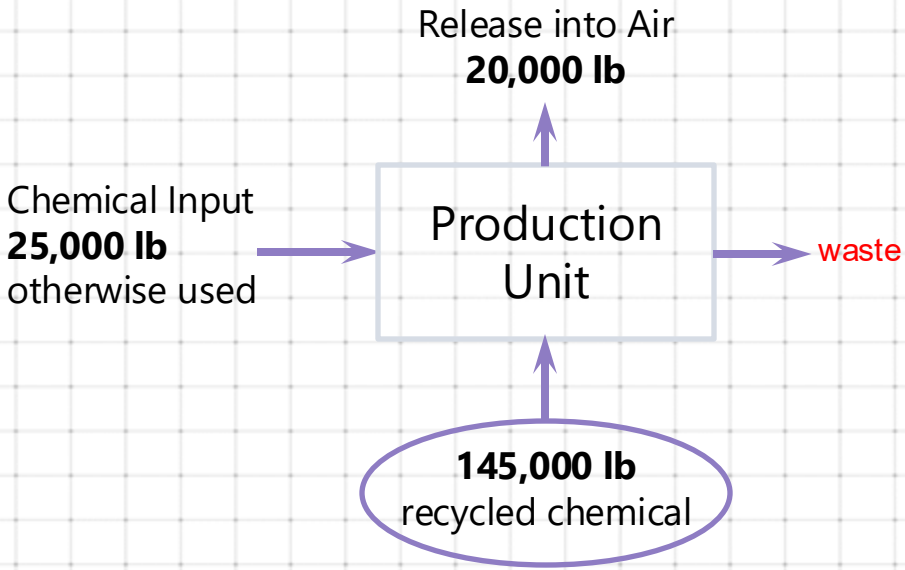
c. Amount of Chemical(Product) Held In Inventory

d. Amount of Chemical Compound

e. Other Amount

Section 3 b: 50,000

A reminder about Recycling Loops



Non-Integral Recycling

Production Unit Material Balance

Inputs = Outputs (By-Products)

Byproduct = 25,000 + 145,000 = 170,000 lb

Integral Recycling

Production Unit Material Balance:

Inputs = Outputs (By-Products)

(integral recycling loop is not input, never leaves Production Unit)

Byproduct = 25,000 lb