Lesson 4 – Inventory Development

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This is the Inventory Development lesson.

Upon completion of this lesson, you will be able to:

- Describe the main approaches to inventory development,
- Describe the methods for estimating emissions,
- Explain how to select a method to estimate emissions,
- Explain the methods for collecting data for an emissions inventory, and
- Identify the sources of data for the inventory.

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Methods for Estimating Emissions

In Lesson 3 we covered the two main approaches that your agency can follow in estimating emissions: the top-down approach and the bottom-up approach. Whether using the top-down or the bottom-up approach, the main methods used in estimating emissions of criteria and toxic pollutants include:

- Emission factors;
- Material balance (including fuel analysis);
- Source testing;
- Emission estimation models (usually software);
- Surveys and questionnaires; and
- Engineering judgment/best approximation.

Each of these methods are discussed in detail in the following pages.

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Emission Factor Method for Estimating Emissions

An emission factor is a ratio that relates the emissions of a pollutant to an activity level at a plant that can be easily measured, such as an amount of material processed, or an amount of fuel used. Given an emission factor and a known activity level, a simple multiplication yields an estimate of the emissions. Emission factors are generally developed from measured data for one or more facilities within an industry category, so they represent typical values for an industry, but do not necessarily represent what is occurring at a specific source. Published emission factors are available in numerous sources. Emission factors allow the development of generalized estimates of typical emissions from source categories or individual sources.

To calculate emissions using emission factors, three basic inputs to the estimation algorithm are required:

Activity information;

An emission factor; and

Information on capture and control efficiencies of any control device when using an uncontrolled emission factor.

The basic emission estimation equation when using an uncontrolled emission factor is: E = R x EF(uncontrolled) x (100 – C)/100

where: E = emission estimate for the process
R = activity level such as throughput
EF = emission factor assuming no control
C = capture efficiency x control efficiency (expressed in percent);
C = O if no control device is in place The basic emission estimation equation when using a controlled emission factor is: E = R x EF(controlled)

Nonpoint source emissions sometimes are not easily estimated by a direct measure of activity. In such a case, an emission factor that is based on a surrogate measure for activity level such as population or employment in an industry ***can be used***.

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Material Balance Method for Estimating Emissions

Material balance emissions are determined based on the amount of material that enters a process, the amount that leaves the process, and the amount shipped as part of the product itself. Fuel analysis is an example of a material balance. Emissions are determined based on the application of conservation laws. The presence of certain elements in fuels may be used to predict their presence in emission streams. For example, sulfur dioxide or SO2 emissions from oil combustion can be calculated based on the concentration of sulfur in the oil. This approach assumes complete conversion of sulfur to SO2 . For every pound of sulfur burned, two pounds of SO2 are emitted.

This technique is equally applicable to both point and nonpoint sources. Material balance is particularly useful for sources resulting in evaporative losses. Typical processes for which a material balance is particularly useful are solvent degreasing operations and surface coating operations. Material balance should not be used for processes where material reacts to form secondary products or where the material otherwise undergoes significant chemical changes.

The basic emission estimation equation for mass balance is:

$$E_x = (Q_{in} - Q_{out}) * C_x$$

where: E_x = total emissions for pollutant x
Q_{in} = quantity of material entering the process
Q_{out} = quantity of material leaving the process as waste, recovered, or in product
C_x = concentration of pollutant x in the material.

The term Q_{out} could involve several different fates for an individual pollutant. This could include the amount recovered (or recycled) or the amount leaving the process in the product or waste stream.

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Source Testing Method for Estimating Emissions

Source testing emission rates are derived from short-term emission measurements taken at a stack or vent. Emission data can then be extrapolated to estimate long-term emissions from the same or similar sources. Continuous emission monitors or CEMs continuously measure and record actual emissions during the time of monitor operation. CEMs data can also be used to estimate emissions for different operating and longer averaging times. Results of source testing conducted by either a state or local agency or by the source itself can be used for estimating air emissions.

Although source testing generally yields more accurate emission estimates than emission factors or material balance, its use in emissions inventories may be limited for several reasons. First, source testing can be expensive. Second, source testing provides a snapshot of emissions from a process. As a result, uncertainties in source testing emission estimates arise because the process conditions may change over time while the test results can only reflect the emission rate and conditions during the test runs. Finally, standardized source testing reference methods have not been developed for all air pollutants particularly HAPs.

Source test data are of great value for obtaining general information on the characteristics of a particular industry and for obtaining specific information on pollutants being emitted and control device operational parameters. The raw data contained in source test reports can be used to develop emission factors for ***each pollutant and process tested***. Although source test data are site-specific, these data can be extrapolated to apply to other representative emission sources for purposes of calculating emissions.

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Emission Estimation Model Method for Estimating Emissions

Emission estimation models are empirically developed process equations used to estimate emissions from certain sources. An example emission estimation model is the TANKS software for estimating volatile organic compound emissions from fixed- and floating-roof storage tanks. Some emission estimation models currently available are based on measured or empirical values. Emission estimation software is used when a large number of equations and interactions must be manipulated and the effect of many different parameters must be accounted for in order to estimate emissions. The most widely used emission estimation models are:

- The Landfill Air Emissions Estimation Model
- TANKS to estimate emissions from fixed- and floating-roof storage tanks
- WATER to estimate air emissions from wastewater collection and treatment systems
- MOBILE for estimating emissions from cars and trucks
- NONROAD for estimating emissions from nonroad mobile sources such as construction and agricultural equipment

Additional emission estimation models are described in the various chapters of the Emissions Inventory Improvement Program, EIIP, series.

If you choose to use a non-EPA model to estimate emissions, you should do a thorough evaluation of that model/software and you should get prior approval from your EPA Regional Office.

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Survey and Questionnaire Method for Estimating Emissions

Surveys and questionnaires are commonly used to obtain facility-specific data on emissions and their sources. Also, they can be used to collect local or statewide data for certain source categories, such as wood burning for home heating.

The scope of the survey must be determined during the planning phase of the inventory. For example, a detailed survey may target all facilities within a specific source category or may list specific pollutants. This approach would reduce the number of sources contacted and improve the quality of the data collected because the survey questionnaire is tailored to specific types of sources with similar processes. Alternatively, the survey may not target specific sources nor limit the pollutants inventoried. This approach will require a more generic design of the survey questionnaire and consequently may result in less detailed and possibly less accurate data. In either case, you should ensure early on that your agency has the staff and resources to design, mail, process, administer, and analyze the results of a survey.

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Engineering Judgment Method for Estimating Emissions
An engineering judgment is made when the specific emission estimation techniques such as stack testing, material balance, or emission factor are not possible. This estimation is usually made by an engineer familiar with the specific process, and is based on whatever knowledge may be available.

Engineering judgment or best approximation must be considered as a last resort if none of the methods previously described can be used to generate accurate emission estimates. Engineering judgment may involve the application of speculative or innovative ideas, a poorly documented emission factor, or a crude material balance. In cases where no emission factors are available but adverse risk is low, it may be acceptable to apply factors from a similar source category using engineering judgment.

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Selecting an Emissions Estimation Method
Selecting a method to estimate emissions warrants a case-by-case analysis considering the cost and required accuracy in the specific situation. When selecting an emissions estimation method, you should consider several issues when analyzing the tradeoffs between cost and accuracy of the resulting estimates. These issues include:

- Availability of quality data needed for developing emissions estimates;
- Practicality of the method for the specific source category;
- Intended end use of the inventory (for example, an inventory in support of significant regulatory implications such as residual risk or environmental justice issues may require that more accurate and costly emission estimation methods be used than would an inventory intended for simply a source characterization);
- Source category priority (for example, if a source category is of relatively high priority, it may require a more accurate emission estimation method);
- Time available to prepare the inventory; and
- Resources available in terms of staff and funding. To help you decide which estimation methods to use, you should refer to the EIIP series of documents. An important aspect of

the EIIP's selection of methods was the identification of "preferred" and "alternative" methods.

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Review Question

The use of a fuel analysis for estimating emissions from a coal-fired boiler represents which method of estimating emissions?

a. Emission factors
b. Materials balance
c. Source testing
d. Emission estimation modeling

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Data Collection Methods for Point Sources
For point source inventories, you can obtain information by contacting each point source in the inventory area. The two most common types of plant contacts are: Surveys and Plant Inspections.

You can use the survey technique to obtain source and emissions data by sending a questionnaire to each point source in the inventory area.

Plant inspections give you the opportunity to examine the various processes at a particular facility, interview plant personnel, and review operations and process schematics. While plant inspection is a very resource-intensive data collection technique, it tends to be more accurate then the survey technique, and may be appropriate for larger sources.

You can also use indirect plant contact techniques to gather data for point source inventories, such as examining permit applications and compliance files. You may need to use a combination of data gathering techniques to ensure complete and accurate data are available for compilation of an inventory. Appropriate methods are selected during the planning phase of the inventory process, based on the goals of the inventory and availability of resources.

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Data Collection Methods for Nonpoint Sources

Data resources for nonpoint source inventories vary much more than those for point sources. You can collect nonpoint source data from a number of diverse sources.

Surveys - You can use surveys of a representative sample to collect data that can be extrapolated to the nonpoint source category. You must use caution to ensure that the surveyed subset is representative of the entire population. You may use the same steps to survey nonpoint sources as you use for point sources, but often the steps taken are driven by available resources and data.

Examination of Local, State, and Federal Documents and Databases - State, local, and federal agencies such as the U.S. Bureau of the Census and the Energy Information Administration generate summary reports containing information on population trends, land use, business patterns, agricultural trends, fuel use, chemical production and use, and meteorological conditions. You will find that these documents are often valuable resources for determining

appropriate activity data or parameters for apportioning data. Many of these documents are available on the Internet. You may also find that personnel at these agencies can be valuable data resources.

Examination of Trade Association Reports, Journals, and Databases - Trade association documents, journals, and market research reports can provide information on past sales and future trends for specific industry sectors. You can use this information to determine appropriate activity data or parameters for apportioning data.

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Data Resources for Compiling an Emissions Inventory

This section introduces the various data resources available to you in compiling an emissions inventory. The types of data you will need to compile a complete emissions inventory include:

- Inventory guidance;
- Existing emission data;
- Emission factor resources;
- Models resources;
- Source characterization documents that characterize an industry, including a description of processes, operating parameters, equipment used, emissions generated; and volume and type of output produced; and
- Applicable Activity Parameters.

In many cases a single document can provide information on one or more of the types of data needed for your inventory. For example, EIIP is an excellent resource for inventory guidance as well as source characterization, and AP-42 is an excellent resource for both emission factors and source categorization.

Each of these data resources will be covered in the next few pages.

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Inventory Guidance

The primary guidance on emission inventory development is summarized in the EIIP volumes.

The EIIP volumes were developed through a joint process involving state and local agencies and EPA. These volumes present EPA's recognized standard for the development of reliable, quality-rated inventories. The EIIP documents present preferred and alternative methods for estimating emissions from point, nonpoint, mobile, and biogenic source categories. Hard copies of these manuals are available from the National Technical Information Service. Electronic copies of the EIIP documents can be downloaded off the World Wide Web through the EIIP Web site.

Additional emissions inventory guidance, such as EPA's SIP Emission Inventory Guidance, can be downloaded off the World Wide Web through EPA's CHIEF Web site.

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Existing Emission Data

A well-documented, existing air emissions inventory is a good starting point for preparing a new inventory. Information from an existing inventory could be incorporated into questionnaires to facilities, asking them to update activity, emissions and other appropriate information. The existing inventory could also be used as a resource for estimation methods for the new inventory.

Be aware that existing inventories may focus on pollutants other than those needed in the inventory being prepared. Thus, certain sources that emit only one type of pollutant may not be well represented.

In addition to previous inventories, there are other current and accessible national emission databases available for review and assessment in developing an emissions inventory.

A less desirable but possible source of emissions data is through the extrapolation of emissions from one geographic region to another. This approach may be most appropriate when the socioeconomic conditions between two regions are comparable. In these situations, the emissions data for one region can be extrapolated to the other region based on population, employment, or other representative surrogates of the activity causin g the emissions.

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Emission Factor and Material Balance Information

The following four main types of resources can be used to locate emission factors:

Emission Factor Documents
Emission factors have long been used as a cost-effective means to develop emission inventories. They are simply multipled by activity levels to estimate emissions. The primary documents for emission factors are:
• Compilation of Air Pollutant Emission Factors (AP-42); and
• Locating and Estimating Air Emissions Documents.

Emission Factor Databases
The most widely used emission factor database for state and local agencies is: •Factor Information Retrieval Data System or FIRE.

Source testing data used for compliance purposes and in developing operating permits for stationary sources may be readily available through state and local air permitting agencies.

Material Safety Data Sheets and Certified Product Data Sheets.
The MSDS and CPDS are sources of speciation profiles. Each MSDS and CPDS lists specific compounds and weight percentages of hazardous ingredients present in a certain material. The MSDS and CPDS are especially important when using material balances as an emissions estimation tool. The MSDS and CPDS are easy to obtain as a result of state and federal right-to-know laws that require that information be made available on the composition of products being used in the work place.

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Models Information

Several emission estimation models are available for download free-of-charge from EPA's web site.

- Landfill Gas Emissions Model
- TANKS to estimate emissions from fixed- and floating-roof storage tanks
- WATER to estimate air emissions from wastewater collection and treatment systems
- PM Calc for estimating PM emissions

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Source Characterization Information

You will need source characterization information to identify the sources you must include in the inventory. Source characterization information includes:

- Description of the sources, facilities, or activities included in the source category. For example, the boiler source category comprises sources that combust fuels to produce hot water and/or steam. The source category definition can include the North American Industrial Classification System code, Maximum Available Control Technology code, or the EPA Source Category Code or SCC,
- Description of emission sources within the source category. For example, the boilers category includes coal-fired boilers, oil-fired boilers, boilers using other types of fuel, cogeneration units, and auxiliary sources, and
- Discussion of the factors influencing emissions such as control techniques, influences of weather conditions, or process operating factors.

Several resources are available to you for source characterization. Primary resources include:

- AP-42.
- Locating and Estimating Air Emissions from Sources of (Source Category or Substance) Documents. About 30 Locating and Estimating, L&E. documents are currently available. Although L&E documents concentrate on hazardous air pollutants (HAPs), these documents can be useful for criteria pollutant inventories because each volume includes general descriptions of the emitting processes, and provides source characterization.
- Industry Sector Notebooks: The EPA's Office of Compliance has developed a series of notebooks profiling selected major industrial groups. Each sector-specific notebook brings comprehensive details that include an environmental profile, industrial process information, and bibliographic references.

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Applicable Activity Parameters

You may need to use different types of activity data to estimate emissions from nonpoint and point sources - even within the same source category. Point sources may require direct measurement or direct activity such as throughput applied to an emission factor, while emissions from nonpoint sources are often estimated using surrogate activity factors, such as population or employment.

For point sources, activity parameters are generally reported as fuel consumption rates or process weight rates for fuel-burning equipment and industrial processes, respectively. You will need detailed data on process equipment, throughput, capacity, and other parameters to estimate emissions from point sources. You can obtain this information from contacts with individual facilities. The two most common types of plant contacts are surveys and questionnaires, and direct plant inspections. A type of indirect plant contact also commonly employed is the use of permit applications or compliance files.

Nonpoint source emission estimates are generally based on surrogate activity data and an emission factor developed specifically for that activity. Activity data include population, employment, fuel or product usage, product sales, and types of land use correlated with air emissions.

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Review Question

Material Safety Data Sheets and Certified Product Data Sheets are most useful for which method of estimating emissions?

a.Emission factors
b.Materials balance
c.Source testing
d.Emission estimation modeling

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Summary

Now that you have completed this lesson, you should be able to:

- Describe the main approaches to inventory development.
- Describe the methods for estimating emissions.
- Explain how to select a method to estimate emissions.
- Explain the methods for collecting data for an emissions inventory
- Identify the sources of data for the inventory.

Continue by selecting a lesson using the Menu, or, just go to the next lesson.