Lesson 5 – QA/QC

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This lesson is about Quality Control and Quality Assurance or QA/QC.

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

- Define Quality Control,
- Define Quality Assurance,
- Describe the difference between Data Quality Indicators and Data Quality Objectives,
- Describe commonly used QA/QC techniques,
- Describe the procedures for correcting typical errors, and
- List what QA/QC procedures need to be documented.

Page 2
Introduction to QA/QC

A comprehensive Quality Assurance program is essential to the preparation of a reliable, defensible emissions inventory. In addition, a thorough QA/QC system ensures confidence in the inventory.

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Definitions

A QA program comprises two distinct components: Quality Control and Quality Assurance.

Quality Control or QC is a system of routine technical activities implemented by **the inventory development team** to measure and control the quality of the inventory as it is being compiled. QC procedures include technical reviews, accuracy checks, and the use of approved standardized procedures for emissions calculations.

Quality Assurance or QA is a system of external review and audit procedures conducted by **personnel not involved** in the inventory development process. QA is an independent, objective review by a third party to assess the effectiveness of the QC program and the quality, completeness, accuracy, precision, and representativeness of the inventory.

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Don't Overlook QA/QC

A common shortcoming of many inventory development programs is that inadequate resources are devoted to QA/QC activities. A general rule of thumb used by many QA professionals is that 10 percent of the allocated resources should be used for QA activities. This does not include the costs of QC, which are assumed to be built into the process.

Too often, QA activities are concentrated at the end of the inventory process. An effective QA program will include planning, numerous QC checks during inventory development, and QA audits at strategic points in the process.

Although the QA/QC process can take significant time and effort, it will save you time and money in the long run by reducing invalid results

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DQOs

DQOs, data quality objectives, are qualitative and quantitative statements to identify the level of uncertainty that a decision-maker is willing to accept. The purpose of DQOs is to ensure that the final data will be sufficient for the intended use.

DQOs are identified as part of the inventory planning process. They are determined based on the end use of the inventory, but should realistically reflect the limitations resulting from time constraints, resource (staff and funding) limitations, and lack of data. A statement of DQOs should be prepared as part of the inventory preparation plan.

The development of a DQO statement is an iterative process. The managers must work together to balance the quality objectives and the available resources. It is important to acknowledge the constraints that limit the ultimate quality of the inventory, especially if the achievable DQOs fall short of the desired DQOs.

Your task manager is responsible for defining the DQOs for the inventory. Your responsibility as the inventory preparer is to make sure your results meet the agreed upon DQOs.

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DQIs

DQIs or data quality indicators are qualitative and quantitative descriptors used to interpret the degree of acceptability or utility of the data. The principal DQIs are:

Accuracy: The closeness of a measurement to the true value, or the degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of error (precision) and systematic error (bias) that are due to sampling and analytical operations;

Comparability: The degree to which different methods, data sets, or decisions agree or can be represented as similar;

Completeness: The amount of valid data obtained compared to the planned amount; and

Representativeness: The degree to which an inventory is representative of the region and sources it is meant to cover.

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Review Question

After data is collected a team member reports that there was a problem with the measurement device on which some of the data are based. The problem lead to measurement readings that were in error by plus or minus 3%. A team manager reviews the tolerance levels set forth in the planning stages and determines that the data should be collected again.

This situation best represents which combination of the following terms?
a. QA and DQOs
b. QA and DQIs
c. QC and DQOs
d. QC and DQIs

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Quality Control Procedures

Quality control is best implemented through the use of standardized checklists that assess the adequacy of the data and procedures at various intervals in the inventory development process. QC checklists should be used to monitor data collection procedures, data calculations, evaluations of data and data tracking.

Checklists can assist you in finalizing the inventory prior to submitting it to a reviewing agency (e.g., EPA). The checklist includes questions concerning completeness, use of approved procedures, and reasonableness.

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QA/QC Techniques

Some common QA/QC techniques are: Reality Check, Computerized Checks, Peer Review, Statistical Checks, Replication of Calculations and QA Audits.
These techniques can aid in ensuring a defensible inventory is compiled. Keep in mind that each technique has its own strengths and weaknesses and therefore a combination of techniques should be used throughout the process.

- The **reality check** is the most commonly used QA/QC method and is used to catch large errors early in the estimation process. This check is in the form of the questions "Is this number reasonable?" or "Does this number make sense?" You should never use the reality check as the sole criterion of quality. Each reviewer should carefully document the results of the reality check, using standardized forms or report formats, when applicable.

- **Computerized data checks** can be built-in functions of databases, models, or spreadsheets or can be designed as stand-alone programs. You can use automated QA/QC functions to facilitate peer review or, in some cases, replace manual reality checks. Computer-based QC checks can process large volumes of data quickly, significantly reducing the amount of time needed to compile and QA an inventory.

  When using automated data checks, keep in mind that human reasoning and judgment are necessary to evaluate the data for errors. Automated data checks are not a substitute for

evaluation of the data by an auditor; they serve as a tool to allow an auditor to evaluate the data efficiently. EPA has various QC tools available to state, local and tribal emission inventory preparers to assist in the QC of their data.

- **Peer review** is an independent review of calculations, assumptions, and/or documentation by a person with a moderate to high level of technical experience. Peer review generally involves reading or reviewing documentation. Peer review is conducted to ensure that assumptions and procedures are reasonable, but might not include rigorous certification of data or references.

  No specific tools are required to conduct replication of calculations, but the use of checklists or review forms is recommended. A checklist ensures that reviewers have a clear understanding of what they are expected to do. Also, checklists provide an efficient means to document the QC procedure.

- **Statistical check** procedures can be used as tools to facilitate reality checks, peer reviews, and independent audits. They can be used to compare results or to identify unusual or unlikely values. Statistical data checks can process large amounts of data and reduce the subjectivity of informal reality checks.

- **Replication of calculations** is the most reliable way to detect computational errors and can be done by any team member involved in the inventory. Replication of calculations should be conducted throughout the inventory process by the author of the original calculations as a self-check, by the team member conducting QC checks, and as part of the QA audit.

  When using replication of calculations as a QC check of the data, you must keep in mind that replication of calculations does not check to ensure that the approach and assumptions are correct, and does not involve a check of the accuracy or quality of the original data. Also, this is a labor-intensive process.

- **QA audits** are independent audits that involve a systematic evaluation of the emission inventory preparation process. They are a managerial tool to evaluate how effectively the emissions inventory team complies with predetermined specifications for developing an accurate and complete inventory. QA audits are conducted to determine whether QC procedures are effective and being followed, and whether additional QC is necessary to the inventory development process.

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Review Question

Match the term, with the definition

Reality Check	Can be used to compare results or to identify unusual or unlikely values and by processing large amounts of data and reduce the subjectivity of informal reality checks.
Peer Review	Most commonly used QA/QC method and is used to catch large errors early in the estimation process.
Replicaitons of Caluculations	A review of procedures and quality of data by people outside of the inventory team.
Statistical Checks	Conducted to ensure that assumptions and procedures are reasonable, but might not include rigorous certification of data or references.
QA Audits	Detects computational errors, but does not check to ensure that the approach, assumptions or data are correct.

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Typical Errors

A key part of Quality Control is recognizing where errors typically happen and making a plan to avoid them. This is something that should take place in the planning stages.

Typical errors found in inventories include:

- Missing facilities;
- Duplicate facilities that could occur as a result of name changes through corporate acquisitions;
- Improper facility location data;
- Missing operating or technical data;
- Erroneous technical data including misinterpretation of data or transcription errors;
- Inconsistent point and nonpoint source size designation or failure to designate inventory size cutoffs;
- Errors in calculations such as transposition of digits; decimal errors; entering wrong numbers; and misinterpreting emission factor applications; and, finally,
- Data entry and transposition errors and data coding errors.

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Identifying Gaps in the Inventory

Data gaps in the inventory may be the result of:

- Pollutants unaccounted for due to a lack of credible emission factors;
- Facilities that are missing or unaccounted for due to incomplete source lists
- Source categories that have not been considered due to a lack of credible emission factors or activity data;
- Oversight of a facility or source category during inventory compilation; and
- Data entry error resulting in some data not being included in the inventory database.

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Filling Gaps in the Inventory

Filling data gaps is done on a case-by-case basis and depends on the nature of the data gap and the importance of the source category under review. You should prioritize your gap filling effort. You must carefully document your gap filling actions, including all assumptions made and all resources used.

Data quality issues may surface when filling data gaps. For example, you might derive emissions from a certain source category by projecting emissions from previous national inventories based upon growth indicators. These emissions estimates may not adequately capture facility shutdowns, new facilities, changes in operations relative to the previous inventory levels, or additions of new controls. Thus, while there are emission estimates available for gap filling, the data quality will not be of the same level as the emission estimates developed using actual and current data.

You should discuss this tradeoff between accuracy and completeness with your task manager before you make a decision on gap filling strategy.

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Double Counting

Double counting occurs when the emissions from one source are included twice in the same inventory. Double counting can result from:

- Overlap between point and nonpoint sources, and
- Overlap between nonpoint source categories
- Note that it is acceptable to overlap emissions for certain pollutants in the criteria and air toxics inventories. For example, certain organic compounds, which are a subset of VOC's, may be included in the air toxics inventory, while the class of VOC's are included in the criteria pollutant inventory.

For example, emissions from large dry cleaning facilities (above the threshold for point sources) are included in the point source inventory. If you do not take steps to ensure that these emissions are not included in the nonpoint source inventory for dry cleaning facilities, the emissions will be counted twice. Inventory preparers should compare the lists of point and nonpoint emission sources to see if any sources have been included in both inventories. If the emissions from a process at a facility have been included in both the point and nonpoint source inventories, then

the nonpoint source inventory must be adjusted downward to avoid double counting the emissions. **(Point/ nonpoint overlap)**

For example, when compiling an emission estimate for the prescribed burning nonpoint source category, you must be careful not to include emissions from agricultural burning. To avoid this type of double counting, you must become very familiar with the definitions of each nonpoint source category and understand the processes.

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Documenting QA/QC Procedures

Each member of the inventory project team should follow the QA/QC documentation procedures prescribed in the inventory preparation plan. All QA/QC activities and results must be documented and reported, either as part of the inventory report, or as a separate document. The report should include:

- Procedures used to meet the QA/QC objectives of the project;
- Technical approach used to implement the QA plan;
- Dates of each audit, and the names of the reviewers;
- Results of QA activities, including problems found, corrective actions, and recommendations; and
- Discussion of the inventory quality.

As a rule, document everything that pertains to the quality of the inventory. This will help to resolve conflict and increase the credibility of the final report.

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Review Question

The following scenario most accurately depicts which of the terms listed below.

A local agency has identified three factories for inclusion in a county level emissions inventory. Factories A, B, and C emit a total of 20, 30, and 40 lbs per year of benzene, respectively. A total of 90 lbs of benzene is recorded in the inventory. Upon further review, it is learned that factories B and C share some of the benzene emission sources.

a. Independent audits
b. Double counting
c. Data gaps
d. Filling gaps

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Summary

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

- Define Quality Control (QC).
- Define Quality Assurance (QA).
- Describe the difference between Data Quality Indicators and Data Quality Objectives.
- Describe commonly used QA/QC techniques.
- Describe the procedures for correcting typical errors.
- List what QA/QC procedures need to be documented.

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