energy API

AMERICAN PETROLEUM INSTITUTE

Addressing Uncertainty in Oil & Gas Industry Greenhouse Gas Inventories: Technical Considerations and Calculation Methods

API Side Event

CCAR Annual Meeting

1 April 2009

San Diego, California

Rationale for Developing the Uncertainty Document

- Provide companion document for API Compendium and Industry Guidelines
- Improve GHG Assessments
- Enhance confidence of attaining compliance
- Focus data collection resources
- Assess applicability of existing emission factors
- Simplify statistical calculation approach

energy API

AMERICAN PETROLEUM INSTITUTE

About the Uncertainty Document

- Technical considerations for uncertainty analysis at the facility and entity level
- Sources of GHG inventory uncertainty
- Role of industry practices and standards
- Approaches for calculating uncertainty
- Methods for error propagation
- Example applications for Oil & Natural Gas inventories

energy API

AMERICAN PETROLEUM INSTITUTE

Document Contents

1. Introduction
2. Sources of Uncertainty
3. Overview of Measurement Practices
4. Statistical Methods for Quantifying GHG Inventory Uncertainty
5. Calculation Examples

- Appendices
  - A: Glossary of Statistical and GHG Inventory Terms
  - B: Flow Meters Inspection & Maintenance
  - C: Measurement Methods Summaries
  - D: Units Conversions
  - E: Uncertainty Estimation Details for an Example

Section 1: Introduction

- Subsections
  - Importance of Accurate & Reliable GHG Accounting
  - Overview of Uncertainty Terminology
  - Types of Errors
  - Determination of Uncertainty Interval
- Note
  - ***Appendix A*** expands on the Terminology by including statistical and GHG inventories terms

Section 2:
Sources of Uncertainty

- Subsections
  - Overview of Emissions Inventory Uncertainty
  - Emissions Inventory Uncertainty in the Oil & Natural Gas Industry
  - Sources of Measurement Uncertainty
  - Emission Estimation Approaches
  - Inventory Steps and Data Aggregation
- Note
  - Addresses general concepts and issues germane to GHG inventories in the Oil & Natural Gas industry

Section 3:
Overview of Measurement Practices

- Subsections
  - Flow Measurement Practices
  - Uncertainties of Flow Measurements for GHG Inventories
  - Uncertainty of Sampling and Analysis for GHG Emissions
  - Carbon Content Measurement Practices
  - Heat Content Determination
  - Laboratory Management System
- Notes
  - Based mainly on API MPMS, ASTM and ISO methods
  - ***Appendices B and C*** provide more details

energy API

AMERICAN PETROLEUM INSTITUTE

Section 4:
Statistical Methods for Uncertainty

- Subsections
  - Measurement Uncertainty
  - Overview of Uncertainty Propagation
  - Quantifying Emission Estimation Uncertainty
  - Quantifying Measurement Uncertainty
  - Aggregating Uncertainty
  - Assessing Data Correlations
- Note
  - Based mainly on IPCC, ISO and API MPMS guidance

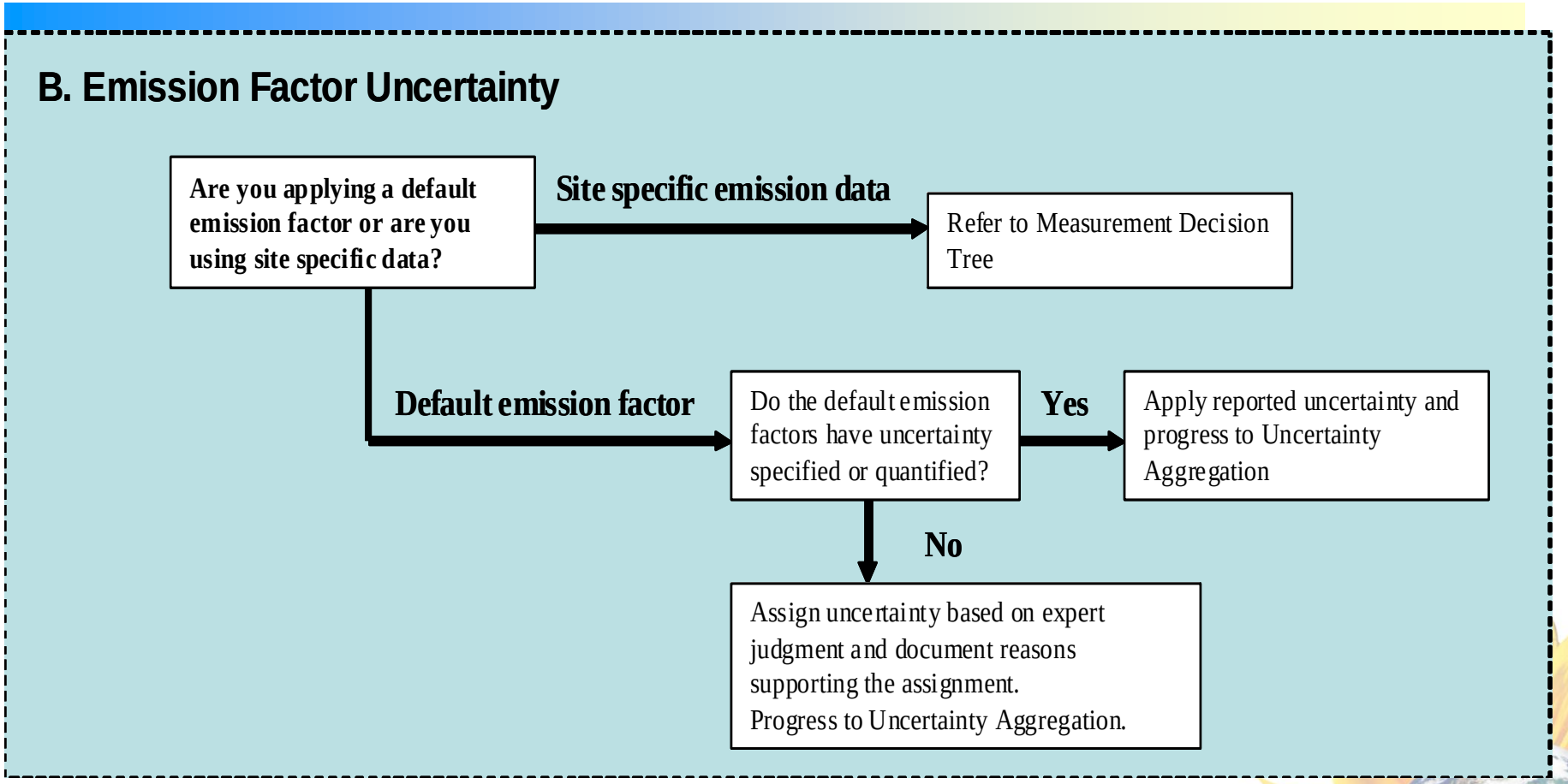
Section 5:
Uncertainty Calculation Examples

- Subsections
  - Introduction
  - Example 1: Onshore Oil Field with High CO_2 Content
  - Example 2: Petroleum Refinery hydrogen plant and FCCU
  - Strategic Reduction of Uncertainty
- Notes
  - Examples used are based on the API Compendium
  - Strategy for using uncertainty reduction to improve GHG inventory
  - ***Appendix E*** provides more details

Quantifying Uncertainty

- General Steps
  - Determine the uncertainty for measured data;
  - Determine the uncertainty for emission factor data;
  - Aggregate uncertainties.
- Statistical calculation methods provided with guidance to applicability
- Decision trees used to help navigate
- Pertinent examples embedded in text

Example:
Use of Decision Trees



Example:
Comparison of Annual CO_2 Emissions

- Assume: annual CO_2 emissions are based on the product of the fuel consumption (activity) times the Tonnes CO_2/fuel volume (EF)
- Compare: Emission estimate results from three approaches:
  1. Aggregate measured monthly gas composition and flow rate;
  2. Measured gas consumption and an EF derived from annual average gas composition;
  3. Measured gas consumption and a default EF.
- Measurement uncertainty based on methods used
- Uncertainty of generic EF $\pm$ 10%

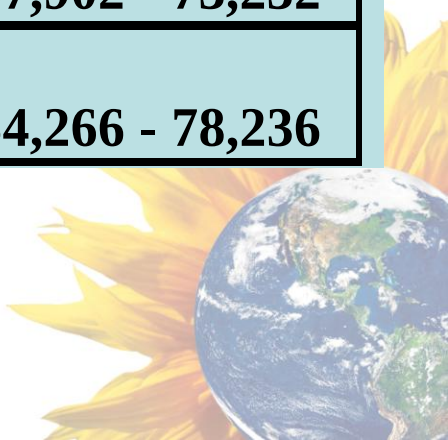
energy API

AMERICAN PETROLEUM INSTITUTE

Example:
Annual Emission Results

Method		**Emissions, Tonnes CO_2**	**Uncertainty* + %**	**Confidence Range Tonnes CO_2**
1	Monthly flow and Carbon Content	**65,551**	**3.91%**	**62,988 - 68,114**
2	Annual flow and annual average Carbon content	**65,567**	**11.69%**	**57,902 - 73,232**
3	Annual flow and default EF	**66,251**	**18.09%**	**54,266 - 78,236**

* At the 95% confidence level



energy API

AMERICAN PETROLEUM INSTITUTE

Example: Results Discussion

- Average CO_2 emissions calculated are only @ 1% apart
- Statistically, the annual emissions calculated are all equal
  - They have overlapping confidence intervals
- Using the generic EF results in the highest (most conservative) emission estimate
- Measurements uncertainty depends on the variability and reproducibility of the methods used
- Monthly approach exhibits lowest uncertainty ranges due to sum of squares aggregation

Summary

- Uncertainty analysis is a tool to assess the confidence range for reported GHG emissions
- The analysis is usually a blend of statistical calculations aided by expert judgment
- It is an excellent tool for
  - Understanding the main contributors to errors
  - Enable targeting large contributing sources for more intense data collection
  - Devising strategies to improve GHG inventories