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MODULE
12

Instrument Metering and Calibration

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Instrument metering and calibration are crucial in measurement and verification (M&V) processes, ensuring the accuracy, reliability, and traceability of measurements. These processes are essential in fields like energy management, environmental monitoring, and industrial processes. Accurate measurements are foundational to validating performance claims, ensuring compliance with regulations, and facilitating informed decision-making.

Learning Objectives

- Instrument metering and calibration
- Fieldwork: formal accreditation, safety, OSHA, and NFPA
- Data accessibility, communication, and valuation
- Reporting on Measurement and Verification (M&V) Projects
- Definitions of IPMVP Options
- The future of measurement and verification
- Sample M&V Plan
- Sample M&V Report
- ESCO's Guide to Measurement and Verification
- Summary and Resources

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INTRODUCTION

- Defined as the process of using instruments to measure physical quantities like temperature, pressure, flow, and electrical parameters.
- Types of Instruments: Mechanical Instruments, Electronic Instruments, and Smart Instruments.
- Importance: Provides necessary data for evaluating system performance, establishes a reference point for assessing changes over time, and ensures adherence to industry standards and government regulations.

METERING AND CALIBRATION OF INSTRUMENTS IN M&V

Metering and Calibration Techniques

- Metering can range from simple to complex, requiring installation of additional meters.
- Accurate measurements are critical for quantifying impacts of energy management activities.
- Metrology, the science of measurement, ensures accurate measurements using validated instruments and methods.
- A broad metrological infrastructure, including standards, traceability, calibration laboratories, and proficiency testing programs, helps maintain accurate, reliable measurements.

METERING AND CALIBRATION OF INSTRUMENTS IN M&V+

Calibration

- Calibration ensures instruments used to measure energy consumption are accurate and reliable.
- It involves comparing readings against a standard of known accuracy and adjusting the instrument as necessary.
- Calibration is especially important for complex and sophisticated instruments like data loggers.

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CALIBRATION

- Process of comparing the output of an instrument to a known standard or reference to determine its accuracy.
- Process includes preparation, comparison, adjustment, documentation, and validation.
- Importance: Ensures that the measurements taken are accurate and reliable, links measurements to recognized standards, provides a chain of accountability, and meets legal and industry requirements for measurement accuracy.
- Example: An industrial flow meter must be periodically calibrated to ensure its accuracy.

MEASUREMENT UNCERTAINTY ANALYSIS (MUA)

- MUA identifies, quantifies, and combines various sources of uncertainty in a measurement.
- Common sources of uncertainty include measurement bias, random error, and environmental factors.
- Understanding these sources of uncertainty helps M&V professionals make informed decisions about results and ensure data reliability.

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GUM: GUIDELINES FOR EVALUATING UNCERTAINTY IN MEASUREMENTS

GUM is an international standard for evaluating and expressing uncertainty in measurements.

It consists of several parts:

- ISO/IEC Guide 98-3:2008: A general framework for evaluating and expressing uncertainty in measurements.
- ISO/IEC Guide 98-1:1002: A method for evaluating uncertainty using a Monte Carlo simulation approach.
- UPOTEC Guide 98-2:1006: Guidance on extending uncertainty analysis to multiple output quantities.
- ISO/TEC Guide 08-1:2012: Examines how to apply the GUM guidelines in specific measurements.
- The GUM guidelines are based on probability theory principles and provide a consistent framework for uncertainty analysis.

COMMONLY MEASURED VARIABLES IN M&V ACTIVITIES

- Energy consumption: The amount of energy used by a building, facility, or process over a period of time.
- Power demand: The amount of electrical power required by a facility, system, or process at a given time.
- Temperature and humidity: The percentage of the maximum moisture the air can hold at a given temperature.
- Pressure: The amount of fluid or dash that is moved through a substance over a certain period.
- Flow rate: The measure of how much fluid or dash is moved through a substance over time.
- Light intensity: The intensity of light in lighting systems, particularly for commercial or industrial applications.

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RESOURCES FOR MEASURING VARIABLES

- Energy consumption: The International Standards and Technology Institute (NIST).
- Power demand: The National Renewable Energy Laboratory (REL).
- Temperature and humidity: The National Institute of Standards and Technology (NIST).
- Pressure: The American Society of Mechanical Engineers (ASME).
- Flow rate: The International Organization for Standardization (ISO).
- Light intensity: The Illuminating Engineering Society (IES).

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METERING SYSTEMS IN M&V

Types and Uses:

- Electrical submetering systems measure energy consumption of individual systems or components.
- Energy management systems (EMS) integrate data from multiple sources for real-time information.
- Building automation systems (BAS) focus on controlling and optimizing building systems, including metering capabilities.
- Utility submetering systems measure energy consumption of individual tenants or departments.
- Process metering systems measure variables like temperature, pressure, flow rate, and chemical composition in industrial processes.
- Portable metering systems temporarily monitor energy consumption or process variables during commissioning, troubleshooting, or other short-term activities.

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BEST PRACTICES FOR MINIMIZING UNCERTAINTY IN METERING:

- Regular calibration and maintenance of measurement equipment.
- Use of high-quality sensors and meters with high accuracy and precision.
- Implementation of data validation and quality control processes.
- Secure and reliable communication protocols.
- Secure and accessible data storage with appropriate backup and recovery processes.
- Use of standardized calculation methods and algorithms.
- Use of internationally recognized standards for uncertainty analysis.
- Clear and consistent documentation and reporting procedures.

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