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Field Test Best Practices

A dynamic web tool for practical guidance

BA Webinar

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Outline

- *WHY* – project motivation
- *WHAT* – overview of site content and structure
- *HOW* – demo of how to get a user account, contribute content, and participate in forum

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Field Test Best Practices
A Resource for Practical Residential Building Science

WHY

project motivation

WHY

Key Gaps	Impact on Research
Difficult to find general guidelines and examples of well-designed field test plans	There is great variation in quality of field test plans & experiment design.
No easily-accessible central repository for field test best practices knowledge	There is risk of reinventing wheels. Putting the "RE" in "RESEARCH."
Some researchers lack specific experience on how to conduct rigorous whole-home field tests	Field tests can be slow, costly, and not as informative as they could be.

Efficient field-test design is crucial to achieving SPEED & SCALE

WHY

Need to create a resource that:

- Organizes, and makes publicly available, knowledge from Building America's rich history of high-performance building field tests
- Uses an easily accessible, dynamic medium so information can be searched, sorted, assembled, and updated as needed by users
- Meets program needs in the near term, and serves a broader community of users in future years

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WHAT

overview of site structure & content

WHAT

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NREL Buildings Research

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Home | About | Field Test: Start to Finish | Building Components & Systems | Measurement & Instrumentation | Forum | Search

Login


Leakage and Infiltration Measurement


Lighting Level Measurement


Air Flow Measurement


Duct Pressurization Testing

The Field Test Best Practices site is a collection of best practices and lessons learned from the U.S. Department of Energy's (DOE) Building America program.

On this website, you will find detailed guidance on:

- Planning for your field test
- Conducting a field test
- Choosing, testing, and installing components
- Selecting equipment and knowing when and how to use it.

Get started by browsing the topics below.

Field Test: Start to Finish
- Why Field Test?
- Experiment Design
- Research Questions
- Short Term Tests
- Long Term Monitoring
- Data Acquisition Systems
- Field Test Safety Awareness
- Uncertainty Analysis
- Human Subjects Research

Building Components & Systems
- Building UA
- Walls
- Windows
- Foundations
- Buffer Spaces
- Heating, Ventilation, and Air Conditioning (HVAC)
- Domestic Hot Water (DHW)
- Lighting
- Photovoltaic (PV) Systems

Measurement & Instrumentation
- Leakage & Infiltration
- Temperature
- Humidity
- Fluid Flow
- Electrical Energy
- Pressure
- Weather
- Occupancy
- Combustion Analysis

Related Links

NREL Buildings Research
NREL develops innovative technologies to significantly reduce energy consumption in buildings.

National Residential Efficiency Measures Database
A centralized resource of residential building retrofit measures and costs.

3-D Approach to Content Organization

Field Test Start to Finish

- Structuring research questions
- Experiment design
- Short vs. long term field tests
- Field test execution
- Data analysis & uncertainties
- Reporting requirements
- Examples of test plans & final reports

Building Components & Systems

- Building UA
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- Buffer spaces
- Heating, Ventilation, and Air Conditioning (HVAC)
- Domestic Hot Water (DHW)
- Lighting
- Photovoltaic (PV) Systems

Measurement & Instrumentation

- Leakage & infiltration
- Temperature
- Humidity
- Fluid flow
- Electrical energy
- Pressure
- Heat flux
- Data acquisition systems
- Weather
- Occupancy

Sample Pages

Thermocouples

A thermocouple is comprised of two dissimilar materials (usually metallic wires) bonded together. The junction between the wires forms a microscopic region where voltage is induced between the wires. As the temperature of the junction changes, the voltage will vary in a repeatable, controlled manner, and can be measured at the other end of those wires.

For building science purposes, T-type thermocouples, made of Copper and Constantan with a temperature range from -200 to 350°C, are always appropriate. Shielded thermocouple wire is strongly preferred, to limit noise from power wires being inferred over the thermocouple's microvolt signal.

Accuracy of a thermocouple depends on the material properties, and uniformity of those properties. It is strongly recommended that researchers always purchase thermocouples and extension wire with lowest uncertainty. The preferred extension wire will be labeled "Special Limits of Error" or SLE, and typically has a ±0.5°C accuracy limit. This is half the error range of standard thermocouple wire. SLE wire cost is minimally higher than standard, but may require a slightly longer lead time in purchasing.

Accuracy of a thermocouple measurement also depends on the temperature, and thus location, of any junctions in the signal wiring. Often, a thermocouple is purchased with a connector attached from the factory. That connector creates two additional thermocouples (one for each pin/wire), called cold junctions. Where possible, the connector should be located to maintain similar temperatures to the data logger to minimize the impact of this intermediate cold junction on the measurement.

Several forms of manufactured thermocouples are available, for use in different applications.

Immersion Thermocouples ›

Immersed thermocouples are the preferred method for measuring the temperature of liquid flow in a pipe. They should be mounted in a plumbing tee where an elbow would normally be used. If there is no convenient spot where an elbow would normally be used, a u-shape can be plumbed-in to allow the installation of the tee.

Surface-Mount Thermocouples ›

Surface-mount thermocouples are used when equipment cannot be penetrated. Measuring refrigerant temperature is an example of appropriate surface-mount thermocouple usage; there is no reasonable method for immersing a thermocouple in the refrigerant flow path. Surface-mount thermocouples are also used to measure solid surface temperatures.

Bare Thermocouples ›

In building applications, bare thermocouples are used for measurement of air temperatures. While they can be used for other measurements, the best practice is to use one of the other thermocouple types (immersion or surface-mounted thermocouples) for measuring liquid or solid temperatures. Bare thermocouples are just that – a soldered or welded junction of Copper and Constantan where the sheathing has been stripped or pulled back from T-type thermocouple wire.

Electrical Energy

In many field tests, the electrical energy use of the house as a whole or a specific component is the focus of the project. In retrofits, the goal is to decrease the energy use of the home. In new homes, there is typically an expected energy use of the house based on models. For any projects involving a novel system, like a new type of heating, ventilation, and air conditioning (HVAC) equipment or lighting system, measuring the energy use of that system alone are of interest. As new homes become more efficient, plug loads like TVs and computers become a larger part of the home's electrical usage and so those items may need to be monitored separately as well. Regardless of the intent of the field test, electrical energy will likely be measured for some purpose.

On this page you will find:

Safety in Electrical Panel Work ›

Working on a high voltage system is extremely hazardous. Work inside of a circuit breaker panel (such as hardware installation and wiring) must be done by a qualified electrician.

Current Transformer ›

Current transformers (CTs) allow measurement of current flow without interrupting the circuit of interest. They are commonly used in buildings field testing where inserting an ammeter in series with the circuit is impractical. A CT that measures alternating current (AC) is made of a toroidal (or similar) magnetic core with a length of wire wrapped around the torus to form a secondary winding. When a current-carrying conductor is passed through the CT ring along its cylindrical axis a magnetic field is induced in the CT core, which in turn induces a current in the secondary coil that is proportional to the current through the ring.

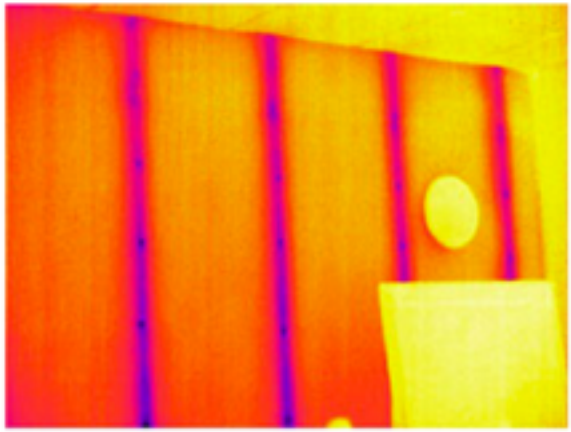
Calibrated Resistor / Shunt for Direct Current (DC) Measurements ›

A calibrated resistor (also called a shunt) can be used to measure direct current (DC) with high precision. The current of interest is passed through a resistor of known resistance, R, and the voltage drop V is measured across the resistor. Per Ohm's Law, $I=V/R$. These types of measurements may be required when investigating the energy use characteristics of a DC component within a system. For example, you could use a shunt to measure how much power the fan is drawing inside of a furnace.

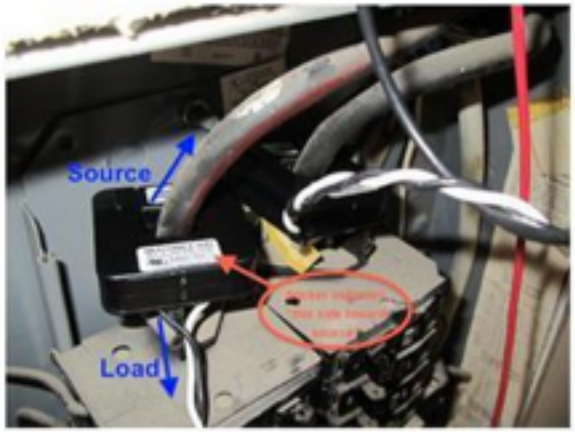
Calibrated resistor

Photos, Tables, & Diagrams

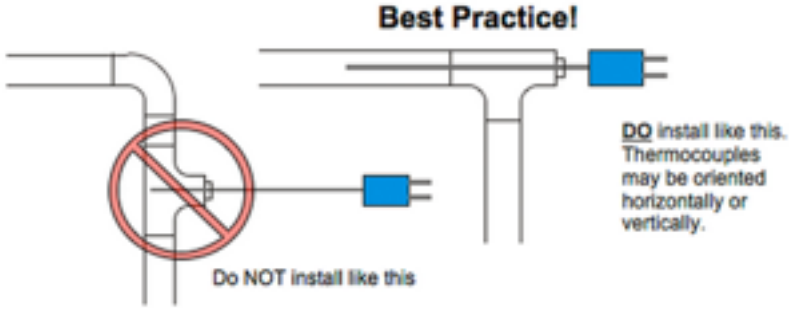
Measurement method	Can be used for data acquisition?	Approx labor cost @ $100/hr	Approx equipment cost
Turbine flow meter	Yes	200	200
Pumped reservoir	Yes	150	50 to 100
Magnetic flow meter	Yes	200	800 to 4,000
Ultrasonic flow meter	Yes	300	1,400 to 8,000
Utility-type water meter (no pulse output)	No	200	60 to 100
Utility-type water meter (with pulse output)	Yes	200	150 to 300
Tipping bucket	Yes	200	400
Rotameter	No	300	200 to 500



IR Thermograph showing studs and drywall screws in an exterior wall



Orientation of source and load on a current transformer



Installation where an elbow would normally be used.

WHAT

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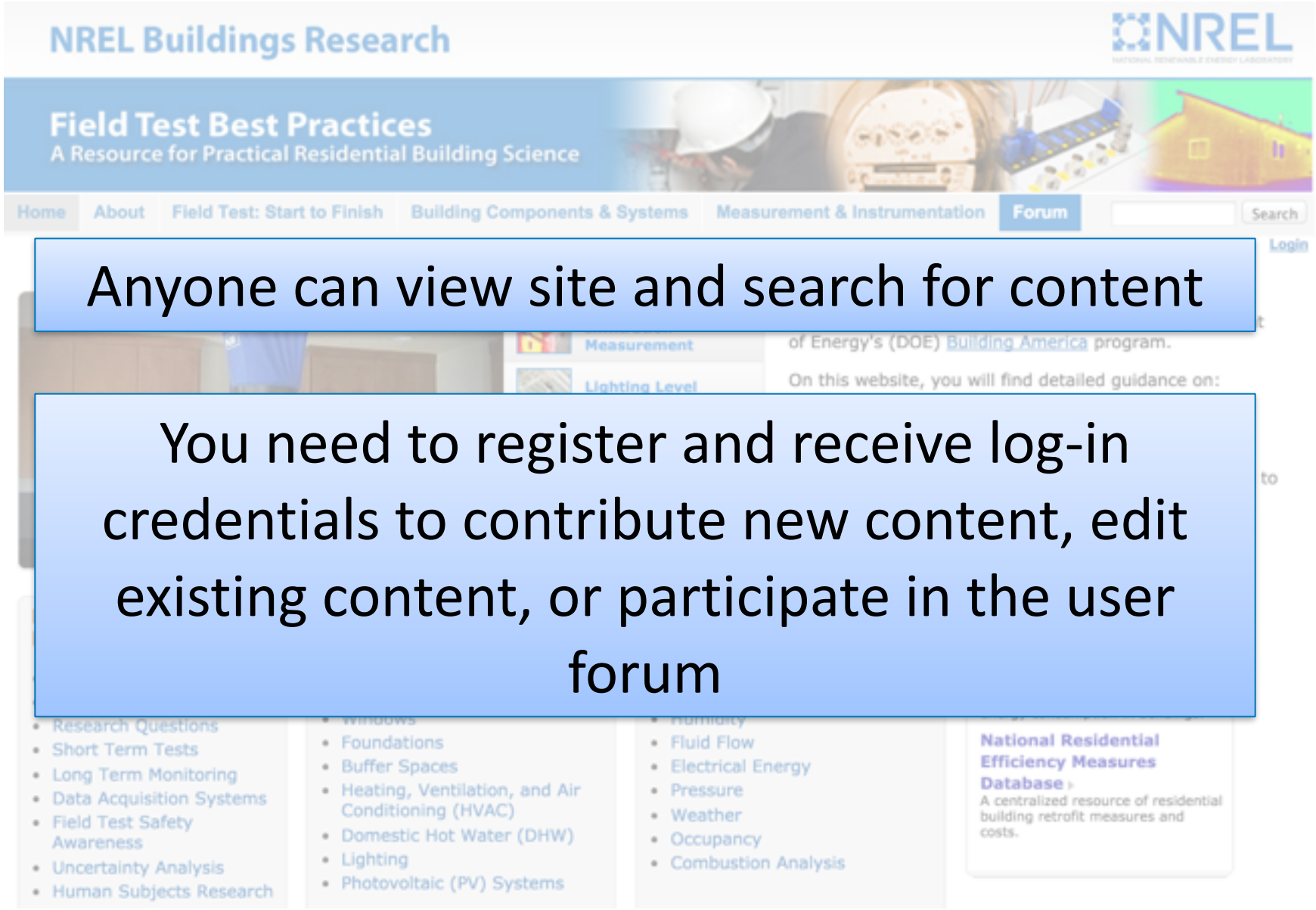
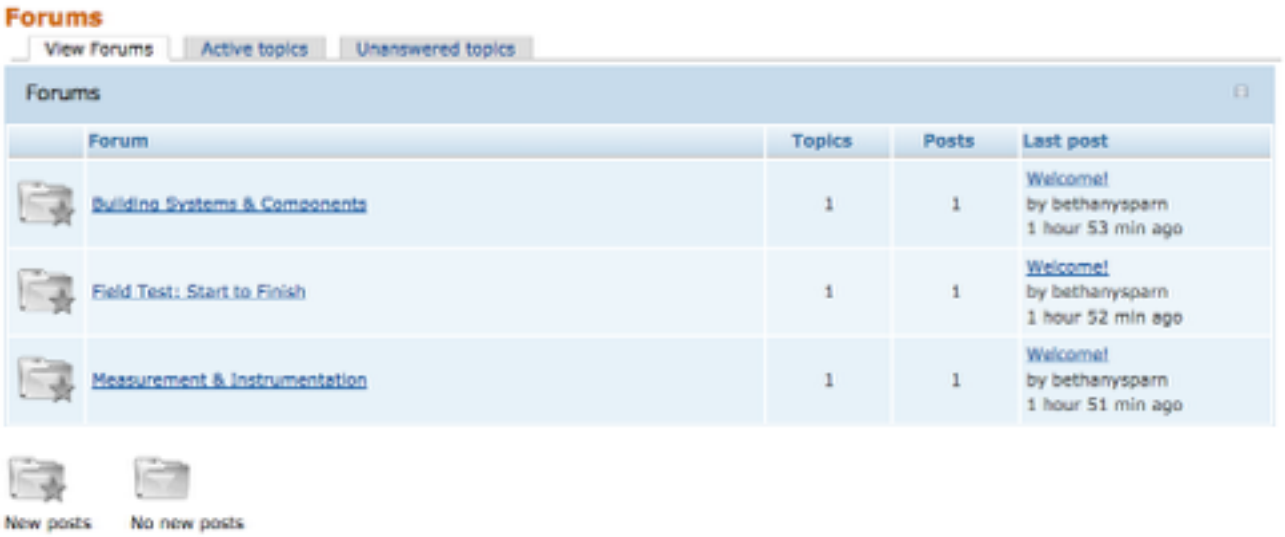


WHAT

Brand New: Facilitated Forum

- Allows informal discussion & tips exchange between members
- Can talk about direct experience with specific equipment
- Post photos, pdfs, links to other information



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HOW

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