
Stove Testing: Toward Common & Useful Methods

Tami Bond & Laura Fierce, Penn Taylor,
Nordica MacCarty, Wiecher Kamping,
Crispin Pemberton-Pigott

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Format of this session

- 15 min – Tami Goals, actions this year,
 proposed way forward
- 5 min – Penn Lab challenges
- 5 min – Nordica Field challenges
- 5 min – John Role of standard-setting bodies
- 30 min - Audience *Guided discussion* ★

Personnel notes – Tami's group

- Graduated: Chris Roden



- New:
Laura Fierce



Current Focus of ETHOS Technical Committee (TC)

- Fuel efficiency
- Pollutant emissions
 - Carbon monoxide & particulate matter
 - Method of relating to task, energy, or fuel burned
- Not exposure measurements

Recent history of testing

- Why have a testing protocol?
 - Humans have limited senses
 - Assist in design
 - Compare stoves in field
 - Develop standards *etc etc*
- Three tests: developed by Aprovecho / Berkeley
 - Water Boiling Test (WBT), Controlled Cooking Test (CCT), Kitchen Performance Test (KPT)
 - WBT is the test conducted most often
 - Some comments & criticisms
(and we need to move on)
- 2007 agreements
 - ETHOS Tech Committee formed
 - Start with existing water boiling test (WBT)

ETHOS Tech Committee Overview

2008 activity

- Web site set up (thanks **Erin** and **Tom**)
 - Issues posted to Methods list
 - Need to winnow them out from stoves list
- Formalized **committee members**
- Steps forward on **consensus protocols**
 - Water boiling test procedure & processing
 - Emission testing
 - Missed 31 July 2008 deadline, but...
 - Working on process

Testing protocol components

1. Procedure for operating the stove
2. Method of measuring and recording data
 - Temperatures (for efficiency)
 - Emissions
3. Method of interpreting the data

Operating, measuring, interpreting are separate issues.

Emissions & efficiency must be measured together.

Comments/criticisms of WBT address issues that are **separable**

1. Equations used to process data do not represent physics or thermodynamics.
2. More guidance or perspective is needed when describing the test.
3. The test is not useful for all stoves
(May result in unfair advantages for some stoves)
Batch, low-power
4. The results of the test are not reproducible.
5. Test procedures do not mimic procedures in stove use (e.g. lighting, practice, fuels)

Measurement scenarios



increasing quantity needed
increasing time commitment



increasing complexity
increasing expense

I. In-field monitoring

- confirm improvements
- rapid feedback to stove artisans

II. Stove design lab

- evaluate design choices
- demonstrate emission improvements

III. High-end testing (univ? lab?)

- validate less-expensive measurements
- parametric testing to understand variability
- understand nature of emissions for designing

Identify role of each and required accuracy

Activity on protocols, 2008

- Equations and documents rewritten
 - Penn Taylor, Morgan DeFoort
 - From lab perspective
- Comments now cast as revisions to documents
- Major activity: independent evaluation of changes (Fierce/Bond)
 - Feasibility will be addressed

Evaluation - Preview

Test Procedure: High Power, Hot Start

Berkeley (pg. 7)

1. Restart timer. Do not start until fire has started.
2. Fill pot with 5 kg of water (detailed instructions).
Instructions for multi-pot
3. Light the fire with wood from pre-weighed bundle.
4. **Record starting time; bring first pot to boil without wasting fuel.**
5. Record time when **first pot** reaches local boiling temperature.
6. After reaching boiling temperature quickly do the

Colorado State (pg. 9, 3.7)


Steps 1-5 should be completed as quickly as possible after the completion of the cold start while the stove is hot.

1. Fill pot with required amount of water (**2.5, 5, or 10kg**) that is at a **temperature of 15°C**.
The amount of water should be weighed rather than measured by volume and **should be ±2g**.
2. **Add insulation to pot** and insert thermocouple through insulation so that

Laura's change notes

- I. **Original document indicates that 5 kg is the preferred mass of water; revision implies that 2.5, 5, or 10kg is OK.**
- II. **Revision specifies starting water temperature.**
- III. **Revision specifies mass tolerance.**
- IV. **Original does not call for insulation.**
- V. **The revision includes emissions**

WBT 3.0 outline

1. Background and Purpose
2. Test protocol
 - Operating the stove
 - Setting up measurements incl. emissions
 - MODIFICATIONS FOR PRECISE LAB TESTING 
3. Equipment setup
 - Includes emissions (based on “Emission Testing for Real People”, Bond, Roden, Ogle, Still)

Appendix A. Underlying equations

Appendix B. Current equipment manufacturers

Addresses “issue types 1 & 2”- Equations, Guidance

Timeline (for document): early March 2009

Companion Document: Changes and their Implications

- Description of the change
- Technical/quantitative assessment
 - Merits
 - Implications
- Practical assessment
 - What's required to implement?
 - How easy to accomplish in field settings?
- Implications for existing test data
 - Can raw data be reprocessed?

Timeline: March, then April 2009

Comments/criticisms of WBT

1. Equations used to process data do not represent physics or thermodynamics. ✓
2. More guidance or perspective is needed when describing the test. ✓
3. The test is not useful for all stoves **Need Proposals**
(May result in unfair advantages for some stoves)
Batch, low-power
4. The results of the test are not reproducible. **Next**
5. Test procedures do not mimic procedures in stove use. **Next**

Beyond WBT 3.0

Understanding in-use vs lab

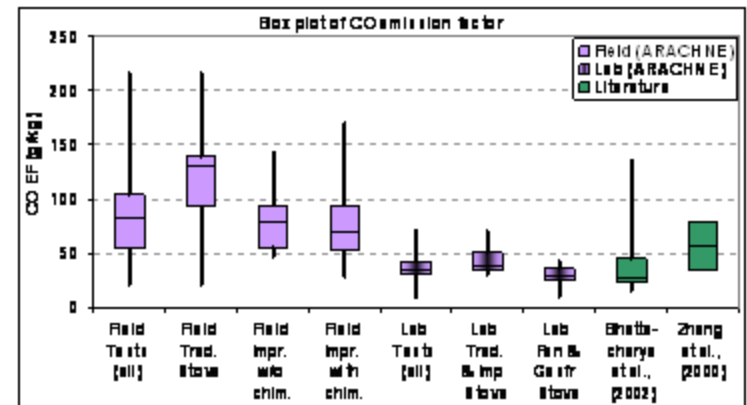
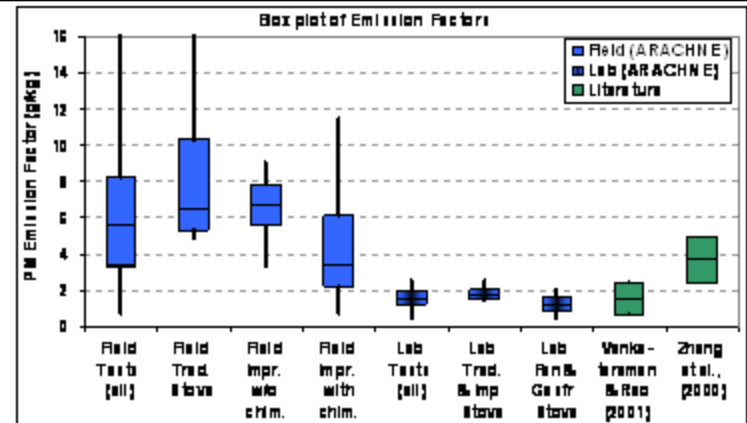


“Speculation is Worthless”

Need two types of data:

- Controlled Cooking Test vs Water Boiling Test (same stove)
- Precise lab – parametric testing

Get lots of data sets and analyze



Roden, Bond, Conway, Osorto, MacCarty & Still, Atmospheric Environment, 2009

Invest time in systematic understanding

Audience Question 1

Help write the statement describing
allowable separation between

“widely feasible procedures” and

“precise laboratory procedures”

Audience Question 2

What stakeholders need to accept the protocols we develop?

What are the barriers to that acceptance and how can we overcome them?

Audience Question 3

Bridge the division between lab versus field
(*BRAINSTORM*)

ETHOS TC participants

Christina Astante, ARECOP
Victor Berrueta, GIRA, Mexico
Tami Bond, University of Illinois at
Urbana-Champaign, USA
Morgan DeFoort, Colorado State
University, USA
Karabi Dutta, India
Evan Haigler, CEIHD, USA
Nordica MacCarty, Aprovecho
Research Center, USA
Jim Jetter, U.S. Environmental
Protection Agency, USA
Veena Joshi, SDC, India
Wiecher Kamping, Philips Consumer
Lifestyle, Netherlands
Bear Kaufmann, gasification group,
Berkeley, USA
Salik Khawaja, British Petroleum, UK
Nick Lam, Berkeley Air, USA

Mathew Langol, ANCC/Aprovecho,
Uganda
Philip Lloyd, University of Cape
Town, South Africa
H.S. Mukunda, Indian Institute of
Science/Bangalore, India
Hellen Owala, Practical Action,
Kenya
Crispin Pemberton-Pigott,
GTZ/Probec, Swaziland
James Robinson, HEDON, UK
Norbert Senf, Heatkit, Canada
Penn Taylor, Iowa State University,
USA
Chandra Venkataraman, IIT
Bombay, India
Piet Visser