

Overview of ISO 19867-1 Laboratory Testing



Jim Jetter

Kathmandu, Nepal; Dhaka, Bangladesh; December 2018

Outline

- How was the ISO standard developed?
- How are emissions and efficiency tests conducted?
- How are safety tests conducted?
- How are durability tests conducted?



ISO Technical Committee 285

- 3 standards published
 - ISO 19867-1:2018, Laboratory testing
 - ISO TR 19867-3:2018, Voluntary performance targets
 - ISO TR 21276:2018, Terms and definitions
- 2 standards under development
 - ISO DIS 19869, Guidance on field testing
 - ISO NP 19915, Guidelines for social impact assessment



ISO TC 285

- Working Group 1 – Conceptual Framework
- Working Group 2 – Laboratory Testing
- Working Group 3 – Field Testing
- Working Group 4 – Social Impact Assessment
- Task Group 1 – Communications
- Task Group 2 – Fuels
- Task Group 3 – Title and Scope



Working Group 2 – laboratory testing

- Richard Ebong, Convenor, ISO 19867-1 and -3
- Jim Jetter, Project Leader, ISO 19867-1 and -3
- Michael Johnson, Expert ISO 19867-1 and
Team Leader ISO 19867-3
- >100 members from 18 countries and 5 liaison organizations



ISO Lab and Field Testing Protocols

- **Based on**
 - Best practices from existing protocols
 - Knowledge/experience of Working Group experts
 - Methodology in related sectors
- **Trade-offs**
 - Cost
 - Reflection of actual use
 - Statistical power



Best practices from existing laboratory testing protocols

	China	India	HTP	CSI-Indo	WBT	IWA
3 cooking power levels			✓	✓		
2 cooking power levels					✓	✓
1 cooking power level	✓	✓				
Efficiency	✓	✓	✓	✓	✓	✓
PM (particulate matter), gravimetric (filter) method	✓	✓		✓	✓	✓
CO (carbon monoxide)	✓	✓	✓	✓	✓	✓
Emissions factors based on useful energy (MJ _{delivered})	✓	✓	✓	✓	✓	✓
Emission rates (per time)					✓	✓

How to test a stove for emissions and efficiency with ISO 19867-1

Determine Fuel

- Either use fuel specified by manufacturer
- Or use fuel identified in the field



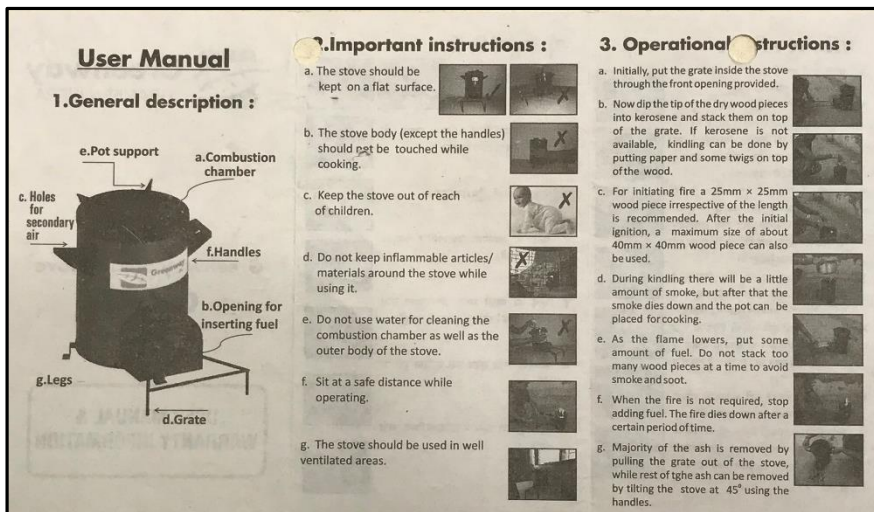
Determine Cooking Vessel

- Either use cooking vessel (e.g., pot) specified by manufacturer
- Or use cooking vessel identified in the field



Determine Operating Procedure

- Either use operating procedure specified by manufacturer
- Or use operating procedure identified in the field



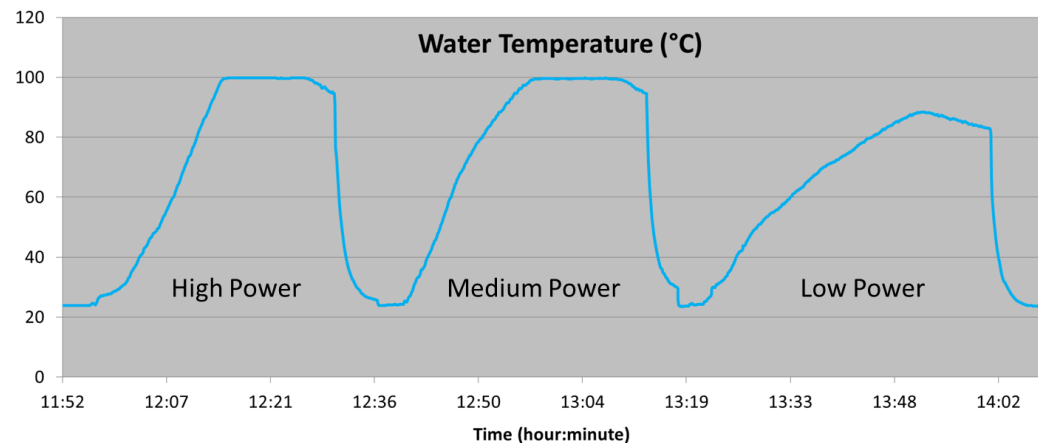
Determine fuel load

- Test stove to determine amount (mass) of fuel required for ~30 minutes of operation at:
 - High power
 - Medium power (if applicable)
 - Low power (if applicable)



Test the stove

- At high power for 30 minutes
- At medium power for 30 minutes (if applicable)
- At low power for 30 minutes (if applicable)

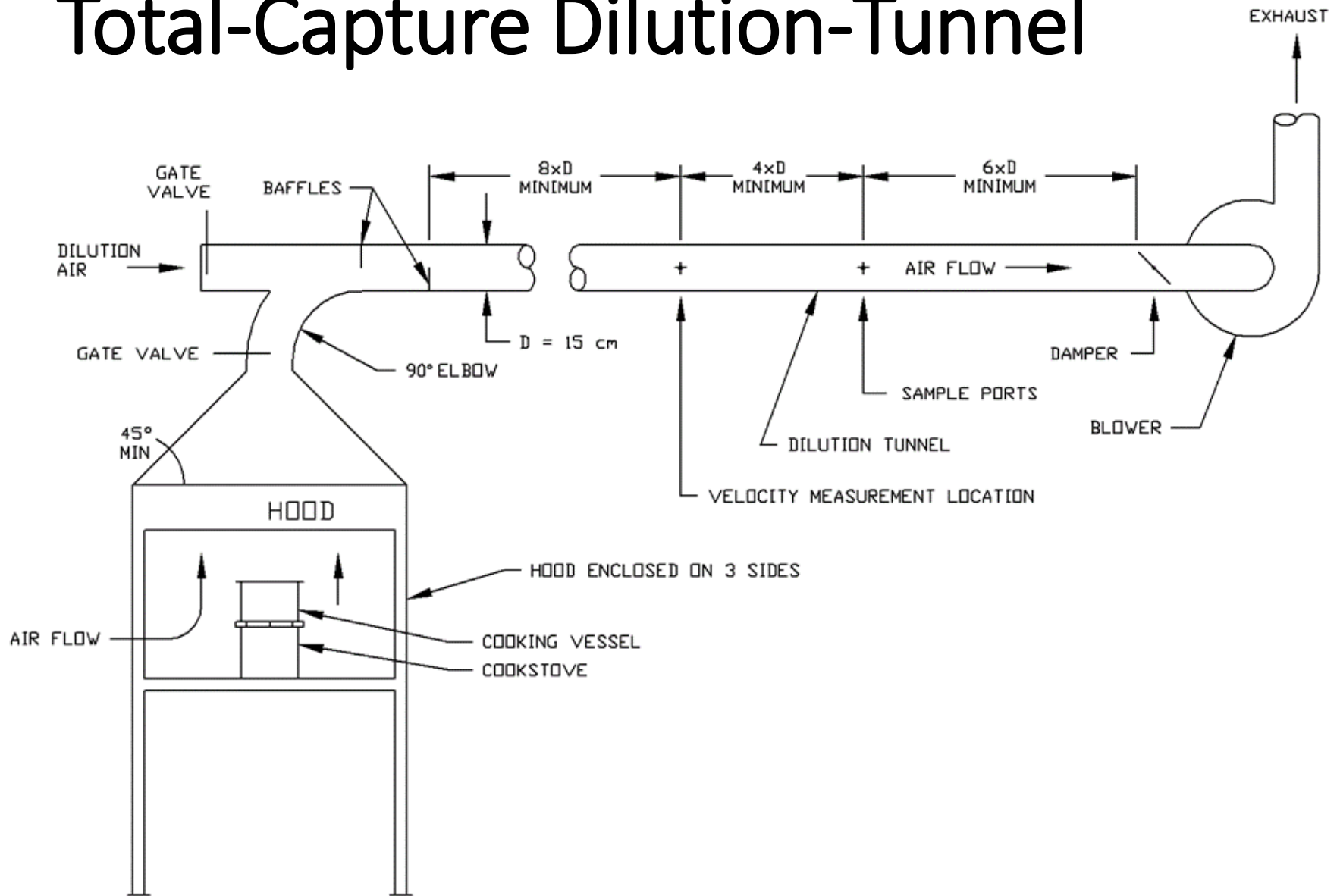


Measure

- Water temperature and mass
- Fuel mass, moisture, and energy content
- Char (if applicable) mass and energy content
- Time
- Emissions of $\text{PM}_{2.5}$, gravimetric (filter) method
- Emissions of CO and CO_2



Total-Capture Dilution-Tunnel



Solar cookers

- Test for cooking power per ASAE S580.1 – *Testing and Reporting Solar Cooker Performance*



Report

- Cookstove system tested
 - Cookstove
 - Fuel
 - Cooking vessel
 - Operating procedure
- Test conditions
 - Fuel burning rates at high, medium, and low power
- Performance (at high, medium, and low power)
 - Cooking power (kW)
 - Efficiency
 - Emission factors ($\text{g/MJ}_{\text{delivered}}$) and emission rates (g/min) for $\text{PM}_{2.5}$, CO, and CO_2

Example results

Cookstove	Acme Model X-9876
Fuel	Wood, eucalyptus, 2 x 2 x 36 cm, 11% moisture (wet basis)
Cooking vessel	Pot, stainless steel, flat bottom, 5 liter, 20 x 22 cm dia.
Operating Procedure	Per manufacturer's written instructions

Power Level	High	Medium	Low
Fuel burning rate (g/h)	720	547	355
Cooking Power (W)	1690	1513	960
Efficiency Metric 1 (%)	37.7	40.4	41.9
Efficiency Metric 2 (%)	39.3	43.6	46.7
PM _{2.5} per useful energy (mg/MJ _d)	68.9	47.2	56.5
CO per useful energy (g/MJ _d)	3.76	1.88	2.15
PM _{2.5} emission rate (mg/h)	532	257	195
CO emission rate (g/h)	22.9	10.2	7.4

Safety testing

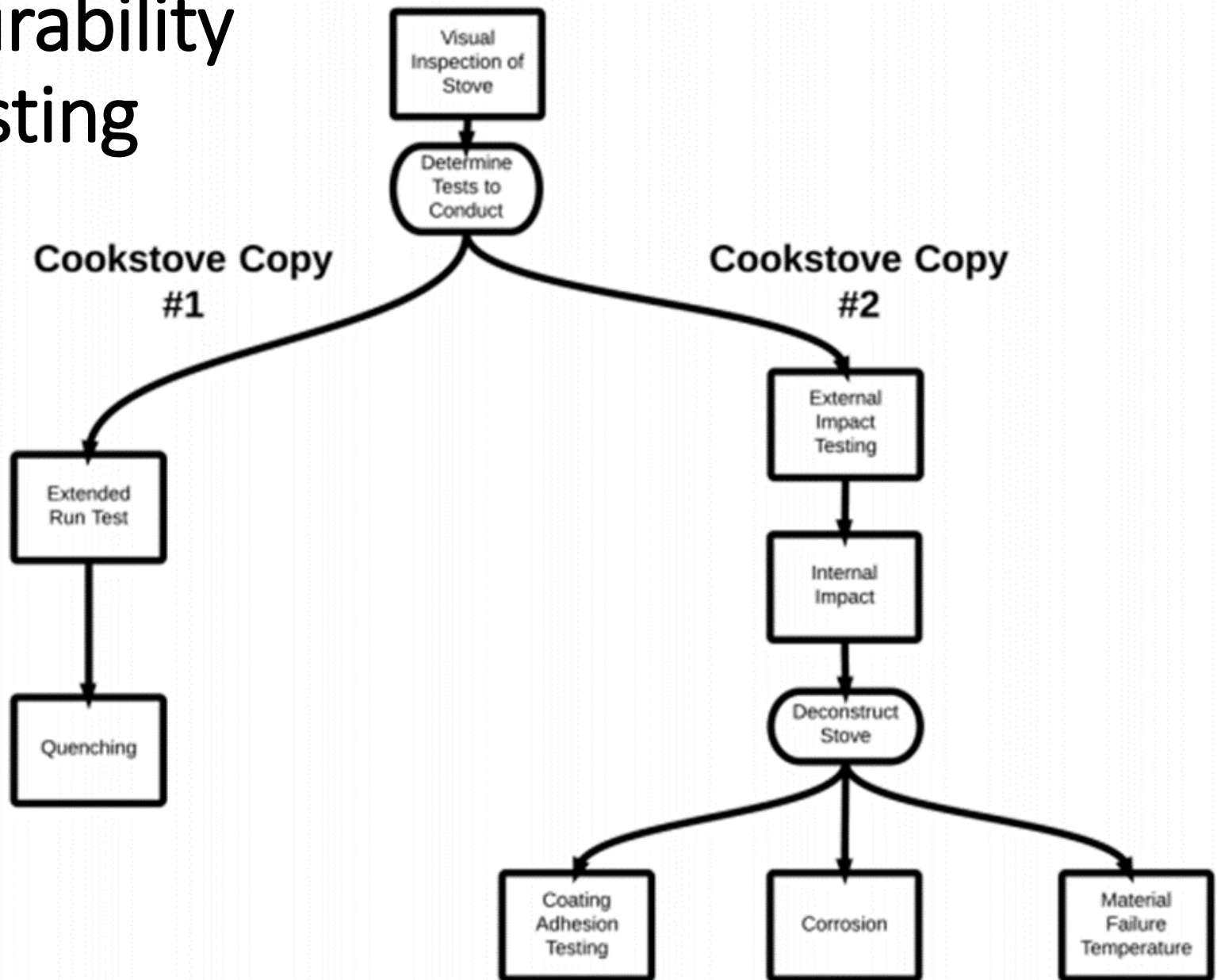
- Test 1: Sharp edges and points
- Test 2: Cookstove tipping
- Test 3: Containment of fuel
- Test 4: Obstructions near cooking surface
- Test 5: Surface temperature
- Test 6: Heat transfer to the environment
- Test 7: Handle temperature
- Test 8: Chimney shielding
- Test 9: Flames surrounding cooking vessel
- Test 10: Flames exiting fuel chamber



Example safety test results

Safety test component	Sub-score	Sub-score range	Weight
1. Sharp edges and points	3	0 - 4	1,5
2. Tipping	4	0 - 4	3
3. Containment of fuel	3	0 - 4	2,5
4. Obstructions near cooking surface	4	0 - 4	2
5. Surface temperature	4	0 - 4	2
6. Heat transfer to environment	4	0 - 4	2,5
7. Handle temperature	4	0 - 4	2
8. Chimney shielding	2	0 - 4	2,5
9. Flames surrounding cooking vessel	4	0 - 4	3
10. Flames exiting fuel chamber	4	0 - 4	4
Total safety factor score			91
Tier Rating (if applicable)			4

Durability testing



Example durability test results

Durability test component	Risk factor sub-score	Risk factor sub-score range
1. Extended run	0	0 - 5
2. External impact	2	0 - 6
3. Internal impact	1	0 - 6
4. Corrosion	5	0 - 5
5. Coating adhesion	4	0 - 5
6. Quenching	0	0 - 5
7. Material failure	0	0 - 5
Total risk factor score		12
Tier Rating (if applicable)		4

Questions & Discussion