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Clean cookstoves and clean cooking solutions — Test protocols for institutional cookstoves

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Foreword

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This document was prepared by Technical Committee ISO/TC 285, *Clean cookstoves and clean cooking solutions*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document is applicable for evaluating institutional cookstoves. Institutional cookstoves often have characteristics requiring specific considerations not already covered under ISO 19867-1 and ISO 19869. These considerations include, but are not limited to, the following.

— The cooking vessels and contents used with some institutional cookstoves may be too heavy to be practically removed for weighing, as specified in ISO 19867-1.

— Institutional cookstoves tend to operate at high firepower with substantial release of emissions requiring specific measurement considerations.

— Built-in-place institutional cookstoves can be difficult or impossible to transport to a laboratory for testing, and this may require them to be tested in place (in situ).

— For some institutional cookstoves that produce char, the hot char remaining at the end of test phases can be difficult or unsafe to remove for weighing, as specified in ISO 19867-1 and ISO 19869.

— Institutional cookstoves often have longer operating durations and more specialized cooking tasks than household cookstoves. Test phases specified in ISO 19867-1:2018, 6.2 are not applicable for most institutional cookstoves.

— Heat radiation from chimneys is a safety concern because of the higher firepower of institutional cookstoves compared with household cookstoves.

Because of these reasons, additional guidance is needed for testing institutional cookstoves.

Institutional cookstoves may be tested for either energy performance only (such as efficiency, power and/or specific energy consumption), or energy performance and air pollutant emissions together. Institutional cookstoves may be tested separately for safety (see Clause 7) and/or durability (see Clause 8).

An institutional cookstove may be tested in a laboratory if the cookstove is either portable (can be transported to the laboratory) or can be built-in-place in the laboratory, as specified in Clause 5. An institutional cookstove may be tested in situ (rather than, or in addition to, in a laboratory), as specified in Clause 6.

In Table 1, options are listed for testing institutional cookstoves for energy performance and air pollutant emissions either in the laboratory or in situ, along with primary energy performance and emissions metrics. Primary and other metrics are described in Clauses 5 and 6.

The performance of two or more different institutional cookstoves may be compared with the same appropriate protocol options and test conditions, as specified in this document.

It is common for an institutional cookstove to be one element of larger, multi-component systems. These systems may include multiple fuel/energy sources or modes of operation. Therefore, multiple tests or protocols may be required to evaluate the range of potential use scenarios for a given cooking system.

Table 1 — Testing options

Testing options	Primary energy performance metrics (units)		Primary emissions metrics (units)[a]
Water-heating test With test sequence defined by either field data in 5.2.6 or protocol, in 5.2.7 — Laboratory testing, Clause 5 — In situ testing, Clause 6	Thermal efficiency (%) Specific energy consumption, fuel energy / product mass (MJ/kg)	Cooking power (kW) Firepower (kW)	Emission factors, pollutant mass / delivered energy (mg/MJ) Pollutant mass/ fuel energy(mg/MJ) Emission rates (mg/min)
Controlled cooking test — Laboratory testing, Clause 5 — In situ testing, Clause 6	Specific energy consumption, fuel energy / product mass (MJ/kg)	Firepower (kW)	Emission factors pollutant mass/ fuel energy (mg/MJ) Emission rates (mg/min)
Uncontrolled cooking test — In situ testing, Clause 6	Usage (min/day)		
[a] NOTE Emissions testing is optional, as described in the Introduction.			

Clean cookstoves and clean cooking solutions — Test protocols for institutional cookstoves

1 Scope

This document provides testing methods to evaluate the energy performance, emissions, safety and durability of institutional cookstoves. For general guidance (not a requirement), institutional cookstoves typically have firepower greater than 10 kW and/or cooking vessel volume greater than 25 l. The evaluation of household cookstoves is covered in ISO19867-1 and ISO19869 and is not addressed in this document.

This document provides the following:

— quantitative and qualitative measurements of performance and safety of institutional cookstoves – methods include uncontrolled and controlled cooking tests;

— guidance for the measurement of air pollution, and;

— guidance for prioritizing measurements that balance comprehensiveness and feasibility.

This document includes testing methods for energy performance, emissions and durability that are applicable to institutional cookstoves that burn solid, liquid, and gaseous fuels and for energy performance, safety and durability that are applicable to institutional cookstoves powered by solar thermal energy.

Safety testing methods are applicable to institutional solar cookstoves and cookstoves that burn solid fuels and are not applicable to cookstoves that burn liquid or gaseous fuels, such as LPG (liquefied petroleum gas), alcohol, plant oil or kerosene. Safety evaluation of gas-fuelled cookstoves can be found in ISO 23550 and the ISO 23551 series. Safety evaluation of liquid-fuelled cookstoves is not found in existing ISO standards. This document is not applicable to electric cookstoves.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 19867-1:2018, *Clean cookstoves and clean cooking solutions — Harmonized laboratory test protocols — Part 1: Standard test sequence for emissions and performance, safety and durability*

ISO 19869:2019, *Clean cookstoves and clean cooking solutions — Field testing methods for cookstoves*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
built-in-place cookstove
cookstove (3.5) in which the majority of assembly and/or construction takes place where it will be used

3.2
char
carbonaceous residue resulting from pyrolysis or incomplete combustion of solid biofuels

3.3
cooking power
average rate of energy delivered to the contents of a *cooking vessel* (3.4) over any chosen period during the course of a cooking sequence or other task

Note 1 to entry: The cooking power is expressed in kilowatts.

3.4
cooking vessel
pot or container in which food or water is heated and prepared

3.5
cookstove
appliance primarily employed for the cooking of food, but which may also be employed for space or water heating or other purposes

3.6
dilution tunnel
device in which ambient or cleaned air is mixed with an emission stream in a controlled and measured volumetric flow rate

3.7
durability
ability of a *cookstove* (3.5) to continue to be operated for an extended period in a safe manner and with minimal loss of performance

3.8
emission factor
ratio of the mass of a pollutant emitted to a defined measure that quantifies the activity emitting the pollutant

EXAMPLE Potential defined measures for emission factors include the *useful energy delivered* (3.23), mass of the fuel consumed, the dry mass of the fuel consumed, or the energy of the fuel consumed.

3.9
emission rate
mass of an air pollutant emitted per unit time

Note 1 to entry: The emission rate is expressed in mg/h or g/s.

3.10
field
locations where cooking is normally performed in real-world situations, such as homes and target communities

3.11
firepower
over a specified period in the burn sequence, rate of energy release from the combustion of the fuel assuming complete combustion

Note 1 to entry: The firepower is expressed in kilowatts.

3.12
ignition
initiation of a period of a self-sustained combustion reaction

3.13
institutional cookstove
appliance primarily employed for the cooking of food, but which may also be employed for space or water heating or other purposes, in settings that require more *cooking power* (3.3) than provided by household appliances

EXAMPLE Settings may include, but are not limited to, schools, hospitals, restaurants, displaced-persons camps, etc.

3.14
laboratory
facility that provides controlled conditions for conducting research and evaluating performance

3.15
laboratory testing
measurement of product performance quantified under controlled and documented conditions, where performance can be replicated by duplicating those conditions

3.16
$PM_{2,5}$
fine particulate matter such that the aerodynamic diameter of the particles is less than or equal to 2,5 µm

3.17
risk
product of the severity of the consequences of a hazard and the likelihood that the hazard will occur

3.18
safety
ability of a *cookstove* (3.5) to be operated at an acceptable level of *risk* (3.17) of harm

3.19
solar cookstove
device that delivers useful cooking heat from thermal energy received from the sun

3.20
thermal efficiency
ratio of *useful energy delivered* (3.23) to fuel energy used

3.21
thermocouple
temperature sensor consisting of two dissimilar metals forming an electrical junction

3.22
usage
action, amount, or mode of using a cooking device; often a quantitative measure of time that a *cookstove* (3.5) is used

3.23
useful energy delivered
energy transferred to the contents of a *cooking vessel* (3.4), including sensible heat energy that raises the temperature of the contents of the cooking vessel and the latent heat of evaporation of water from the cooking vessel

Note 1 to entry: For *cookstoves* (3.5) that are used for both cooking and space heating, useful energy delivered may also include heat delivered to a living space.

Note 2 to entry: For cookstoves that are used for both cooking and baking, or for baking only, useful energy delivered may also include the heat delivered to the baking process.

3.24
water-heating test
test of a *cookstove* (3.5) that uses one or more *cooking vessels* (3.4) or heat exchangers containing water that are heated to a specified temperature less than the local boiling point during a defined set of burn sequences

4 Abbreviated terms

C	carbon
CCT	controlled cooking test
CI	confidence interval
CO	carbon monoxide
CO_2	carbon dioxide
EF	emission factor
LPG	liquefied petroleum gas
$PM_{2,5}$	particulate matter with an aerodynamic diameter ≤ 2,5 µm
SD	standard deviation
UCT	uncontrolled cooking test
~	approximately

5 Emissions and energy performance of institutional cookstoves tested in the laboratory

5.1 General

The laboratory testing systems to be used shall be designed to handle the high firepowers often seen with institutional cookstoves. The laboratory emissions testing system shall provide sufficient dilution to ensure that gaseous pollutant concentrations are within the range of instruments, and that $PM_{2,5}$ concentrations are low enough to avoid overloading filter samples. If a total-capture dilution-tunnel system is used, then the system shall provide sufficient airflow to ensure total capture of air pollutant emissions, and adequate heat removal exists so air/gas temperature in the dilution tunnel does not exceed 60 °C. A total-capture dilution-tunnel system shall meet the requirements specified in ISO 19867-1:2018, 5.3.8.

If a partial-capture emissions measurement system is used, then the system shall meet the requirements specified in ISO 19869:2019, 8.4 and 8.5.

If a typically built-in-place cookstove is to be tested in the laboratory, then the cookstove may be either:

— constructed on a platform, pallet, or wheeled cart for moveability; or

— constructed in the laboratory for testing and then deconstructed and removed after testing.

The following testing protocols may be used for testing institutional cookstoves in the laboratory, depending on the objectives and constraints of the testing.

— ISO 19867-1:2018, Clauses 5 and 6, laboratory test methods with exceptions for institutional cookstoves

  This protocol can be used for testing institutional cookstoves under controlled conditions with a water-heating test. Test conditions may be defined with or without data from field use on fuels, cooking vessels, operating procedures, test phase duration(s) and test phase power level(s). Exceptions to ISO 19867-1:2018 for testing institutional cookstoves are specified in 5.2.

— ISO 19869:2019, 7.6, controlled cooking test with exceptions for institutional cookstoves

  This protocol can be used for testing institutional cookstoves under controlled conditions with an appropriate standard cooking task that is typical of the region for the cooking technologies being tested. Exceptions to ISO 19869:2019 for testing institutional cookstoves are specified below in 5.3.

5.2 ISO 19867-1:2018, Clauses 5 and 6, laboratory test methods with exceptions for institutional cookstoves

In ISO 19867-1:2018, Clauses 5 and 6, laboratory test methods for emissions and efficiency, may be used with the following exceptions for institutional cookstoves.

If the cooking vessel with contents (water) cannot be safely and practically removed from the institutional cookstove for weighing as specified in ISO 19867-1:2018, 6.7, then the cookstove may be tested using either the platform scale method in 5.2.3 or the pre-evaporation method in 5.2.4.

Institutional cookstoves often have longer operating durations and more specialized cooking tasks than household cookstoves. The test phases specified in ISO 19867-1:2018, 6.2 are not applicable for most institutional cookstoves. The test phase duration(s) and power level(s) for testing shall be defined by the methods specified in 5.2.6.

In addition to the energy performance metrics specified in ISO 19867-1:2018, specific energy consumption, as defined in ISO 19869:2019, Clause 7, shall be calculated and reported to enable comparison of results with controlled cooking tests conducted in the laboratory or in situ.

5.2.1 Volume of water

The volume of water in the cooking vessel specified in ISO 19867-1:2018, 6.5.2 may not be applicable to institutional cookstoves. For testing institutional cookstoves, the volume of water for testing shall be determined by either (a) field data or (b) cookstove manufacturer's written instructions or (c) agreement between the interested parties, such as the testing laboratory, sponsors (entities paying for testing), authorities, etc. Conflicts of interest shall be avoided, see ISO 19867-1:2018, 9.2.4.3.

If field data are available regarding typical volume of water or liquid observed during actual use, then that volume of water may be used for testing. A detailed description of the methodology and statistical indicators of the representativeness of the field data shall be provided along with the laboratory test results, as specified in Clause 9, if field data are used to determine the water volume.

The method used to determine the water volume (a, b, or c in this subclause) shall be included in the final report of results, as specified in Clause 9.

The volume of water used for testing may significantly affect the results. A sensitivity analysis to evaluate the impact of using different volumes of water is recommended.

Note that for institutional cookstoves with pot skirts or with sunken pots, filling the pot with water up to the level at which the pot is exposed to hot combustion gases typically maximizes thermal efficiency and minimizes emission factors based on useful energy delivered.

5.2.2 Cooking vessel lids

Testing without a lid on the cooking vessel, as specified in ISO 19867-1 may or may not be applicable for institutional cookstoves. For testing institutional cookstoves, the use of a lid shall be determined by either (a) field data or (b) the cookstove manufacturer's written instructions or (c) agreement between the interested parties, such as the testing laboratory, sponsors, and authorities.

If field data are available regarding the use of lids observed during actual use, then lids may be used for testing. A detailed description of the methodology and statistical indicators of the representativeness of the field data shall be provided along with the laboratory test results, as specified in Clause 9, if field data are used to determine the use of lids.

The method used to determine the use of a lid (a, b, or c in this subclause) shall be included in the final report of results, as specified in Clause 9.

If the cooking vessel is a pressure cooker, then the pressure cooker shall be operated with its lid, following the instructions from the manufacturer. The cooking vessel shall be described in the final report.

5.2.3 Platform scale method

If the platform scale method is used, then the following specifications apply.

The institutional cookstove, cooking vessel, and contents (water) shall be placed together on a platform scale with sufficient maximum capacity and with resolution, accuracy, and precision of at least 0,1 % of the total measured mass. The platform scale shall be used to determine the mass of water in the cooking vessel lost to evaporation for efficiency calculations, as specified in ISO 19867-1:2018, 5.4.2.

Some cookstoves (especially some ceramic cookstoves) absorb moisture from the air when at ambient temperature and lose moisture through evaporation when heated – this may affect mass measurements. For cookstoves constructed entirely with metal, the change in mass, due to changes of water absorbed in the stove material, can be assumed to be negligible. For cookstoves constructed of other materials, tests shall be conducted to determine the change in mass due to moisture absorption and loss from the cookstove itself. The change in mass shall be accounted for in calculations for efficiency. If the change in mass cannot be consistently accounted for, then the platform scale method shall not be used.

5.2.4 Pre-evaporation method

If the pre-evaporation method is used, then the following specifications apply.

Water shall be weighed before placing it into the cooking vessel. The water can be weighed in batches that are added together to determine the total weight of water in the cooking vessel.

Water shall be at a temperature within ±5 °C of the ambient air temperature at the beginning of the test phase.

The cookstove shall heat water to a final temperature limited as follows:

$$T_f \leq (T_b - 20\ °C) \quad (1)$$

where

T_f is the temperature (final) of water at the end of the test phase (°C);

T_b is the temperature of the local water boiling point (°C).

The efficiency calculation shall be based on the mass of fuel used for heating the water to a temperature T_f, assuming the mass of water lost to evaporation is negligible.

If an institutional cookstove is tested for emissions, then emissions measurements shall continue for the test phase duration(s), as defined in 5.2.6. Depending on the testing protocol and the performance of the cookstove, the test phase may continue past the time when the temperature of the water reaches 20 °C below the local boiling point to capture and measure the emissions.

5.2.5 Char remaining after a test phase

When cookstoves are fuelled with wood and other solid biomass fuels, char typically remains at the end of test phases, and the char is weighed as specified in ISO 19867-1:2018, 5.3, 5.4, 6.2, and 6.7.2.

If char particles remain in ash at the end of test phases, then a screen may be used to separate the particles. If a screen is used, then the screen size shall be reported with the results of the test. A screen opening size of 3 mm is recommended.

For some institutional cookstoves, it may be difficult and unsafe to remove the remaining hot char at the end of test phases. The decision to exclude removing and weighing of char shall be at the tester's discretion and shall be documented in the testing report. If it is unsafe to remove the remaining char, then the char shall not be weighed, and the following metrics from ISO 19867-1 shall not be applicable:

— cooking thermal efficiency calculation with energy credit for remaining char [ISO 19867-1:2018, Formula (7)];

— char energy productivity [ISO 19867-1:2018, Formula (8)];

— char mass productivity [ISO 19867-1:2018, Formula (9)].

5.2.6 Test phase duration(s) and power level(s)

The test phase duration(s) and power level(s) for testing shall be defined by either:

a) a field data; or

b) the institutional cookstove testing protocol described in 5.2.7.

Field-informed duration(s) and power level(s) may be used for testing if field data are available.

EXAMPLE If verifiable field data indicate that a certain institutional cookstove is typically used to boil 100 kg of root vegetables once per day, then it is appropriate to test that cookstove in the laboratory with 100 kg of water at a power level sufficient to maintain boiling temperature for a similar time duration.

If field data are used to determine the duration(s) and power level(s), then a detailed description of the methodology and statistical indicators of the representativeness of the field data shall be provided along with the laboratory test results. If the pre-evaporation method described in 5.2.4 is used, then the time may be limited for test-phase durations for the purpose of determining efficiency, because the end of phases may occur when the water temperature reaches T_f, as defined in 5.2.4.

If emissions testing is conducted, then emissions shall be captured and measured during the fuel ignition period, fuel-burning period, and shutdown period for each test phase.

The method used to determine the test phase durations(s) and power level(s) (a or b in this subclause) shall be included in the final report of results.

5.2.7 Institutional cookstove testing protocol

This testing protocol is intended to provide a standardized method for evaluating efficiency and emissions for institutional cookstoves. The pre-evaporation method (see 5.2.4) is specified so that any institutional cookstove can be tested without the safety risk of weighing hot water at the end of test phases and without the cost of using an expensive platform scale.

It is important that cookstoves meet user needs as well as perform well in terms of efficiency and emissions; therefore, additional function tests are recommended, as follows.

If an institutional cookstove is designed to boil water, then an additional function test should be performed to evaluate whether the cookstove has adequate cooking power to bring water to a boiling temperature. The local boiling point of water should be determined as specified in ISO 19867-1:2018, 6.7.1 j). The final water temperature and time required should be reported along with the specified results for efficiency and emissions.

If an institutional cookstove is designed to flash fry food in cooking oil, then an additional function test should be performed to evaluate whether the cookstove has adequate cooking power to flash fry food in cooking oil. The evaluation of flash-frying capability by experienced unbiased cooks should be reported along with the specified results for efficiency and emissions.

The following test protocol may be used when data on the duration(s) and power level(s) of cookstove use in the field are not available, or when data indicate inconsistent use. For example, if actual duration and firepower data document a wide range of operation with no representative sequence, then the following test protocol may be used.

The institutional cookstove shall be tested at one, two, or three power levels, as specified in ISO 19867-1:2018, 6.1. Power levels shall be determined as specified in ISO 19867-1:2018, 6.6.

The pre-evaporation method (see 5.2.4) shall be used. For each power level, the test phase fuel-burning period shall end when either the water temperature reaches 20 °C below the local boiling point or one hour elapses, whichever occurs first.

If emissions testing is conducted, emissions shall be captured and measured during the fuel ignition period, fuel-burning period, and shutdown period for each test phase.

The shutdown period shall begin after the fuel-burning period and shall end when either the water temperature drops 5 °C or 10 min elapses, whichever comes first.

5.3 ISO 19869:2019, 7.6, controlled cooking test with exceptions for institutional cookstoves

The controlled cooking test from ISO 19869:2019, 7.6, may be used in a laboratory with the following exceptions for institutional cookstoves:

— experienced cooks (not laboratory technicians) shall operate the institutional cookstoves with minimal interference from the laboratory staff;

— institutional cookstoves may be tested either for specific energy consumption only or specific energy consumption and emissions together.

Specific energy consumption shall be determined as specified in ISO 19869:2019, Clause 7.

Average firepower shall be determined as specified in ISO 19869:2019, 9.3.

5.4 Emissions testing for institutional cookstoves with multiple chimneys

If an institutional cookstove with multiple chimneys is tested for emissions, then a representative sample shall be collected by using either a total-capture-hood, as specified in ISO 19867-1:2018, 5.3.8, to capture the emissions from all chimneys, or a sampling probe, as specified in ISO 19869:2019, 8.5.3, that collects a representative sample from all chimneys.

If more than one cookstove is connected to a chimney, then each cookstove shall be tested separately.

6 Emissions and energy performance of institutional cookstoves tested in place (in situ)

6.1 General

In situ institutional stoves may be tested using either of the following protocols, depending on the objectives and constraints of the testing:

— water-heating test (ISO 19867-1:2018, Clauses 5 and 6) with exceptions for institutional cookstoves specified in 6.2;

— controlled cooking test (ISO 19869:2019, 7.6) with exceptions for institutional cookstoves specified in 6.3;

— uncontrolled cooking test (ISO 19869:2019, 5.3.3) with exceptions for institutional cookstoves specified in 6.4.

If an in situ institutional cookstove is tested for emissions, then a partial-capture emissions testing system, specified in ISO 19869:2019, 8.4 and 8.5, shall be used.

6.2 Water-heating test (in situ), ISO 19867-1:2018, Clauses 5 and 6, with exceptions for institutional cookstoves

This protocol can be used for testing institutional cookstoves under controlled conditions with a water-heating test. Test conditions may be defined with or without data from field use on fuels, cooking vessels, operating procedures, test phase duration(s) and test phase power level(s). In situ water-heating tests are equivalent to laboratory water-heating tests, and shall use the methodology with exceptions to ISO 19867-1:2018 for testing institutional cookstoves, as specified in 5.2.

6.3 Controlled cooking tests (in situ), ISO 19869:2019, 7.6, with exceptions for institutional cookstoves

6.3.1 General

This protocol can be used for testing institutional cookstoves under controlled conditions with an appropriate standard cooking task that is typical of the region for the cooking technologies being tested.

In situ controlled cooking tests are equivalent to laboratory-controlled cooking tests and shall use the methodology in 5.3.

Specific energy consumption shall be determined as specified in ISO 19869:2019, Clause 7.

Average firepower shall be determined as specified in ISO 19869:2019, 9.3.

6.3.2 Controlled cooking tests with a water boiling cooking task

Controlled cooking tests that include water boiling shall be conducted using ISO 19869:2019, Clause 7 for specific energy consumption. The volume of water shall be determined as specified in 5.2.1.

6.3.3 Controlled cooking tests without a water boiling cooking task

Controlled cooking tests that include cooking, not water boiling, shall be conducted using ISO 19869:2019 Clause 7 for specific energy consumption.

6.4 Uncontrolled cooking tests (in situ), ISO 19869:2019, 5.3.3, with exceptions for institutional cookstoves

This protocol can be used for testing institutional cookstoves under uncontrolled conditions with the cooking task not constrained. Cooks are free to prepare what they want, how they want, using whatever cooking implements and fuels they choose.

If at least three of the same type of cookstove are available for testing, then a minimum of three stoves shall be tested, each with at least three replicates. If two of the same type of cookstove are available, then the two cookstoves shall be tested, each with at least three replicates. If only one cookstove is available, then the cookstove shall be tested with at least three replicates. For institutional stoves prone to inconsistencies, such as those built in place by hand, more tests may be required. See ISO 19869:2019, 5.5, for further guidance.

Average firepower shall be determined as specified in ISO 19869:2019, 9.3.

Usage shall be determined as specified in ISO 19869:2019, Clause 6.

6.5 Emissions testing for institutional cookstoves with multiple chimneys

If an institutional cookstove with multiple chimneys is tested for emissions, then a sample shall be collected by using a sampling probe that collects a representative sample from all chimneys.

If more than one cookstove is connected to a chimney, then each cookstove shall be tested separately.

7 Safety testing

7.1 General

Safety testing for institutional cookstoves shall be conducted as specified in ISO 19867-1:2018, Clause 7, with the following exceptions.

The surface temperature tests specified in ISO 19867-1:2018, 7.2.6, are not applicable and shall be replaced with the surface temperature test specified in ISO 19869:2019, 10.6.4.6. Surface temperatures for burn thresholds in ISO 19869 follow guidance in ISO 13732-1. Surface temperature testing shall be applicable to all surfaces, including the chimney, at heights below 1,5 m from any surface the user may stand upon.

Heat radiation from chimneys is a safety concern because of the higher firepower of institutional cookstoves compared with household cookstoves. Chimneys shall be evaluated with a chimney shielding and insulation test, as specified in 7.2.

The safety scoring system specified in ISO 19867-1:2018, 7.2.5.4 is not applicable, and institutional cookstoves shall be scored for safety as specified in 7.3.

Safety test specifications are summarized in Table 2.

Table 2 — Safety tests

Safety tests	Specifications
Sharp edges and points	ISO 19867-1:2018, 7.2.2
Tipping	ISO 19867-1:2018, 7.2.3
Containment of fuel	ISO 19867-1:2018, 7.2.4
Obstructions near cooking surface	ISO 19867-1:2018, 7.2.5
Surface temperature	ISO 19869:2019, 10.6.4.6
Chimney shielding and insulation	7.1
Flames surrounding cooking vessel	ISO 19867-1:2018, 7.2.8

Table 2 *(continued)*

Safety tests	Specifications
Flames exiting fuel chamber	ISO 19867-1:2018, 7.2.9

7.2 Chimney shielding and insulation test

Due to the higher firepower of institutional cookstoves compared with household cookstoves, it is important to shield users both from high surface temperatures that may cause burns and from radiant heat that may cause heat exhaustion.

To rate a best score of 4, a chimney shall have both shielding to effectively protect from burns and insulation to protect from radiant heat. Shielding and insulation may be provided by the same structure, e.g. a triple-walled chimney. Shielding shall be at least 2 m high from any surface the user may stand upon. Any openings in the shielding shall be small enough and/or far enough from the chimney to prevent fingers from touching the hot surface of the chimney. The surface temperature of the shielding shall achieve a best rating of 4 in the surface-temperature test specified in ISO 19869:2019, 10.6.4.6. Insulation shall cover all surfaces within sight of the user to reduce radiant heat.

To rate a "good" score of 3, a chimney shall have both shielding to effectively protect from burns and some insulation to protect from radiant heat. Shielding and insulation may be provided by the same structure, e.g. a triple-walled chimney. Shielding and insulation shall be at least 2 m high from any surface the user may stand upon. Any openings in the shielding shall be small enough and/or far enough from the chimney to prevent fingers from touching the hot surface of the chimney. The surface temperature of the shielding shall achieve at least a "good" rating of 3 in the surface-temperature test specified in ISO 19869:2019, 10.6.4.6.

If a chimney has no protective shielding or the shielding does not have any openings, then the surface temperature test, as specified in Table 2, shall apply with the score entered for the chimney shielding and insulation criterion, as described in the scoring system in 7.3.

7.3 Safety scoring system

The report of results for the safety test shall include individual scores for each criterion of the test, the overall score based on the weighting system, and an overall pass or fail result.

An overall "fail" result shall be reported if there is a score of 1 for either tipping or surface temperature, otherwise a "fail" result shall not be reported.

NOTE It is possible for a safety test to indicate a relatively high overall score but an overall "fail" result due to tipping or surface temperature.

The safety test scoring system is summarized in Table 3.

Table 3 — Safety scoring system

Safety tests	Score range	Failing score	Weighting factor	Weighted range
Sharp edges and points	1-4	n.a.	1,5	1,5-6
Tipping	1-4	1	4	4-16
Containment of fuel	1-4	n.a.	2,5	2,5-10
Obstructions near cooking surface	1-4	n.a.	2	2-8
Surface temperature	1-4	1	5	5-20
Chimney shielding and insulation	1-4	n.a.	3	3-12
Flames surrounding cooking vessel	1-4	n.a.	3	3-12
Flames exiting fuel chamber	1-4	n.a.	4	4-16
Overall				25-100

8 Durability testing

8.1 General

Institutional cookstoves typically have large thermal masses and operate for extended periods. They may be required to withstand more aggressive use than the typical use for household cookstoves.

ISO 19867-1:2018, Clause 8, durability measurements, may be used in a laboratory with the following exceptions for institutional cookstoves.

8.2 Specific equipment requirements for durability stress testing of institutional cookstoves

ISO 19867-1:2018, 8.1 may be used with the following exceptions:

— sufficient representative fuel to complete 32 h of operation is required;

— impact testing (internal and external) is to be conducted with weights more representative of the mass of cooking-related items found in industrial kitchens. The masses to be used for impact testing shall include the following:

  — 50 g ± 1 g;

  — 100 g ± 1 g;

  — 250 g ± 1 g;

  — 500 g ± 1 g;

  — 750 g ± 1 g;

  — 1 000 g ± 1 g.

8.3 Extended run test

ISO 19867-1:2018, 8.2.2 may be used with the following exceptions.

— The large thermal mass of institutional cookstoves means they can often require an extended period to reach a steady-state temperature. Maximum material surface temperature shall be determined following one of two approaches: either institutional cookstoves shall be operated for at least 8 h to establish maximum material temperature, or an institutional cookstove to be tested shall be equipped with thermocouples capable of monitoring surface temperature in real-time. If thermocouples are used, a cookstove shall be operated for at least 4 h and then surface temperatures shall be collected every 15 min. The cookstove shall be deemed as reaching steady-state when none of the surfaces being measured changes in temperature by more than 10 °C over a 15-minute period.

— Three extended run tests shall be completed on each cookstove with at least 12 h between each test replicate.

8.4 External and internal impact testing

ISO 19867-1:2018, 8.2.3 and 8.2.4 may be used with the following exceptions.

— External and internal impact testing shall be conducted using the weights prescribed in 8.2. Testing shall follow testing procedures outlined in ISO 19869:2019, 8.2.3 and 8.2.4 but begin with the heaviest weight prescribed in this document.

— Scoring of the external and internal impact testing shall use the risk factors in Table 4.

Table 4 — Impact testing risk factors

Lowest weight at which damage is seen	Risk factor
no damage seen at any of the weights tested	+0
1 000 g	+1
750 g	+2
500 g	+3
250 g	+4
100 g	+5
50 g	+6

9 Reporting

9.1 General

For general guidance on reporting, refer to ISO 19867-1:2018, Clause 9 and Annex H.

9.2 Contents of the test report

The test report shall include the follow elements:

- title page,
- table of contents,
- acronyms and abbreviations,
- list of figures,
- list of tables,
- description of institutional cookstove system tested:
  - cookstove,
  - fuel,
  - cooking vessel,
  - cooking vessel lid, if applicable,
  - operating procedure,
- description of the test method used:
  - description of the measurement methods,
  - test results,
  - interpretation of data and limitations,
  - quality assurance/quality control,
  - discussion of results,
  - acknowledgements,
  - references,
  - annex (as needed).