



Environmental Analysis Program

Pomona College
Biogeochemistry Laboratory

SOP-L111

Muffle Furnace Operation

Standard Operating Procedure

SOP Number	SOP-L111
Revision	0.1
Author(s)	Marc Los Huertos
Date	2026-06-26
Organization	EA Program, Pomona College

FOR INTERNAL USE ONLY

This document is the property of the Environmental Analysis Program at Pomona College.
Unauthorized distribution is not permitted.

Table of contents

1 Purpose	2
2 Scope	2
3 Definitions	2
4 Responsibilities	2
5 Safety and Hazards	3
5.1 Required PPE	3
5.2 Emergency Procedures	3
6 Equipment and Materials	3
7 Procedure	4
7.1 Pre-Use Inspection	4
7.2 Loading	4
7.3 Temperature Programming	4
7.4 During Operation	4
7.5 Unloading	5
7.6 Shutdown	5
8 Maintenance	5
9 Quality Control	5
10 Waste Disposal	6
11 References	6
12 Related SOPs	6
13 Training Record	6

1. Purpose

This procedure describes the safe operation, temperature programming, and maintenance of the muffle furnace used in the EA Program laboratory. The muffle furnace provides controlled high-temperature combustion (up to 1,100 C) for loss-on-ignition analysis ([SOP-L406](#)), pre-combustion of crucibles and glass fiber filters, ashing of organic materials, and flux fusion preparations.

2. Scope

- **Applies to:** All use of muffle furnaces in EA Program laboratories, including routine ignition (550 C for SOM), high- temperature ashing (up to 1,000 C), and pre-combustion of labware
- **Does not apply to:** Drying ovens operating below 300 C (see [SOP-L105](#)); tube furnaces for elemental analysis (integral to analytical instruments); kilns
- **Location:** EA Program laboratory, SGM 134

3. Definitions

- **Ashing:** High-temperature combustion of organic matter in an open crucible in the muffle furnace, leaving only the inorganic (mineral) residue; the basis of loss-on-ignition analysis.
- **Crucible:** A heat-resistant container (ceramic, porcelain, or platinum) used to hold samples during furnace ignition; must be pre-ignited to constant mass before use.
- **Loss on ignition (LOI):** The mass loss when a dried sample is ignited at 550 °C for 4 hours, expressed as a percentage of dry mass; used as a proxy for soil organic matter content.
- **Muffle:** The interior chamber of the furnace, thermally isolated from the heating elements; provides a controlled oxidizing atmosphere for combustion.
- **Pre-combustion:** Heating glassware, crucibles, or glass fiber filters to 450–550 °C to destroy any organic contamination before use in carbon or organic matter analyses.
- **Ramping:** Programming the furnace to increase temperature at a controlled rate (e.g., 5 °C min⁻¹) to prevent thermal shock to crucibles and to avoid rapid oxidation that can cause sample loss.
- **Set point temperature:** The target temperature programmed into the furnace controller; verify with a calibrated thermocouple if precise temperature is critical.

4. Responsibilities

Role	Responsibility
Lab PI	Approve SOP, authorize furnace use
Lab Manager	Schedule maintenance, verify thermocouple calibration
Trained Personnel	Operate the furnace per this SOP
New Students	Complete training before independent use

5. Safety and Hazards

Hazards

- **Thermal:** The furnace exterior, door, and chamber reach extremely high temperatures. Crucibles removed from the furnace at 550 C or above can cause severe burns on contact. The furnace remains hot for hours after shutdown.
- **Fire:** Combustible materials (paper, wood, plastic) placed on or near the furnace can ignite. Keep a 30 cm clear zone around the furnace on all sides.
- **Fumes:** Combustion of organic matter produces CO₂, water vapor, and potentially odorous or irritating fumes. Ensure adequate room ventilation or connect the furnace exhaust to a fume hood or duct if available.
- **Electrical:** The furnace draws high current. Do not use extension cords. Inspect the power cord for damage before each use.

5.1. Required PPE

- ☐ Heat-resistant gloves (rated to at least 500 C)
- ☐ Safety glasses or face shield
- ☐ Lab coat (cotton preferred; synthetic fabrics melt)
- ☐ Closed-toed shoes

5.2. Emergency Procedures

For burns, apply cool running water immediately and seek first aid. If the furnace produces unusual smoke, odors, or sparks, shut it off at the circuit breaker and evacuate the room. Refer to [SOP-L002 Laboratory Safety](#).

6. Equipment and Materials

Item	Notes
Muffle furnace (programmable)	SGM 134; confirm maximum temperature rating
Crucible tongs (long-handled, heat-rated)	For placing and retrieving crucibles
Ceramic crucibles or porcelain boats	Pre-combusted before first use
Heat-resistant pad or ceramic tile	For resting hot crucibles during transfer to desiccator
Desiccator with active desiccant	For cooling crucibles before weighing
Thermocouple or secondary thermometer	For periodic temperature verification

7. Procedure

7.1. Pre-Use Inspection

1. Inspect the furnace chamber for debris, cracked insulation, or damage to the heating elements. Do not operate if damage is visible; report to the lab manager.
2. Verify that the area around the furnace is clear of combustible materials (minimum 30 cm clearance on all sides and top)
3. Confirm that the furnace is plugged directly into a dedicated wall outlet (no extension cords or power strips)

7.2. Loading

1. Arrange crucibles or boats inside the chamber so they do not touch each other or the heating elements. Leave space for air circulation.
2. Close the furnace door gently; do not slam (the refractory lining is fragile)

7.3. Temperature Programming

1. Set the target temperature and ramp rate per the analytical SOP:
 - Loss on ignition (SOP-L406): ramp to 550 C, hold 4 hours
 - Pre-combustion of glass fiber filters: ramp to 450 C, hold 4 hours
 - Pre-combustion of crucibles: ramp to 550 C, hold 1 hour
 - Ceramic boat preparation (SSM, SOP-L407): ramp to 900 C, hold 30 minutes
2. If the furnace is programmable, set the ramp rate to approximately 10 C per minute unless the analytical SOP specifies otherwise
3. Start the program and verify that the displayed temperature begins to rise

Tip

Avoid placing samples into a furnace that is already at full temperature unless the analytical SOP explicitly requires it. Rapid thermal shock can crack crucibles and cause spattering.

7.4. During Operation

1. Do not leave the furnace unattended during the initial ramp-up (first 30 minutes). Check that the temperature is tracking the set point.
2. Post a “Furnace in Use” sign on the furnace and the lab door, noting the expected completion time
3. Do not open the furnace door during the hold period unless troubleshooting

7.5. Unloading

1. After the hold period, turn off the furnace or allow the programmed cooldown to proceed
2. Allow the furnace to cool to below 200 C before opening the door. Opening at higher temperatures causes rapid thermal shock to samples and exposes the operator to radiant heat.
3. Using crucible tongs and heat-resistant gloves, transfer crucibles to a heat-resistant pad, then immediately to the desiccator
4. Allow crucibles to cool to room temperature in the desiccator (approximately 30–45 minutes) before weighing

7.6. Shutdown

1. Verify that the furnace is off and the temperature is decreasing
2. Remove the “Furnace in Use” sign
3. Leave the furnace door slightly ajar (1–2 cm) after it has cooled below 100 C to prevent moisture buildup inside the chamber

8. Maintenance

Task	Frequency
Visual inspection of chamber and elements	Before each use
Clean furnace floor of spilled material	After each use
Thermocouple verification (compare to NIST-traceable thermometer)	Annually or after suspected malfunction
Replace heating elements	As needed (contact manufacturer or lab manager)
Check door seal and gasket	Every 6 months

! Important

Never use water or wet cloths to clean the furnace interior. Allow the chamber to cool completely, then brush out ash and debris with a dry, soft brush.

9. Quality Control

- Verify furnace temperature with an independent thermocouple or NIST-traceable thermometer at least annually. The furnace set point and the verified temperature should agree within ± 10 C at 550 C.
- Record the verification date and result in the instrument logbook.
- If temperature uniformity is critical (e.g., for large batches), place thermocouples at the front, center, and back of the chamber and record any gradient.

10. Waste Disposal

Waste Type	Disposal Method
Combusted soil ash	Standard trash (inert mineral residue)
Crucibles	Clean and reuse
Failed heating elements	E-waste; coordinate with campus facilities

11. References

- Furnace manufacturer’s operating manual (consult for model-specific instructions and maximum temperature rating)
- Heiri, O., Lotter, A. F., & Lemcke, G. (2001). Loss on ignition as a method for estimating organic and carbonate content in sediments. *Journal of Paleolimnology*, 25, 101–110.

12. Related SOPs

SOP	Title	Relationship
L002	Laboratory Safety	General safety framework
L105	Drying Ovens	Low-temperature companion
L200	Balance Calibration	Pre- and post-ignition weighing
L406	Loss on Ignition	Primary application SOP
L407	Total Carbon	Ceramic boat preparation

13. Training Record

Before operating the muffle furnace independently, personnel must:

1. Read this SOP in full
2. Complete [SOP-L002 Laboratory Safety](#) training
3. Demonstrate proper use of heat-resistant gloves and crucible tongs
4. Load, program, and unload the furnace under supervision for one complete cycle
5. Be signed off by the PI or lab manager