

# Attachment A

## Best Practices and Step by Step Instructions for Post-Crop Steaming/Steam-Off in Mushroom Farming

Post-crop steaming, also known as steam-off or post-crop pasteurization, is an essential step in ensuring a clean growing environment for subsequent crops. Below is a step-by-step guide based on the Best Management Practices for Mushroom Farming. To properly control adult flies and the larval stages within a mushroom house, 140° F is the recommended minimum temperature. STEP BY STEP instructions begin on Page 2 of this document.

### Purpose

- Prevent pests and pathogens from spreading to subsequent or adjacent crops when substrate is removed from the growing room.
- Kill adult flies, eggs, larvae, and fungal, bacterial, and viral pathogens in the substrate and wooden bed boards. Kill everything including remaining mushrooms so nothing will be spread or grown when spent compost is applied to fields or gardens.
- Reduce the risk of pests infesting new crops and neighboring areas.

### Number of Treatments

Phase 1 Crops: **3 steams** per crop

- Steam four days after fill
- Steam once post-harvest
- Steam once after removal (as needed)

Phase 2 or 3 crops: **2 steams** per crop

- Substrate is bulk pasteurized before putting into the house/fill
- Steam once post-harvest
- Steam once after removal (as needed)

### When to Steam

1. Phase 1 filled crops require a steam pasteurization early in the phase 2 stage of the crop to eliminate pathogens and insects that may have entered the room during the filling process.
2. Post Harvest Steaming (Steam OFF) Begin steaming immediately after the last flush of mushrooms has been picked. Steam the growing room while substrate is still in place to kill any pests in the substrate.
3. **After Substrate Removal:** once the substrate is cleared and the room has been cleaned of any remaining substrate debris, perform a second steaming process, as needed, (Steaming Empty) to treat the room and wooden components.

## STEP BY STEP INSTRUCTION

### POST-HARVEST STEAM OFF DAY 1 BEFORE CLEANOUT

1. **Seal the Room or House**
  - a. Close off the growing room completely before starting the steaming process.
  - b. Check all doors and windows for leaks. Steaming is mostly effective when the room is sealed up tight and the doors are secure enough to prevent fly escape.
    - i. All air intake and exhaust vents need to be sealed with 6 mil black plastic. This seals out all the light to keep the flies from moving towards areas where there may be cracks to escape.
    - ii. Most farms use a threshold wrapped in poly Dacron blue filter to prevent escape under the doors. Doors need to be secure and tight.
    - iii. Spray foam insulation is costly, but the most effective way to seal up old PA style growing rooms.
  - c. Protect adjacent growing rooms and/or houses by checking their sealing so that flies don't leave the house or room being steamed and get into the adjacent rooms or houses as steaming begins.
2. Strip room of every last mushroom.
3. Remove harvesting lights and temperature probes.
4. Shut all doors tight and close any fresh air damper. Roll up all walkway boards to ensure proper airflow.
5. **Apply steam to the room and set the steam thermostat temperature to 150-153°.**
  - i. The steam off is based upon all bed probes being higher than 150° F for a minimum of 8 hours.
  - ii. The HVAC blower unit must be running to circulate the steam through the room more evenly and to get the hot air through the HVAC unit air return and then through the growing room's air supply ducts.
  - iii. Depending on the steam boiler capacity, it may take anywhere from 2 to 4 hours or more to get the room air temperature up to 150° F..
6. **Steam the room for a total time of 26 to 30 hours, minimum 24 hours.**
7. **Ensure the *substrate* temperature reaches 150°F (65°C) to kill pests effectively.**
  - a. Use 5 probes to monitor the house in addition to standard temperature control mechanisms.
    - i. 2 probes to monitor the air temperature
    - ii. 3 probes placed in the beds to monitor the bed temperatures
    - iii. Temperature should be recorded every 4 hours until all beds reach 150° F. Continue to record temperatures until all beds have been at 150° F for at least 8 hours.
8. Keep the house closed for **4 hours with the blower running** after stopping boiler/closing steam valves whenever possible, over-night is best.
9. After steaming is finished, cool down the room by allowing steam out air egresses and put HVAC unit to 100% fan.
10. Once the room is cooled down, it is ready for substrate removal (cleanout).

## POST-HARVEST STEAM OFF DAY 2 CLEAN OUT/STEAM EMPTY DAY

1. Empty the old compost out of the room and haul the old compost off-site.
2. When the room is completely empty, wash down all the boards, walls, doors, air return, and outer duct work with high pressure water.
3. **Once all organic debris is washed away clean, spray all areas with 200 ppm of a quaternary ammonium sanitizer or chlorinated water.**

### The following steps are on an as needed basis:

4. Put washed and sanitized growing nets into the clean room so they can be steamed when the room is steamed empty.
5. Seal room again, doors shut tight and fresh air damper closed.
6. **Apply steam to the empty room.**
  - a. Temperature is set to 150-153° on steam thermostat and must reach at least 150°F (66°C) to 160°F.
  - b. The HVAC unit must be running the blower to circulate the steam through the room more evenly and to get the hot air through the HVAC unit air return and then through the growing room's air supply ducts.
  - c. Depending on the steam boiler capacity, it takes anywhere from 2 to 4 hours to get the room up to that 150°F air temperature.
7. Steam the room empty at 150° F temp for a time range of 14 to 18 hours, **a minimum of 24 hours total.**
8. Cool room down by allowing steam out and using filtered fresh air and AC compressors.
9. Room is now ready for the next crop starting with the filling of Phase 1 or Phase 2 pasteurized compost.
10. Treat wooden components thoroughly, as pathogens can penetrate and survive in wood. See below.

## QUALITY ASSURANCE NOTES

- **Temperature Control**
  - Research shows substrate temperature takes approximately 14 hours to reach 140°F (60°C), regardless of the air temperature. Some farms initially raise air temperature high, then stabilize it once substrate and wood are adequately heated.
  - If only measuring ambient temperature, between 140° and 150° minimum.
- **Follow Recommended Durations**
  - Ensure the process runs for the full recommended time to maximize effectiveness.

- **Consistency**
  - Adopt post-crop steaming as a required practice as part of your growing process **FOR EVERY CROP** to disrupt pest and disease breeding cycles and improve crop health.

#### **OTHER**

- **Wood Treatment**
  - Since wood takes longer to reach effective kill temperatures:
    - Clean and moisten wood before steaming. Pressure washing is ideal before empty steam top to bottom.
    - Allow sufficient time (5–6 times longer than substrate) for the heat to penetrate.
- **Suggested Best Practices for Stumps**
  - Remove stumps from farm site post-harvest and, if being recycled in compost/substrate, monitor for flies and treat accordingly.

*Written with the input of PA growers and Penn State University's "Best Practices for Mushroom Post-Crop Sanitation: Steam-Off/Post-Crop Pasteurization" by David Meigs Beyer, PhD*