BSC MythBusters:
Does Heat Really Affect Protection?

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BSC MythBusters

- There are a lot of rules, “guidelines”, rumors, and myths for using a Biosafety Cabinet.
- Which are true?
- Which are not?
- WHY?

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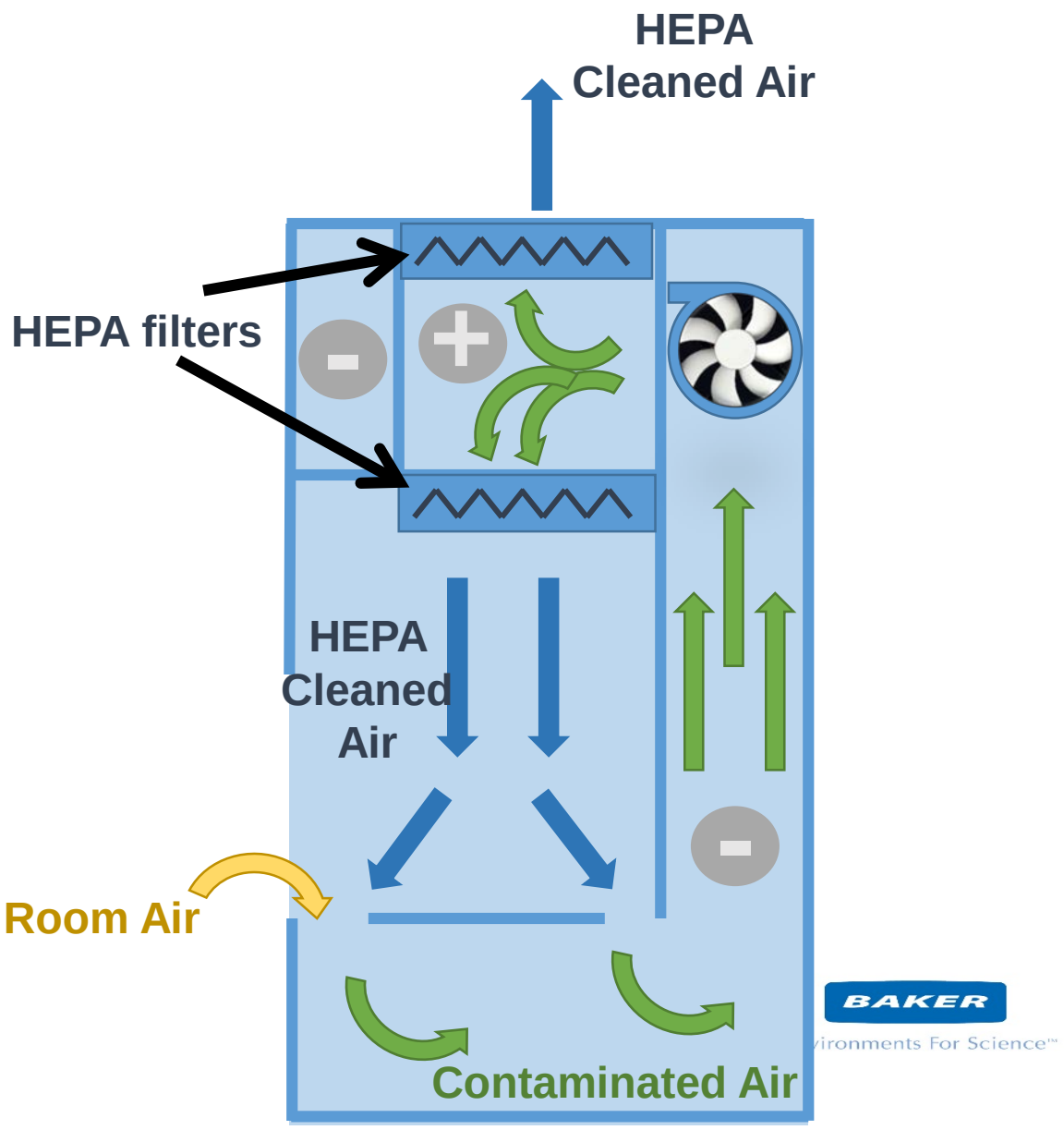
Biosafety Cabinets (BSCs)

- A ventilated enclosure for work with biohazard agents assigned to biosafety levels 1 through 4.
- Provides 3 types of **CONTAINMENT**:
  - Personnel protection
  - Product protection
  - Environmental protection
- All BSCs contain: 1+ HEPA filters & motor/blower

BMBL, 5th Edition, 2009

Class II Type A2 BSCs

- Personnel, Product and, Environmental Protection from particulates and aerosols.
- Minimum 100 fpm intake air
- Partial recirculation



Normal BSC Operation

1. Strong front intake air
2. Side suction slots
3. Downward HEPA filtered air
4. Smoke split to front and back
5. Momentum Air Curtain

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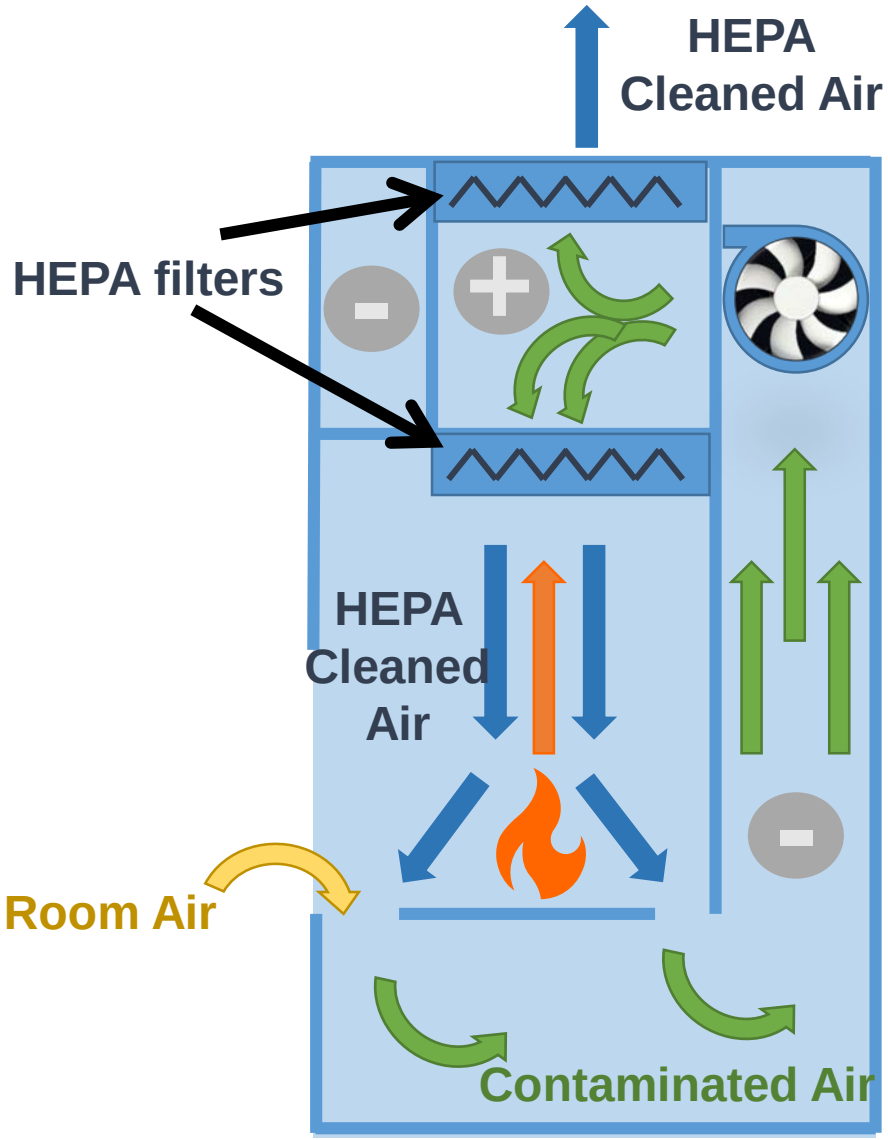
MYTH: Don't use heat sources in a BSC



- Theoretical reasoning:
  - The gas needed to light the flame would be dangerous flowing around the hot BSC motor.
  - Heat changes airflow dynamics within the BSC that are critical for safety.

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Volatile Gas release

- Using our previous research (see Volatile Chem Use in a BSC on BakerCo.com), we can calculate how much propane can be released into a BSC safely without explosion ***given there is no spark or excessive heat***:

$$ER(propane) = \frac{Q_i * MW * LEL * 473}{403 * SG * S_F * 100} = \frac{267cfm * 44.1\ g/mol * 2.1\% * 473}{403 * 1.52g/mL * 10 * 100}$$
$$= 19mL/min$$

$$ER(natural\ gas) = \frac{Q_i * MW * LEL * 473}{403 * SG * S_F * 100} = \frac{267cfm * 18\ g/mol * 1\% * 473}{403 * 0.56g/mL * 10 * 100}$$
$$= 10mL/min$$

- Release rate of propane from a tank to a Bunsen burner = 0.12mL/min

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***If there is no spark, flame, cracked gas tubing, leaky valves, etc. Still not recommended!**

Volatile Gas spontaneous ignition

- Auto Ignition temperature of propane = 504˚C
- Maximum motor/blower allowable temperature = 150˚C

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*If there is no spark, flame, cracked gas tubing, leaky valves, etc. Still not recommended!

Gas Explosion

- If you are fan of the show, you know they do the theoretical exercise, then the practical test. Here's where we try to blow up a BSC using propane and natural gas.
- We did NOT do this.
- But here are some examples of explosions:

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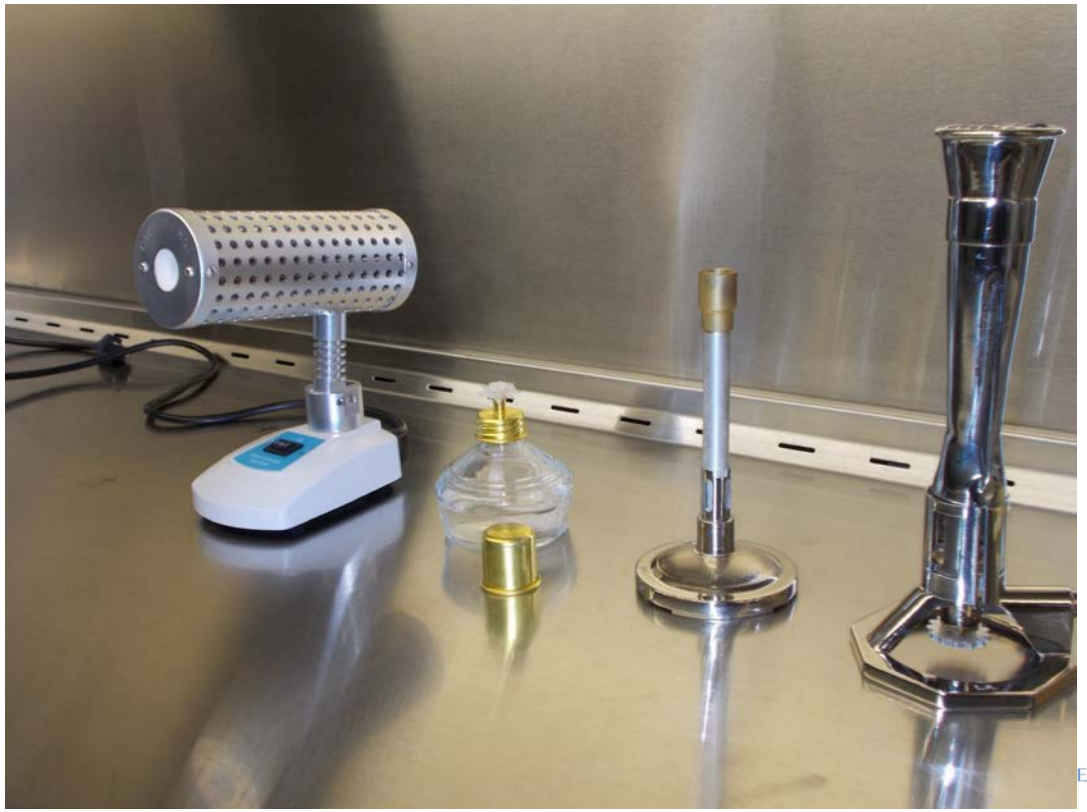
***Flammable gasses in a BSC are NOT recommended!**

Airflow disruption

- Visually
  - Smoke
- BSC performance/Containment
  - Particle Counting
  - NSF International Standard 49 Biological Testing Criteria

Sources of Heat

- Four Commonly used Heat Sources:
  - Standard Bunsen Burner
  - High Heat Bunsen Burner
  - Bacti-Cinerator
  - Spirit Lamp



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Heat Sources in a BSC

- Initial Problems:
  - Lighting a flame in a windy environment
  - Keeping it lit for the duration of the experiment

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Airflow Disruptions

Upward flow of air

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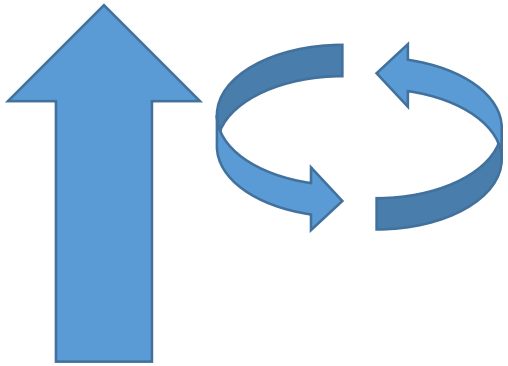
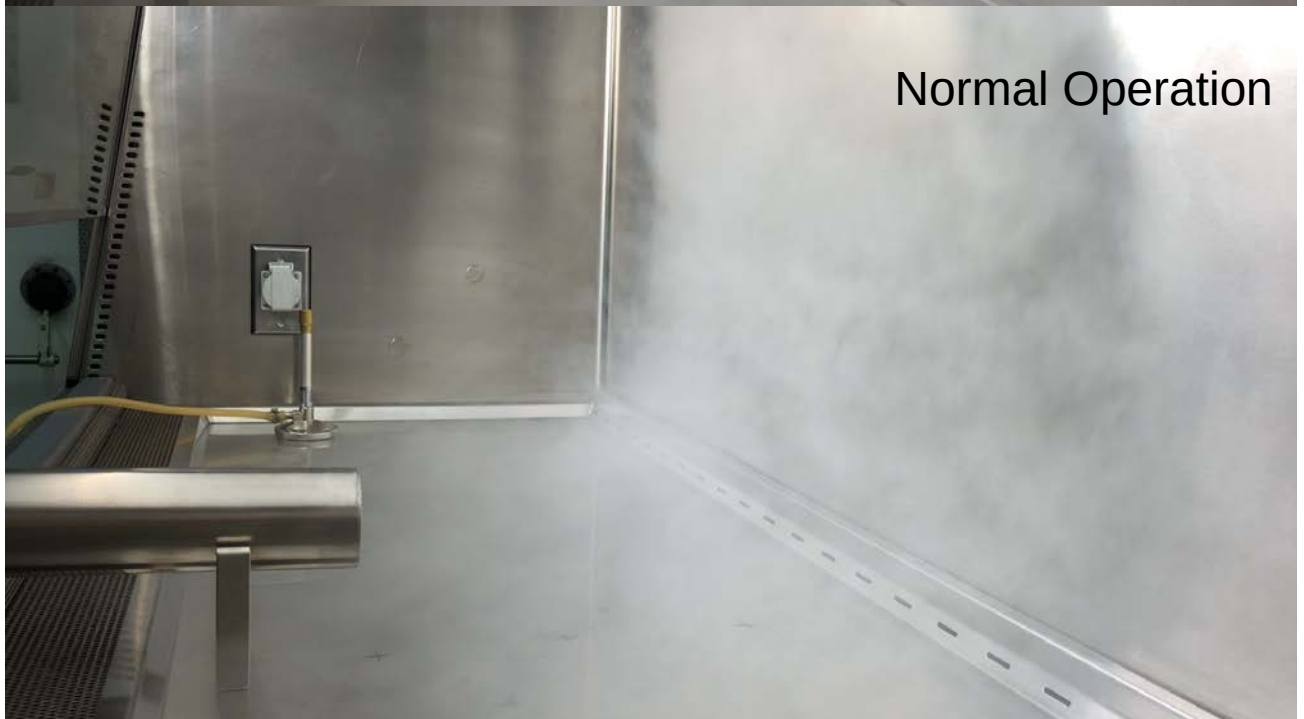


High Heat Bunsen Burner



Normal Operation

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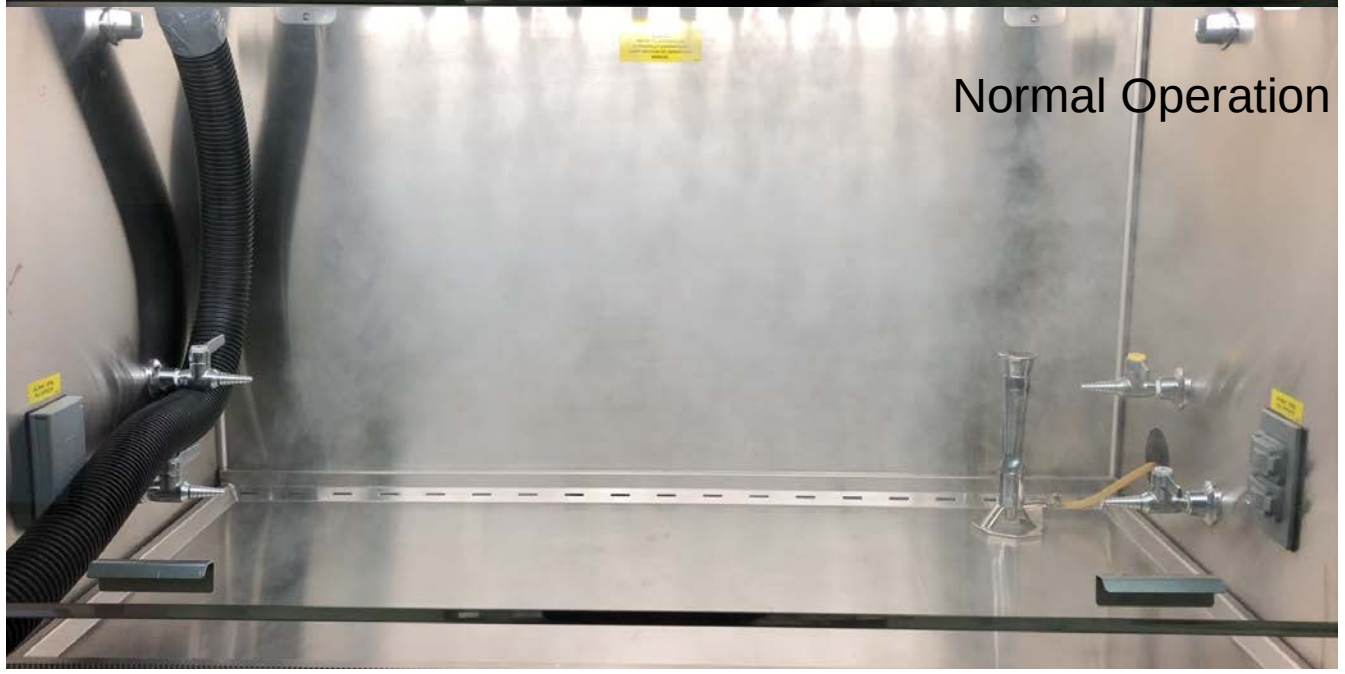

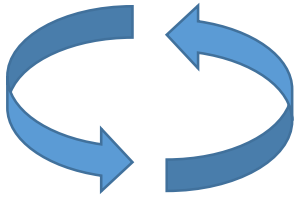

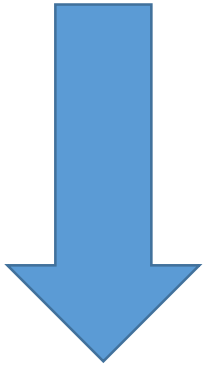

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Spirit Lamp

Bacti-Cinerator

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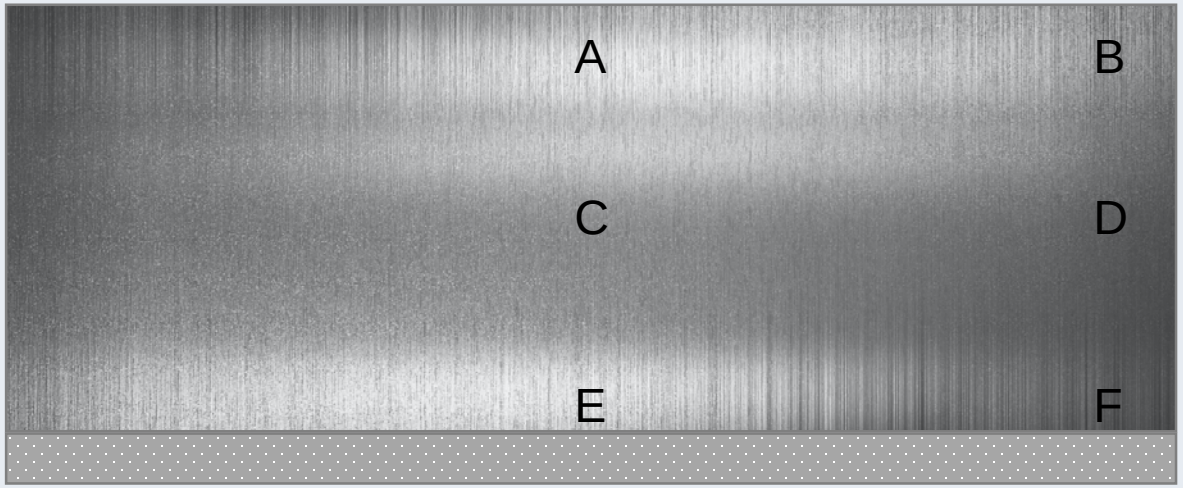
Contamination Experimentation

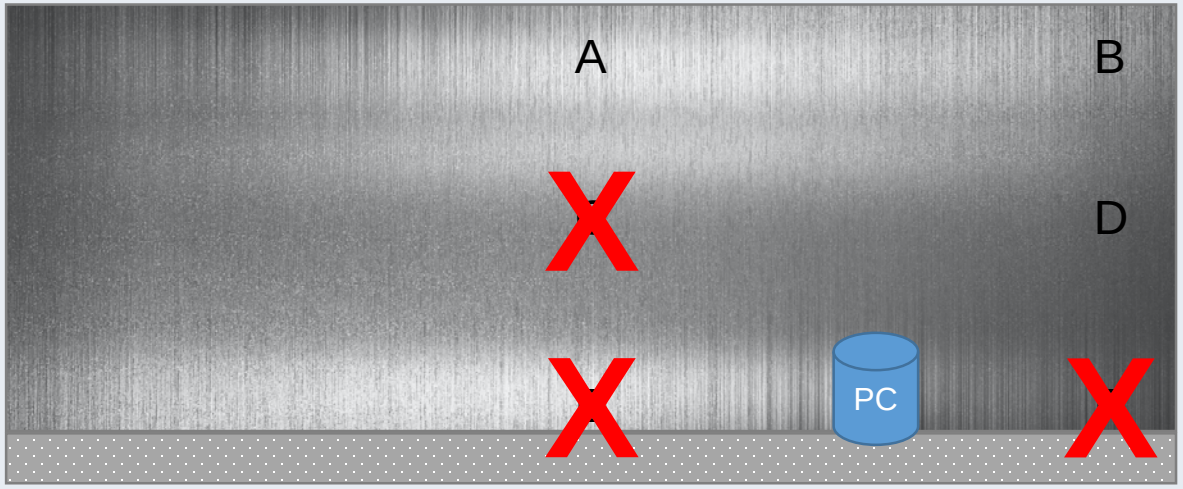
- Tested on a 6 ft and 4 ft Class II Type A2 BSC (SterilGARD e3)
- Split work surface into zones



Note: All experiments were done with an 8” sash opening.

Particle Counting

- Can the BSC maintain ISO Class 5?



Spirit Lamp	PASS ✓
Bacti-Cinerator	PASS ✓
Bunsen Burner	FAIL X
High Heat BB	FAIL X

- Taller flames affected the Momentum Air Curtain and intake air

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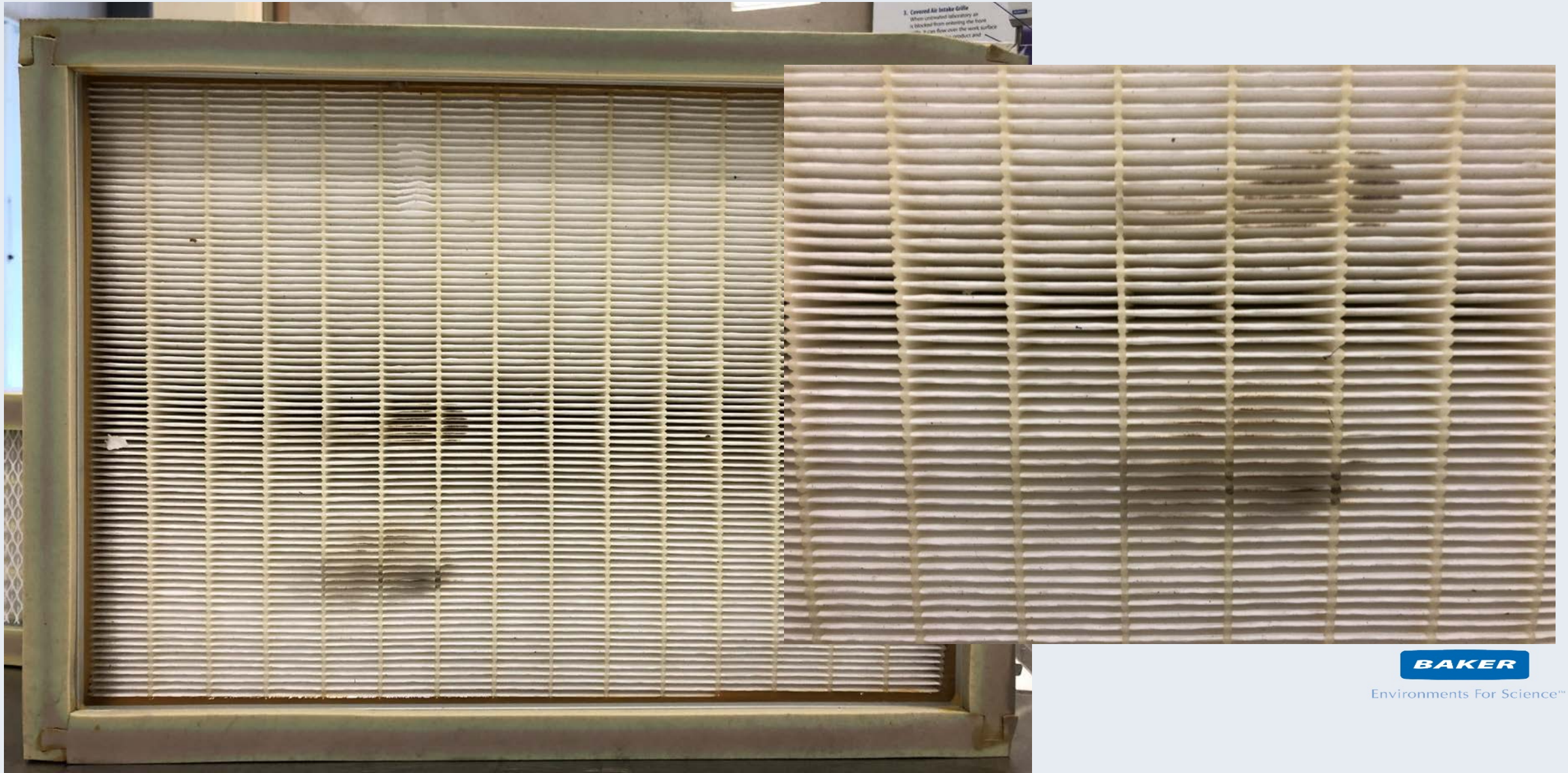
HEPA filters are not immune to heat



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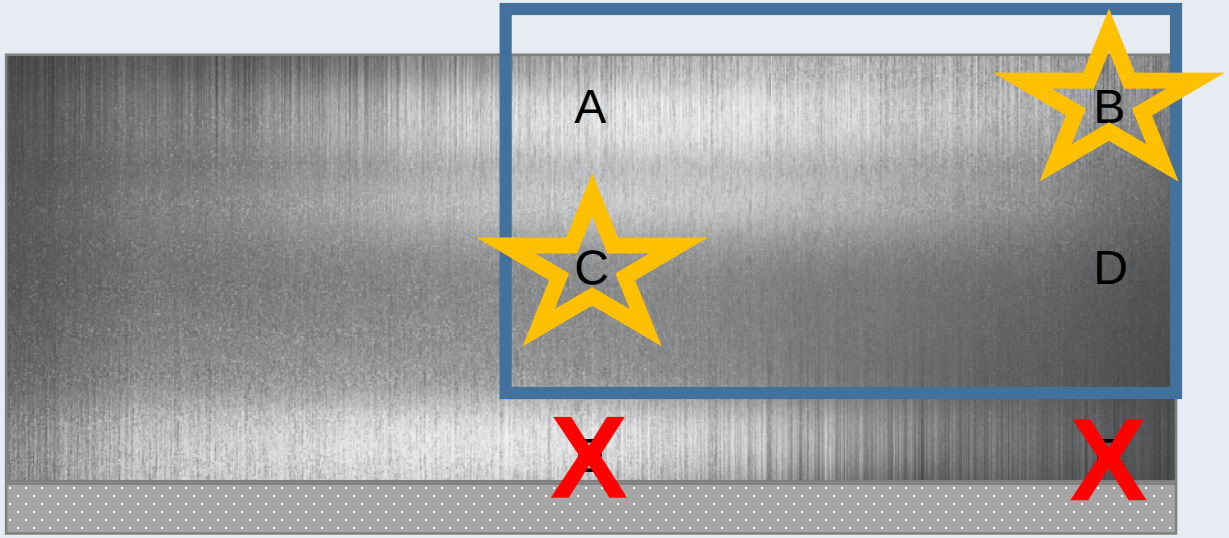
Biological Testing

- Microbiological aerosol testing in accordance with NSF International Standard 49 testing
- Locations A, B, C, D for Product and Personnel; B, C for Cross.



NSF 49 Pass/Fail Criteria:

Personnel

≤ 10 CFUs Impingers
≤ 5 CFUs Slit samplers
Control > 300 CFUs

Product

≤ 5 CFUs
Control > 300 CFUs

Cross

≤ 2 CFUs 14+” away

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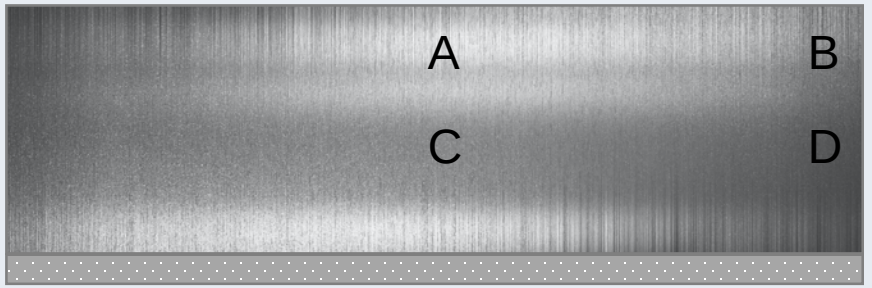
Biological Testing

- Bunsen Burner
  - 6ft BSC:
    - Personnel = **4/4 PASS**
    - Product = **3/4 FAIL**
      - **B,C,D**
    - Cross = **2/2 FAIL**
      - **B,C**
  - 4ft BSC:
    - Personnel = **3/4 FAIL**
      - **B,C,D**
    - Product = **4/4 FAIL***
      - **A, B, C*, D**
    - Cross = **2/2 FAIL**
      - **B, C**

***Major Failure**



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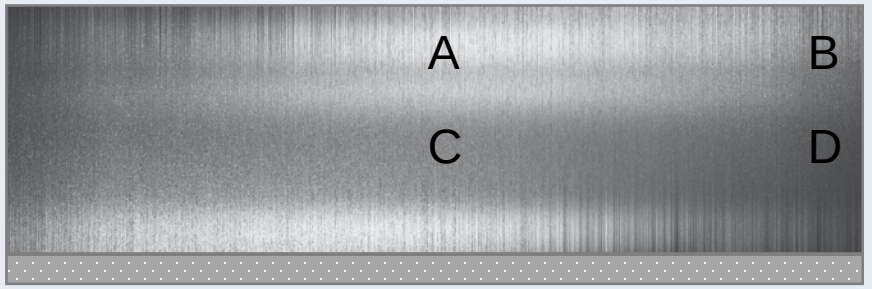
Biological Testing

- High Heat Bunsen Burner
  - 6ft BSC:
    - Personnel = **1/4 FAIL**
      - **C**
    - Product = **3/4 FAIL**
      - **A, C, D**
    - Cross = **2/2 FAIL**
      - **B,C**
  - 4ft BSC:
    - Personnel = **2/4 FAIL***
      - **A, C***
    - Product = **4/4 FAIL**
      - **A, B, C, D**
    - Cross = **2/2 FAIL**
      - **B,C**



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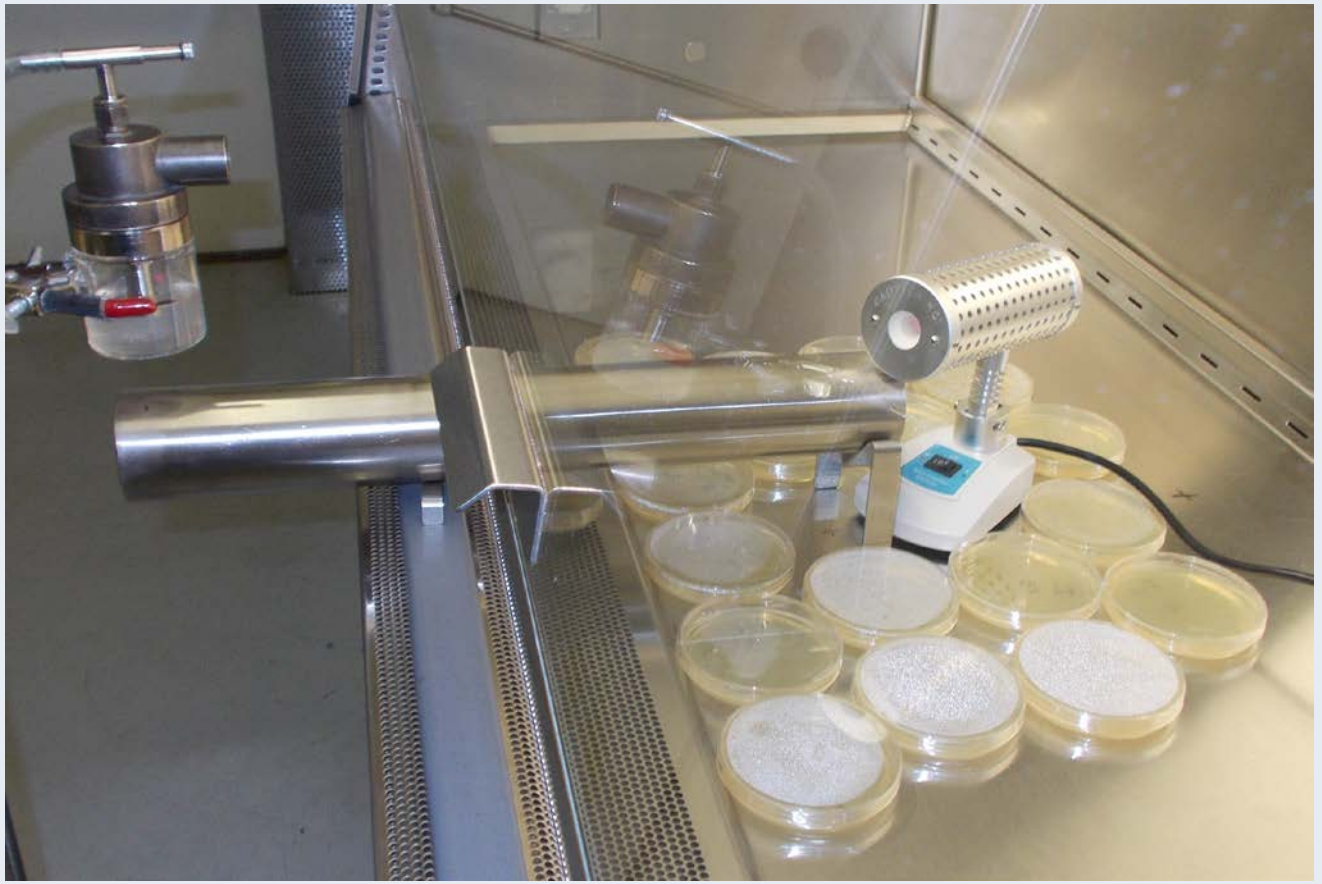
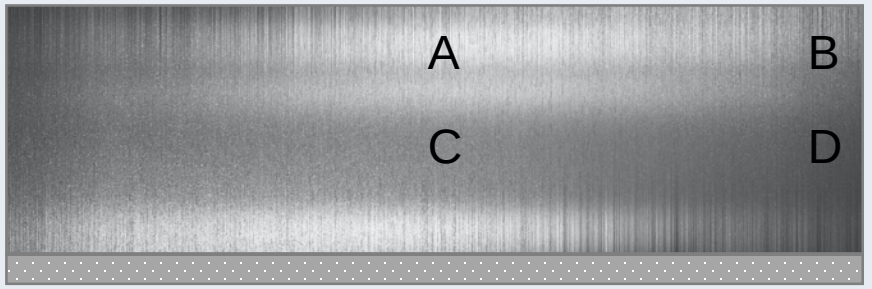
***Major Failure**

Biological Testing

- Bacti-Cinerator
  - 6ft BSC:
    - Personnel = **1/4 FAIL**
      - **D**
    - Product = **1/4 FAIL**
      - **A**
    - Cross = **1/2 FAIL***
      - **C***
  - 4ft BSC:
    - Personnel = **2/4 FAIL**
      - **B,D**
    - Product = **4/4 FAIL**
      - **A, B, C, D**
    - Cross = **2/2 FAIL**
      - **B, C**

*Close to passing





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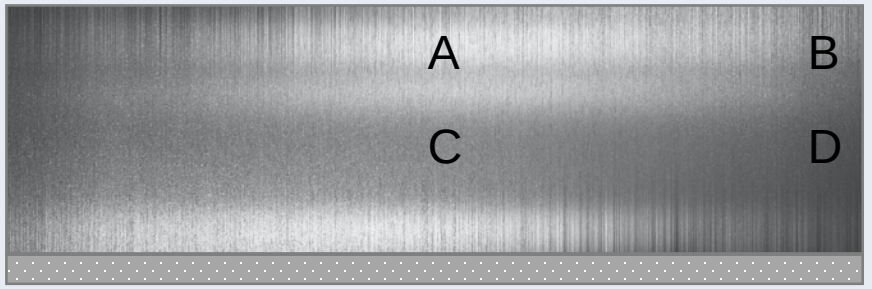
Biological Testing

- Spirit Lamp
  - 6ft BSC:
    - Personnel = **4/4 PASS**
    - Product = **1/4 FAIL***
      - **C***
    - Cross = **1/2 FAIL**
      - **C**
  - 4ft BSC:
    - Personnel = **1/4 FAIL**
      - **D**
    - Product = **2/4 FAIL**
      - **A, B**
    - Cross = **2/2 FAIL***
      - **B*, C***

***Close to passing**
***Major Failure**



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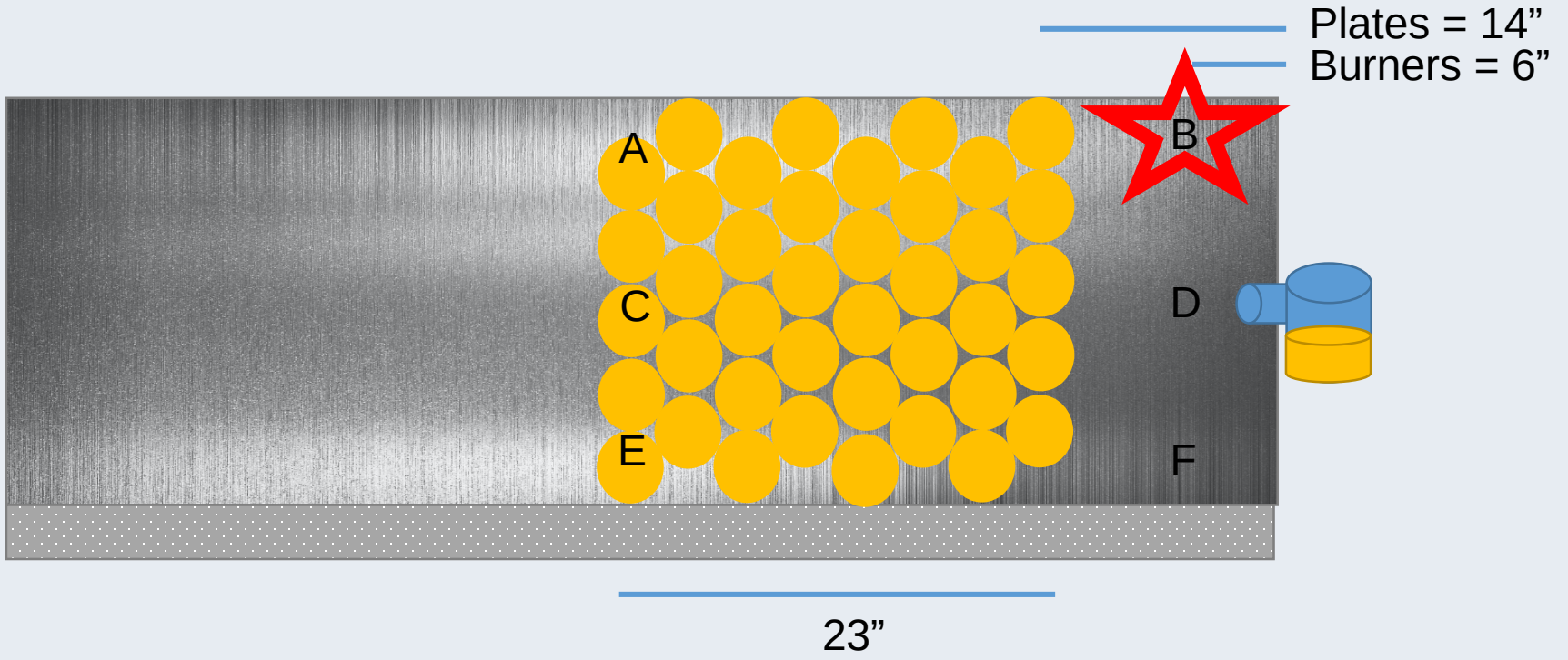
Biological Testing

- Cross Contamination Microbiological Testing also allows you to determine a “safe zone” away from the burner.



- ***Spoiler:*** There isn’t one.

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Observations of Note

- Heat built up quickly within the BSC (>10°C)
  - The worst results were seen after the burners had been on for a while
- Results were worse in the 4ft BSC vs. 6ft BSC
  - Smaller work area = less heat dissipation = greater airflow disruptions
- Aerosol generation was affected by burners
  - Flow out of the nebulizer could be seen fluctuating

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Conclusions

- Heat sources in a BSC cause problems
- Major airflow disruptions
- Personnel, Product and Cross Contamination Protection are compromised
- Gas in a BSC is NOT recommended!
- WHOLE work area is affected

- Use a Burner alone on bench SAFE*✓
- Work in a BSC without a flame SAFE*✓
- Burner inside a BSC NOT ALWAYS SAFE **X**

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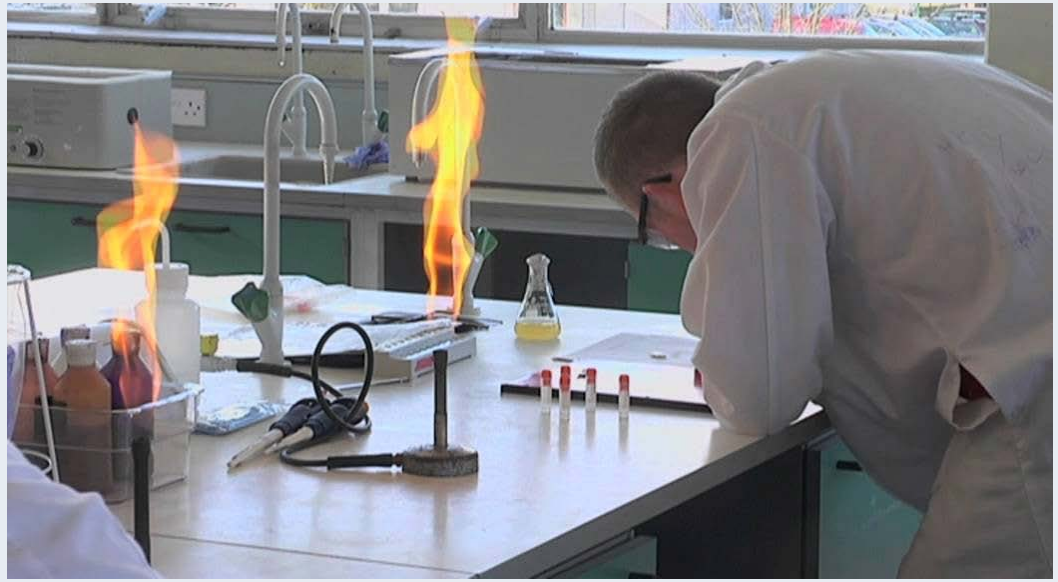
*Given following proper procedures

Alternative Solutions

- Instead of using a flame inside a BSC:
  1. Segregate work to flame work on a bench, other work in BSC
  2. Eliminate use of a flame, try touch heat sources
  3. Disposable loops, sterilized toothpicks, etc.
  4. Reassessment of procedures

Don’t be this guy →



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Upcoming BSC MythBusters

- 2+ people in a BSC?
- How much is “overloaded”?

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Help spread the word of BSC myths, and send me the ones you want busted!

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