Baker



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?

A recurring Baker webinar series that puts common BSC beliefs through controlled testing.

Biosafety cabinets (BSCs)

A ventilated enclosure for work with biohazard agents assigned to biosafety levels 1 through 4.

All BSCs contain one or more HEPA filters and a motor/blower.

Provides three types of containment:

- Personnel protection
- Product protection
- Environmental protection



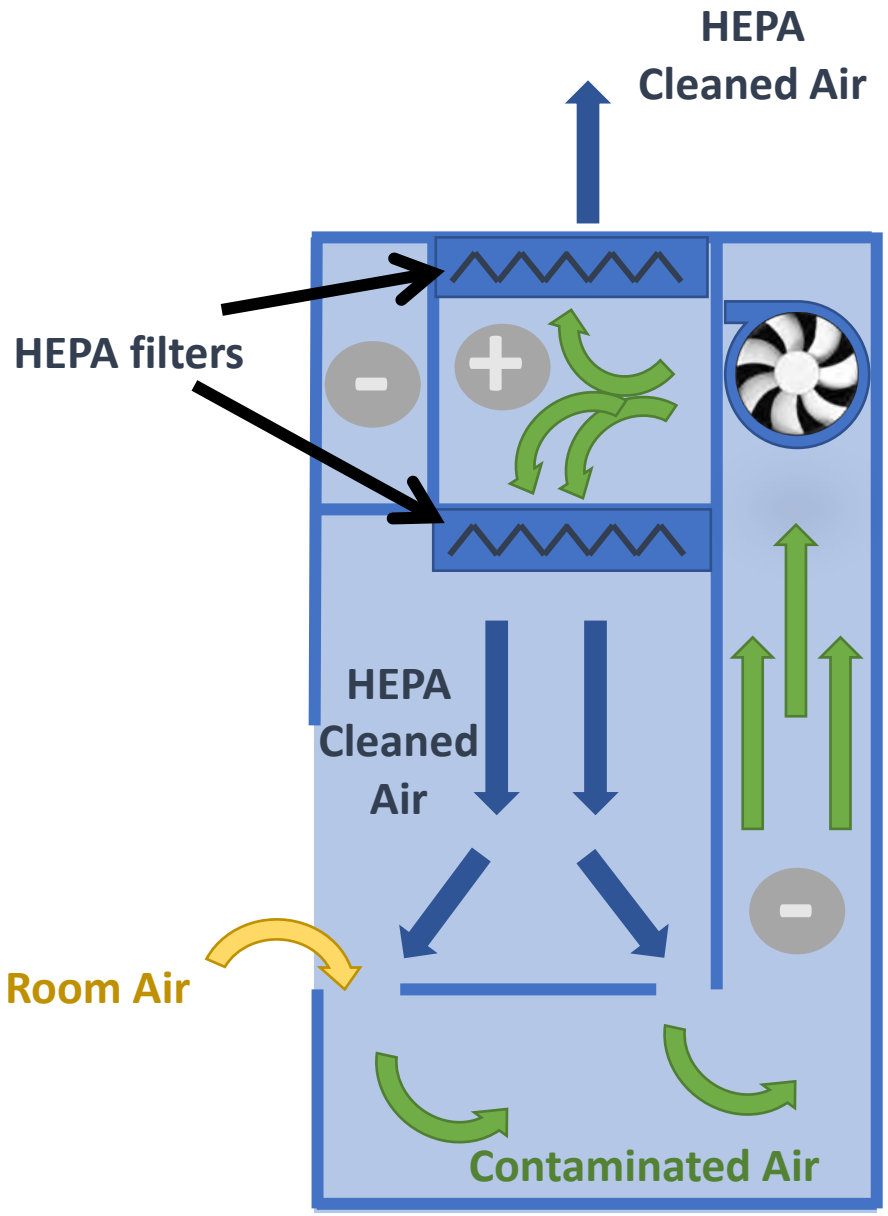
BMBL, 6th Edition, 2020

Class II Type A2 BSCs

Personnel, product and environmental protection from particulates and aerosols.

Minimum 100 fpm intake air.

Partial recirculation.



NSF International, Standard 49

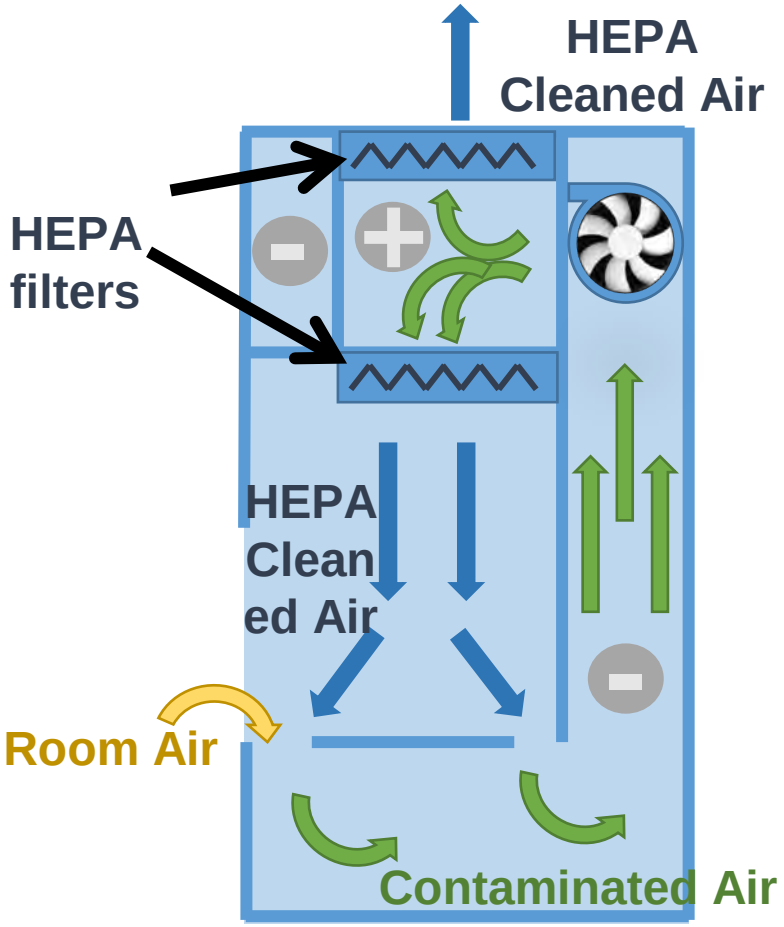
Normal BSC operation

- Strong front intake air
- Side suction slots
- Downward HEPA filtered air
- Smoke split to front and back

- Momentum Air Curtain
- ReadySAFE mode
- Partially recirculating air

Airflow demonstration video https://youtu.be/H-qXtsMdEsE

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.

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***:

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

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

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



*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



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

Gas Explosion

- If you are a 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:






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

Airflow disruption

Visually

- Smoke

BSC performance/Containment

- Particle Counting
- NSF International Standard 49 Biological Testing Criteria



Personnel Protection Test



Product Protection Test

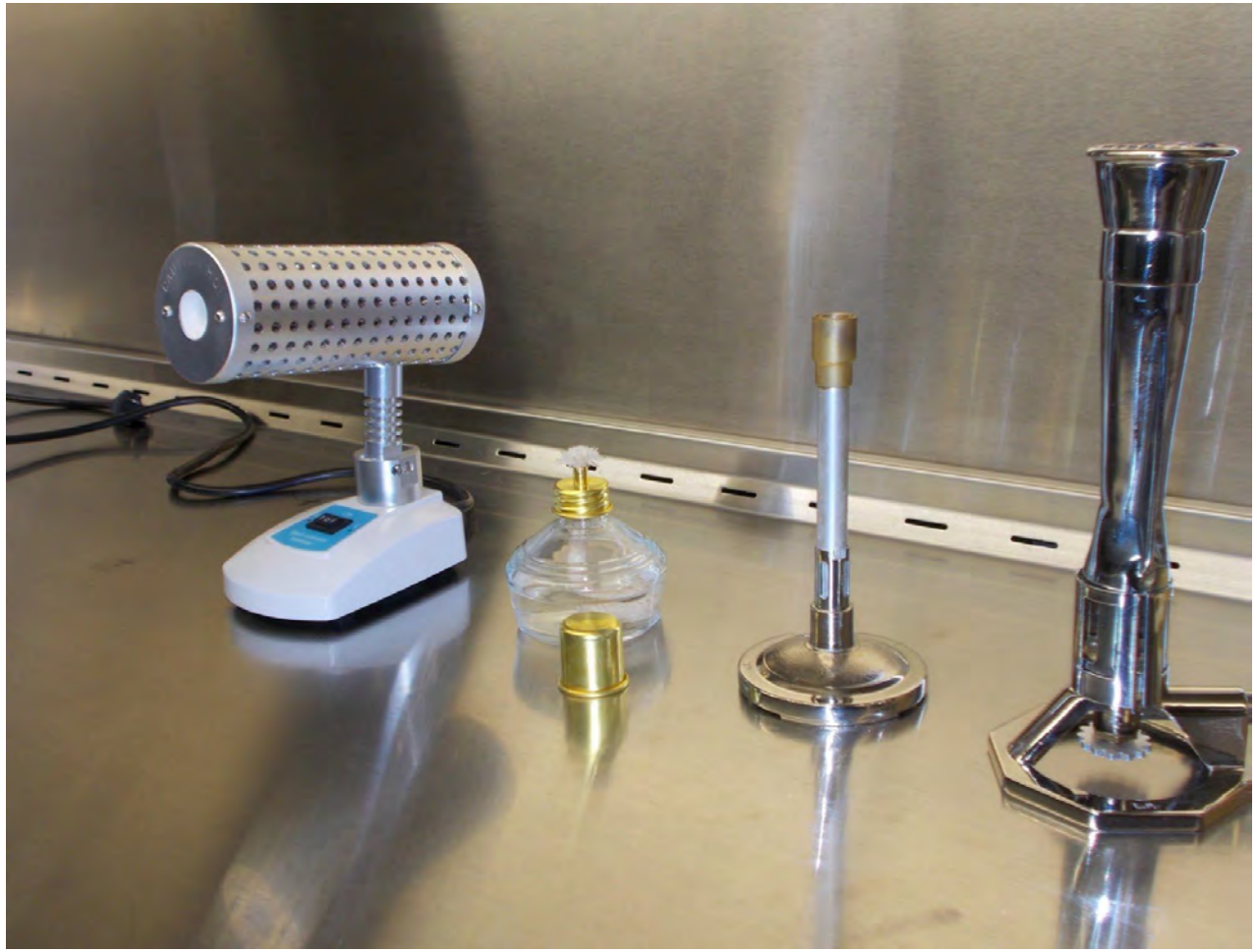


Cross Contamination Test

Sources of Heat

Four Commonly used Heat Sources:

- Standard Bunsen Burner
- High Heat Bunsen Burner
- Bacti-Cinerator
- Spirit Lamp



Heat Sources in a BSC

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Initial Problems:

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





Airflow Disruptions

Upward flow of air

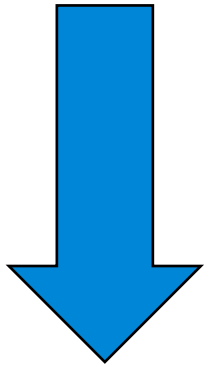


High Heat Bunsen Burner

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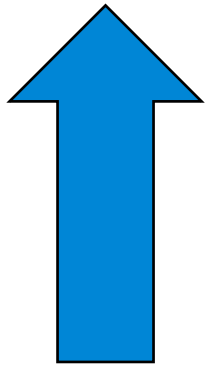
Normal Operation

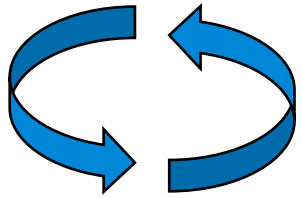




High Heat Bunsen Burner



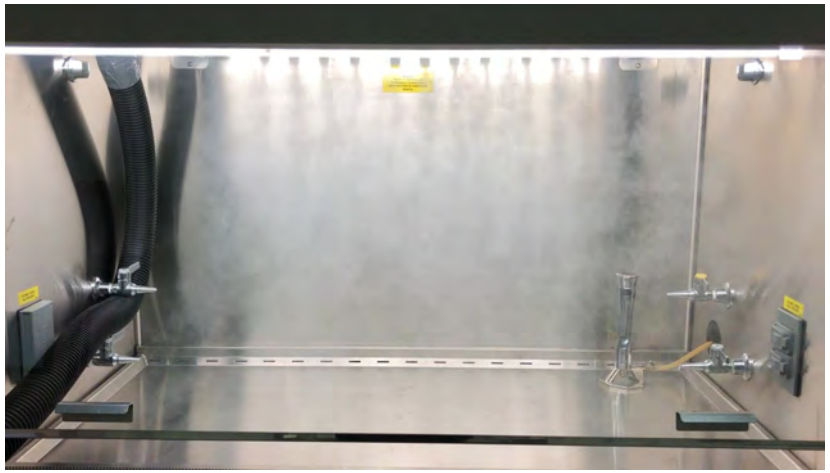


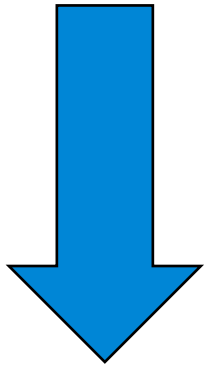


High Heat Bunsen Burner

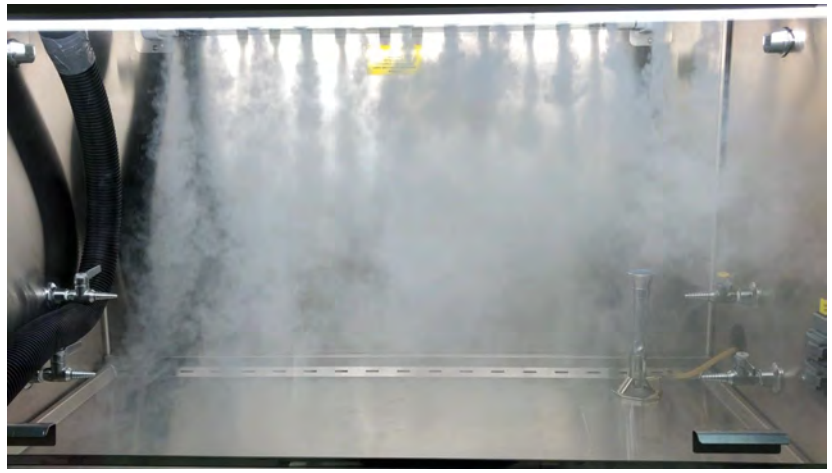
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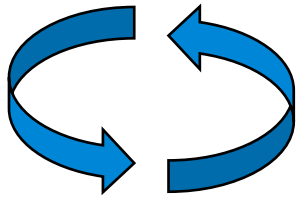
Normal Operation





High Heat Bunsen Burner





Bacti-Cinerator & Spirit Lamp

Bacti-Cinerator

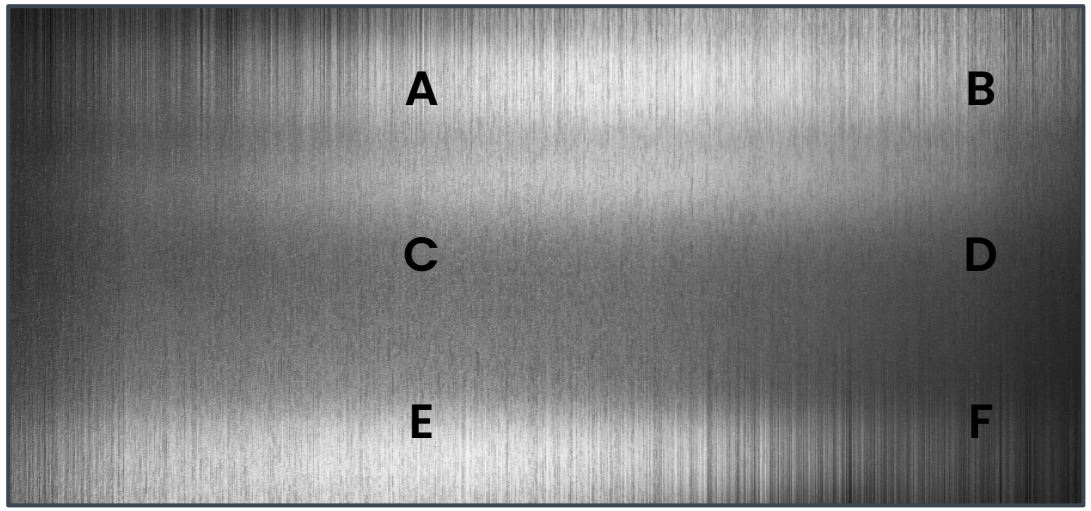


Spirit Lamp



Contamination Experimentation

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



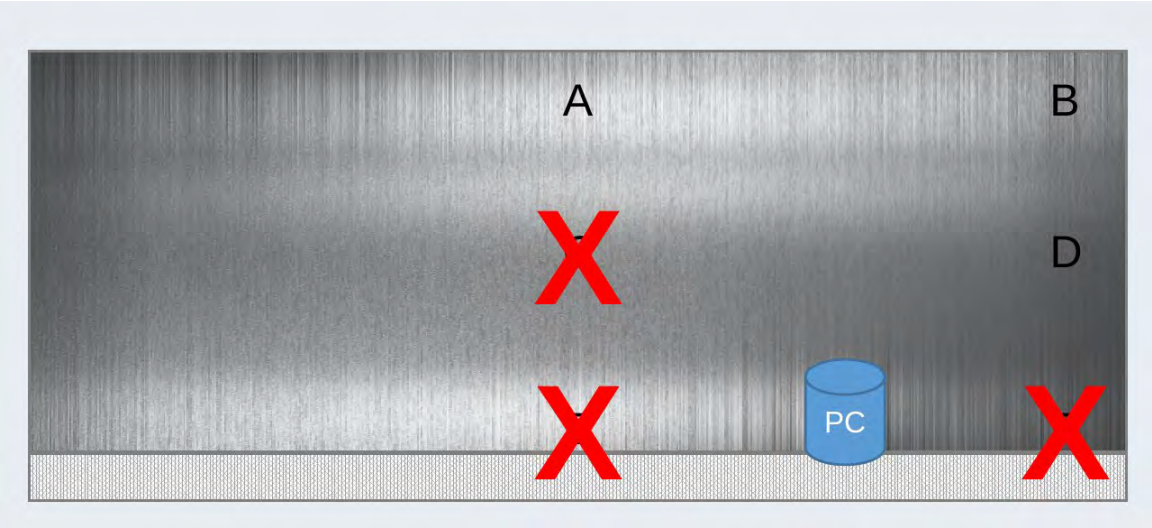


Note: All experiments were done with an 8" sash opening.

Particle Counting

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Can the BSC maintain ISO Class 5?



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

Taller flames affected the Momentum Air Curtain and intake air

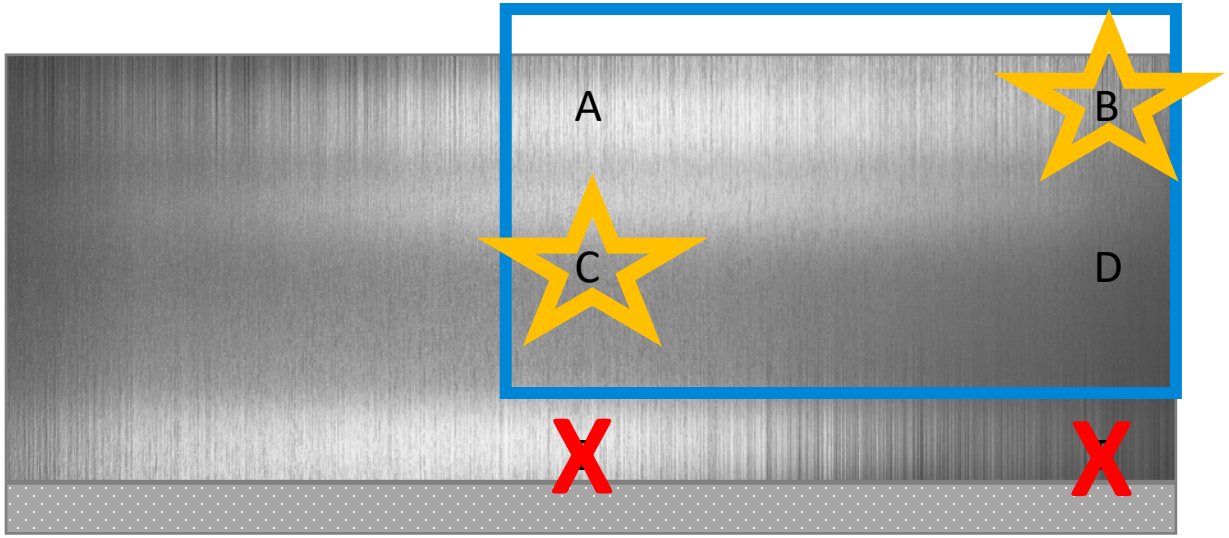
HEPA filters are not immune to heat





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

Biological Testing

Bunsen Burner

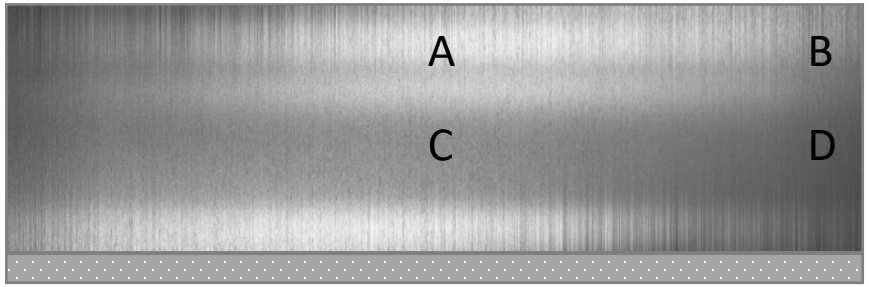
6ft BSC:

- 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**

Biological Testing

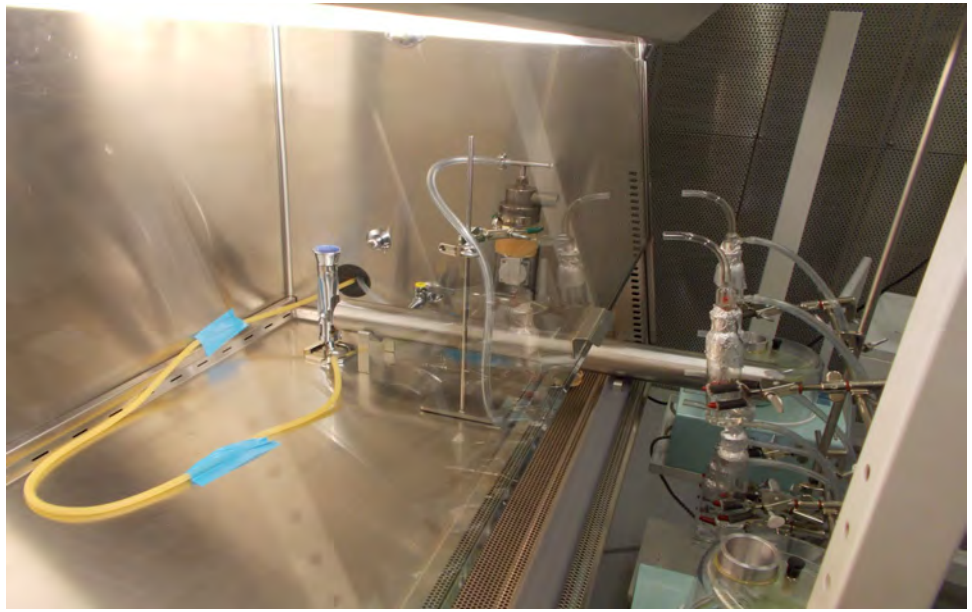
High Heat Bunsen Burner

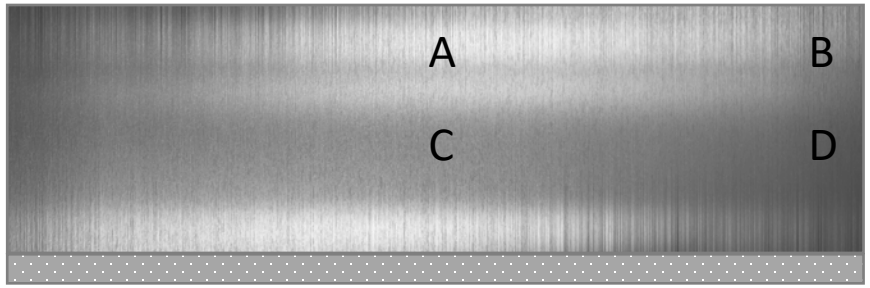
6ft BSC:

- 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**





***Major Failure**

Biological Testing

Bacti-Cinerator

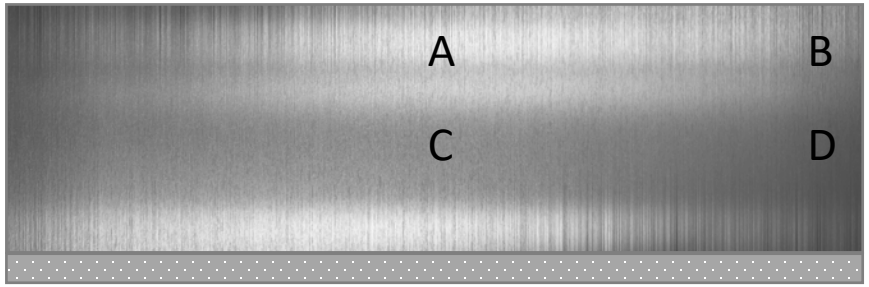
6ft BSC:

- 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**





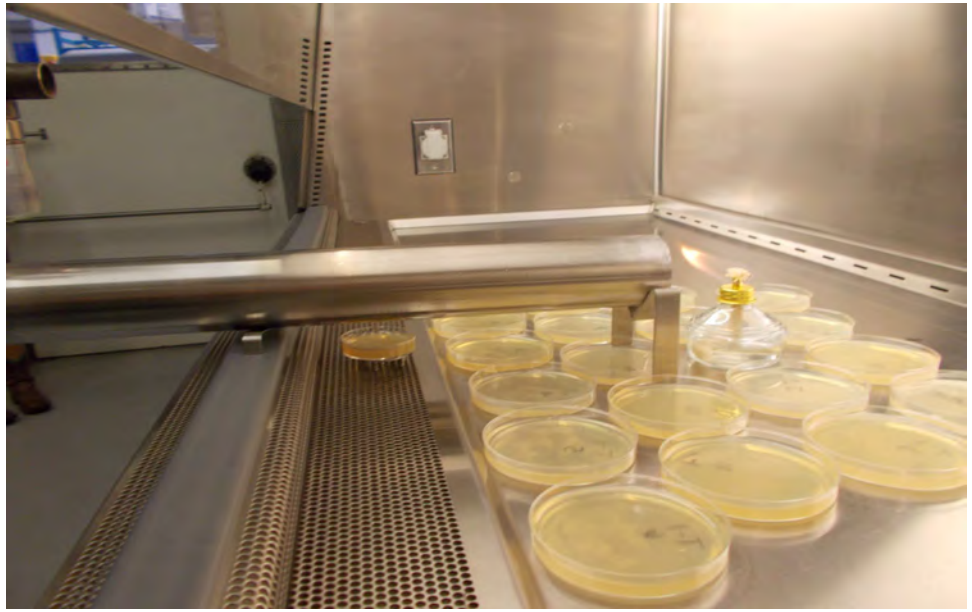
***Close to passing**

Biological Testing

Spirit Lamp

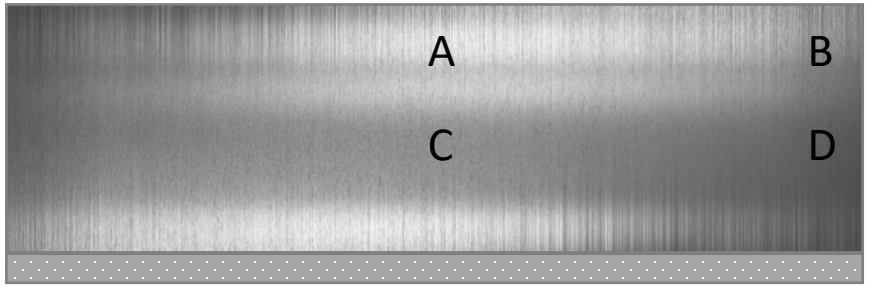
6ft BSC:

- Personnel = **4/4 PASS**
- Product = **1/4 FAIL* C***
- Cross = **1/2 FAIL C**



4ft BSC:

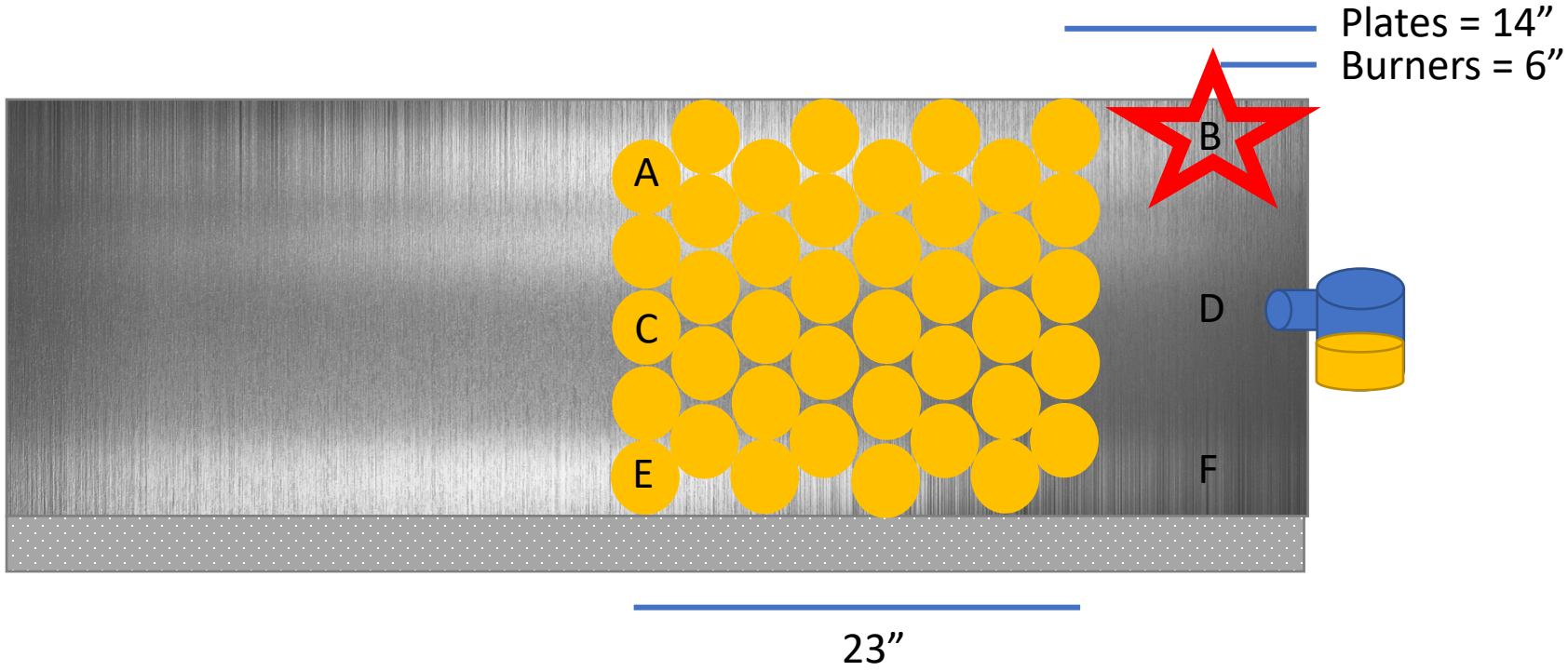
- Personnel = **1/4 FAIL D**
- Product = **2/4 FAIL A, B**
- Cross = **2/2 FAIL* B*, C***



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

Biological Testing

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



Spoiler: There isn’t one.

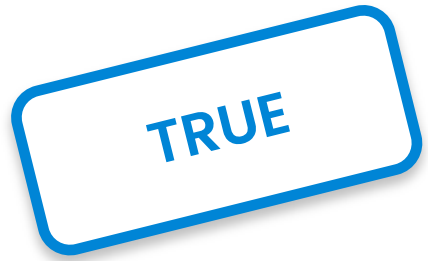
Observations of Note

- 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

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** ✗

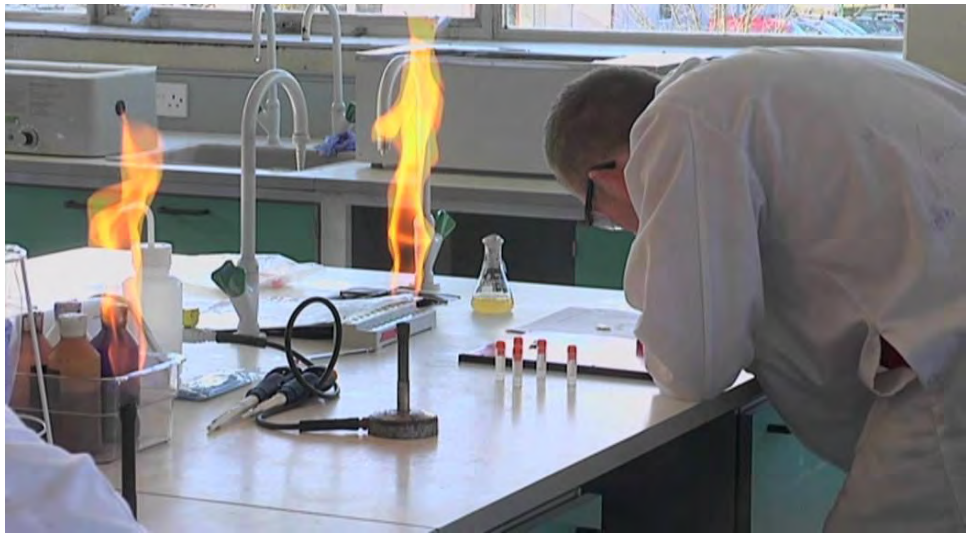


**Given following proper procedures*

Alternative Solutions

Instead of using a flame inside a BSC:

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



Don’t be this guy!

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BSC MYTHBUSTERS

If you have BSC myths you want tested, send them to me!
We'll get some answers.

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