# TESTING ACTIVE FILTERS AND ACHIEVING MAXIMUM EFFICIENCY

**Luis Rudenas, Active Ventilation Engineer**
**Andrew Mc Gregor, Active Filtration Testing Officer**
**James Stephanou, University of Wollongong Graduate**

**Australian Nuclear Science Technology Organization**
**Lucas Heights, Sydney, Australia**

# Overview

- ANSTO conducts active ventilation filter testing throughout the organisation as part of its licensing agreement with the governing body ARPANSA (Australian Radiation Protection And Nuclear Safety Agency).

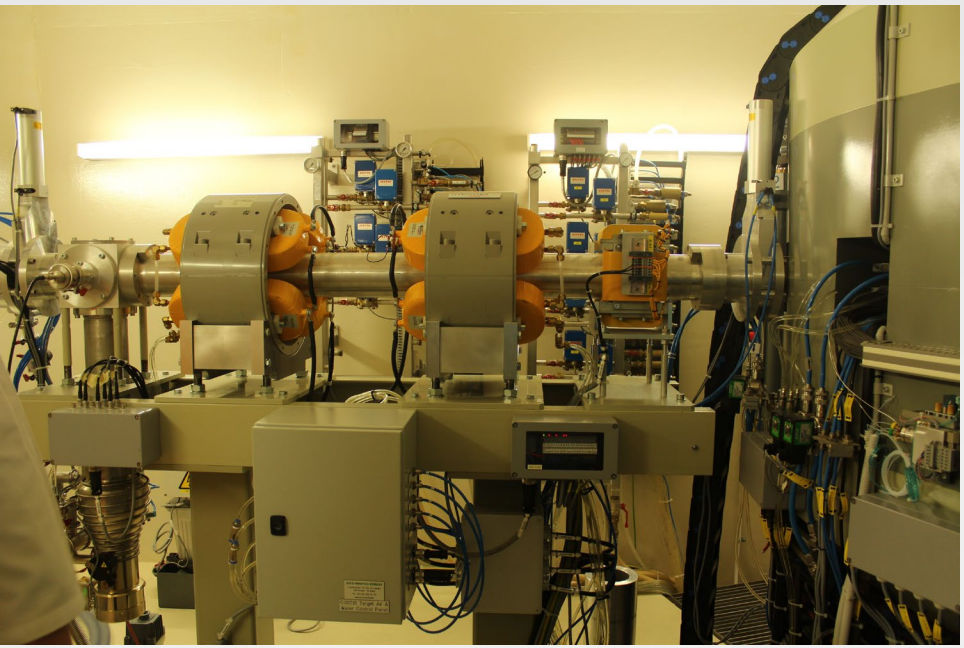
- Testing is performed on a regular basis. Once the test is completed a determination is made as to when the filter will require a change.

# Overview

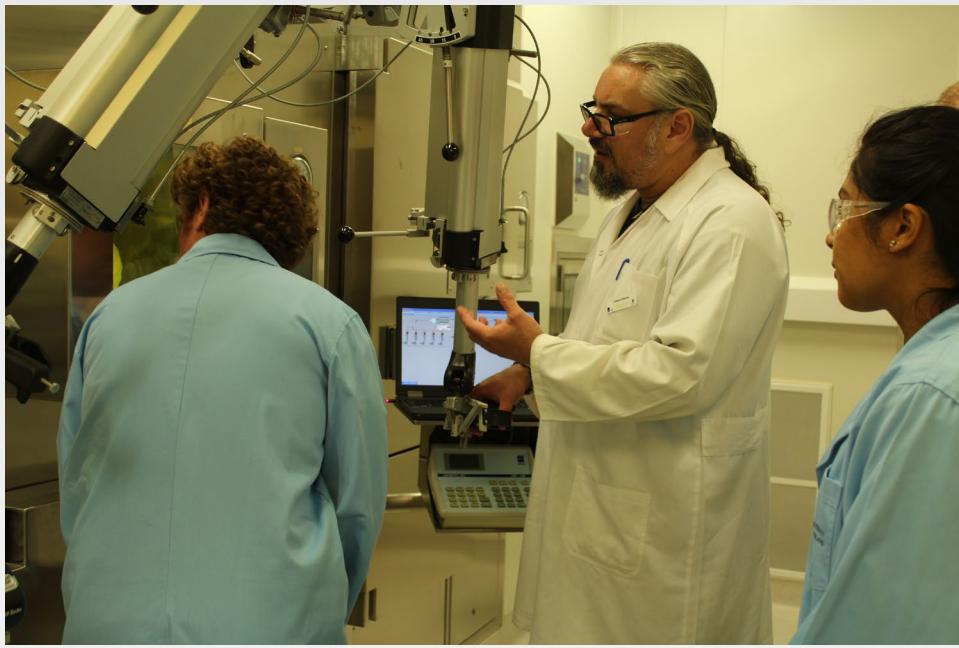
ANSTO collaborates with a range of facilities, some of these facilities that require testing include:

- OPAL Nuclear Reactor
- Australian Nuclear Medicine Facility
- ANSTO Waste Facility
- Australian Radio Pharmaceuticals
- National Medical Cyclotron (RPA Hospital)
- University Of Queensland Cyclotron
- Macquarie University

# Ventilation on the Cyclotron, Labs, Workshops, Hot Cells & Fume Cupboards



Cyclotron Target.



Hot cells being checked.

# Filter testing preparation and process

1. Installation of injection and sampling testing points.
2. Installation of parallel canisters for carbon analysis.
3. Aerosol Uniformity Tests (if more than 1 filter is installed).
4. Checking & changing pre-filters at each test on a yearly basis.
5. Checking the flow rates of the filter banks.
6. Check the Pressure Drop across the HEPA filters and prefilters.

# Filter testing preparation and process

7. Measure HEPA Filters with a particulate aerosol upstream and downstream. Penetration of particles to assess the overall filter system efficiency.

8. Measuring Carbon filters with a gas upstream and downstream to asses the mechanical efficiency of the filters.

9.Carbon analysis (Sample sent to USA for lab testing).

10.Maintenance of filter banks.

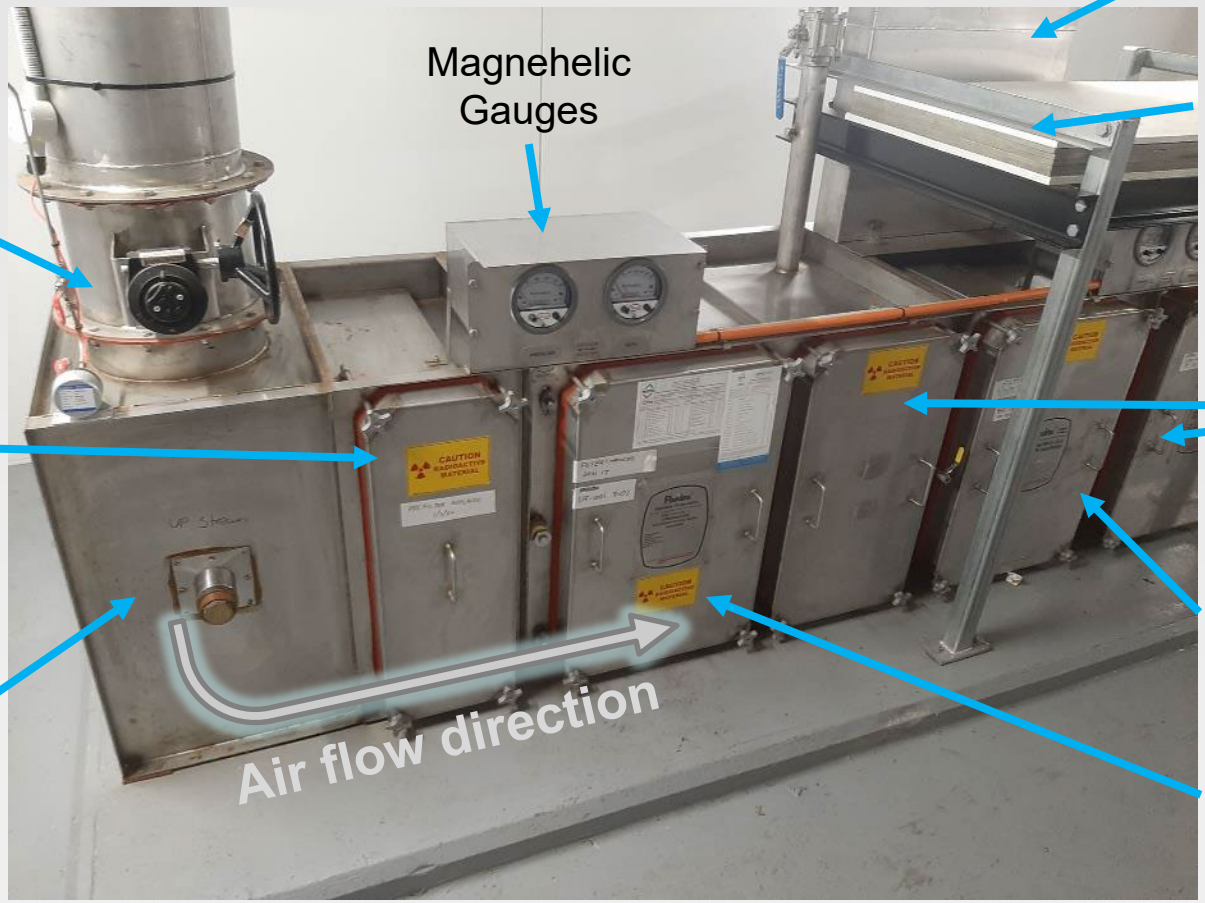
11. Report generating.

# Standards for assembling and testing filters

The following standards are adhered to when testing and assembling filters:

- ASME AG-1 Code on Nuclear Air and Gas Treatment
- ASTM 3803-89 Standard Test Method of Nuclear-Grade Activated Carbon
- ASME N509 Nuclear Power Plant Air-Cleaning Units & Components
- ASME N510 Testing of Nuclear Air-Treatment Systems
- ASME N511 In-Service Testing of Nuclear Air Treatment Systems

# HEPA Filter & Carbon Bank




Carbon Canister Box

Bubble Tight Damper

Magnehelic Gauges

Shielding for Stack

HEPA Scanning Box No required for testing

Pre-filter

Carbon Filter #2

Carbon Filter #1

Sampling manifold

HEPA filter

# Response to test results

## HEPA Filters.

- Requires to pass the mechanical efficiency test at 0.03% maximum penetration for 0.3 microns particles. The HEPA Filters  are changed if the static pressure is twice the value on installation.

# Response to test results

## Carbon Filters.

- Required to pass a Mechanical Efficiency test with a gas at 1% penetration & to pass the ASTM 3803-89 test for the carbon itself.

- If a Mechanical test failure is noted (seal failure or structural damage) to the filter, the filters are to be replaced, reinstalled or if possible repaired.

# Response to test results

## Carbon Filters.

- Following the standard ASTM 3803-89 a penetration level of Methyl-iodine is agreed with the Operator for carbon filter replacement. At 1% penetration an action plan should be started.
- The carbon used to refurbish the filters requires a valid ASTM 3803-89 Certificate (5 years)
- Spare filters also require a valid test certificate (5 years of validity if never used)

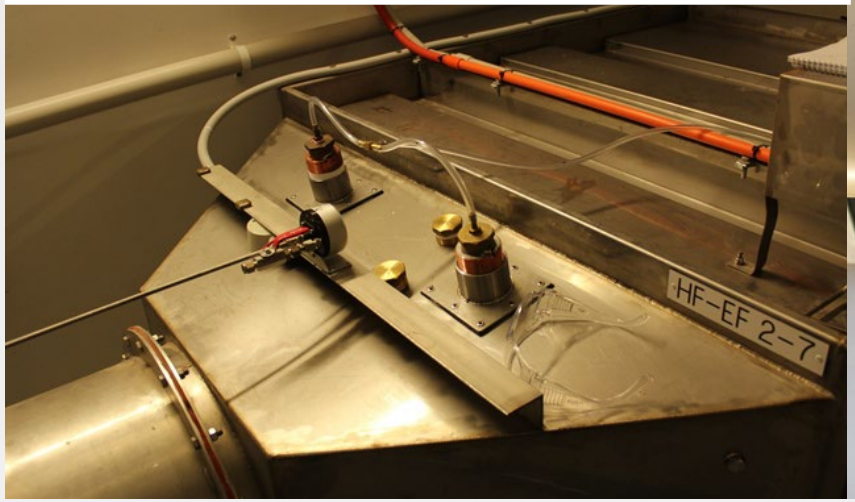
# Copper testing manifold

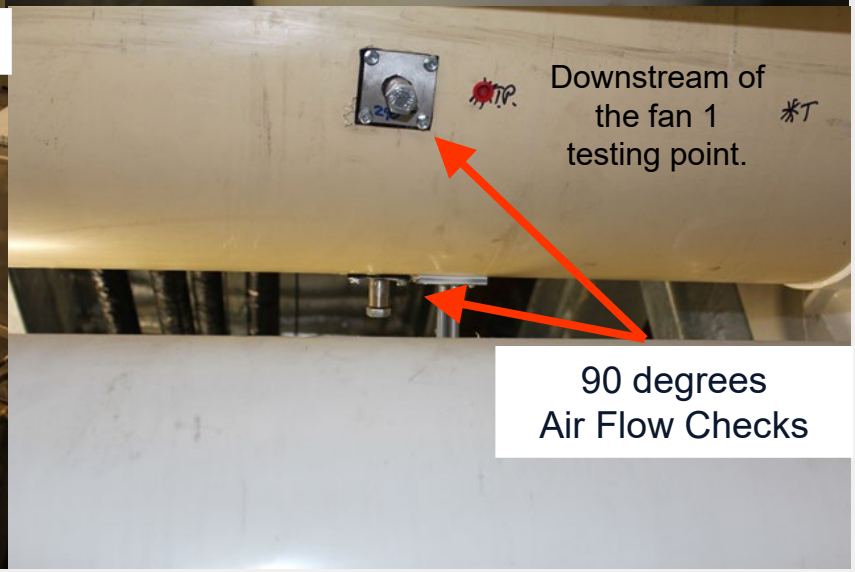
# Injection and Testing in Metal/Plastic

Injection point. Pop-rivets in metal ducts

Injection point. Tech Screws in plastic ducts

100 % manifolds in two filters




90 degrees
Air Flow Checks

# Filter changing Process

<u>If a filter change is required:</u>

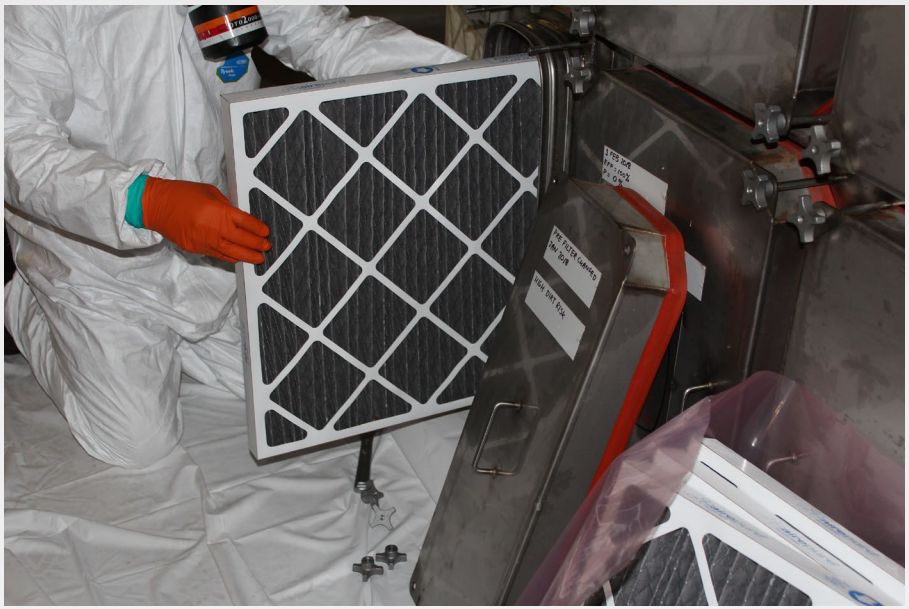
- The area must be classed as a "**Blue**" radiation area.
- Health physics support is required to check the area and filters.
- The Technicians must wear appropriate PPE, including **coveralls, overshoes, Gloves and P3 masks.**
- Old filters must be bagged and disposed of or refurbished.

# Filter changing Process

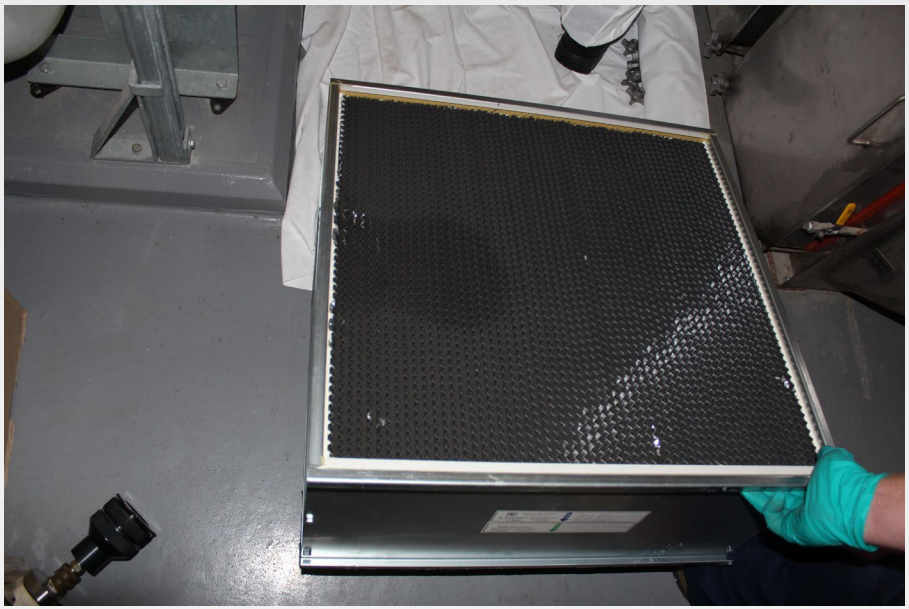
This work is often conducted in hot conditions and access is often very restrictive.

# Prefilters & HEPA Filters Changed at the CAI

Prefilters are changed every year



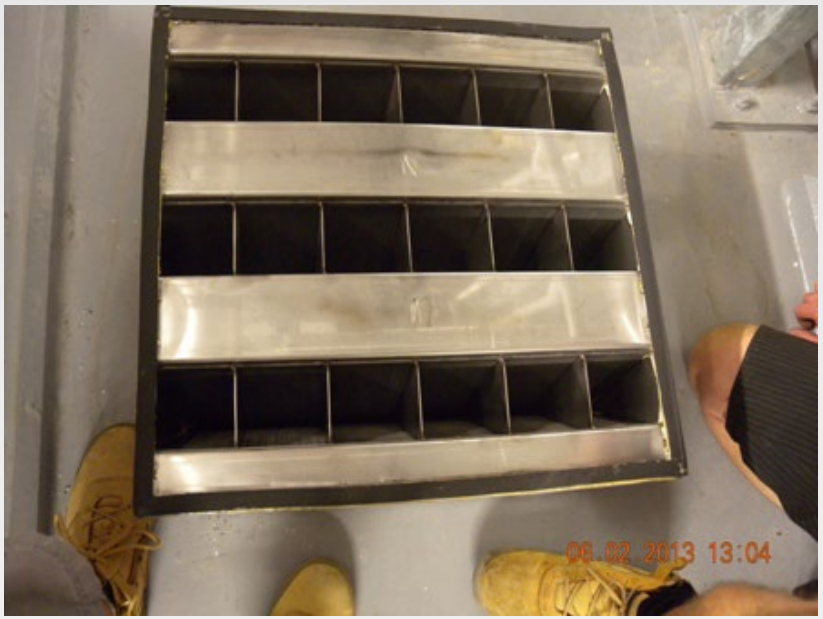
HEPA Filters change on test failure or static pressure increase.



# Carbon & HEPA Filter Mechanical Efficiency Tests Only

## HEPA Filter


## Carbon Filter



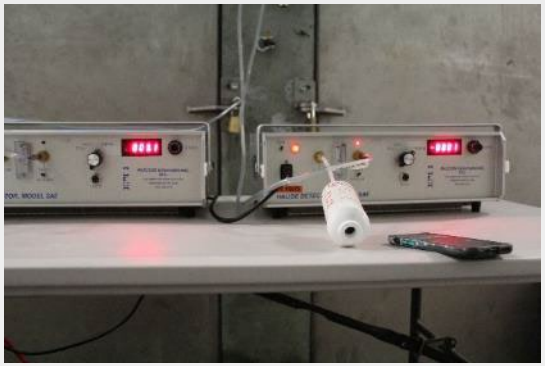
# Carbon & HEPA Filter Mechanical Efficiency Tests Only

HEPA Upstream 100% Concentration.


Carbon Upstream in ppm of 1-Bromobutane

HEPA Downstream penetration


Carbon Downstream in ppm of 1-Bromobutane



Penetration = 100 X (Conc. down/Conc. Upstream)

Carbon Maximum P = 1 % of 1-Bromobutane

HEPA maximum P = 0.03 % PAO Emery 2004

# HEPA Filter Tests Results at CAI Queensland

**Table 1. HEPA Filter penetration test results. Maximum allowed 0.03 %**

| | Cyclotron Vault | Hot Cell Exhaust | Radio-chem Exhaust | Cyclotron Workshop | Hot Lab Research | Shielded Fume Hood | Fume Cup. EF-1-2 | Hot Lab GMP | Radio-chem Exh. Arms | Fume Cup. FC 2-2 | Fume Cup. FC 2-3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | HF-EF 1-11 | HF-EF2-6 | HF-EF2-3 | HF-EF-1-10 | HF-EF-2-2 | HF-EF-2-7 | HF-EF1-2 | HF-EF-2-1 | HF-EF-2-8 | HF-FEF-2-2 | HF-FEF-2-3 |
| 2022 Pen % | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2021 Pen % | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2020 Pen % | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2019 Pen % | 0 | 0 | 0 | 0.004 | 0 | 0 | 0 | 0 | 0.001 | 0 | 0 |
| 2018 Pen % | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2017 Pen % | 0.004 | 0.001 | 0 | 0 | 0.02 | 0.001 | 0 | 0.01 | 0.002 | 0.004 | 0.01 |
| 2016 Pen. % | 0.006 | 0.02 | 0.005 | 0 | 0.014 | 0 | 0.005 | 0.007 | 0 | 0.001 | 0 |
| 2015 Pen % | 0 | 0 | 0 | 0 | 0.013 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2014 Pen % | 0 | 0 | 0 | 0 | | | | | | | |
| 2013 Pen % | 0 | 0 | 0 | 0 | | | | | | | |

# HEPA Filters Static Pressure at the CAI Queensland

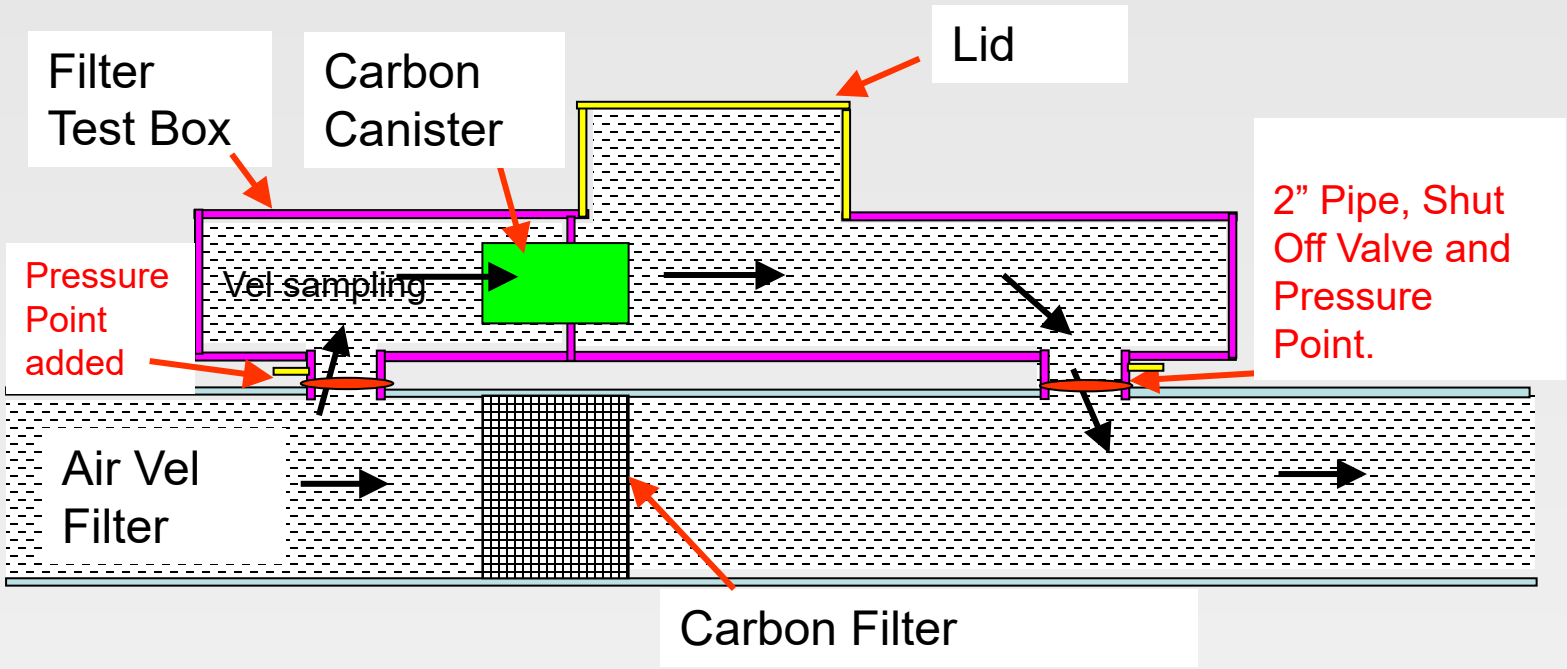
**Table 2. HEPA Filter Static Pressure test results.**

| | Cyclotron Vault HF-EF 1-11 | Hot Cell Exhaust HF-EF2-6 | Radio-chem Exhaust HF-EF2-3 | Cyclotron Workshop HF-EF-1-10 | Hot Lab Research HF-EF-2-2 | Shielded Fume Hood HF-EF-2-7 | Fume Cup. EF-1-2 HF-EF1-2 | Hot Lab GMP HF-EF-2-1 | Radio-chem Exh. Arms HF-EF-2-8 | Fume Cup. FC 2-2 HF-FEF-2-2 | Fume Cup. FC 2-3 HF-FEF-2-3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2022 Pressure | 75 | 45 | 100 | 180 | 155 | 75 | 55 | 250 | 25 | 150 | 110 |
| 2021 Pressure | 50 | 25 | 100 | 155 | 125 | 75 | 50 | 270 | 25 | 140 | 100 |
| 2019 Pressure | 75 | 48 | 100 | 140 | 150 | 100 | 52 | 260 | 60 | 140 | 125 |
| 2018 Pressure | 75 | 48 | 130 | 270 | 160 | 100 | 50 | 250 | 25 | 150 | 150 |
| 2017 Pressure | 78 | 48 | 125 | 300 | 150 | 100 | 50 | 210 | 25 | 130 | 125 |
| 2016 Pressure | 52 | 27 | 77 | 325 | 140 | 100 | 55 | 200 | 10 | 126 | 125 |

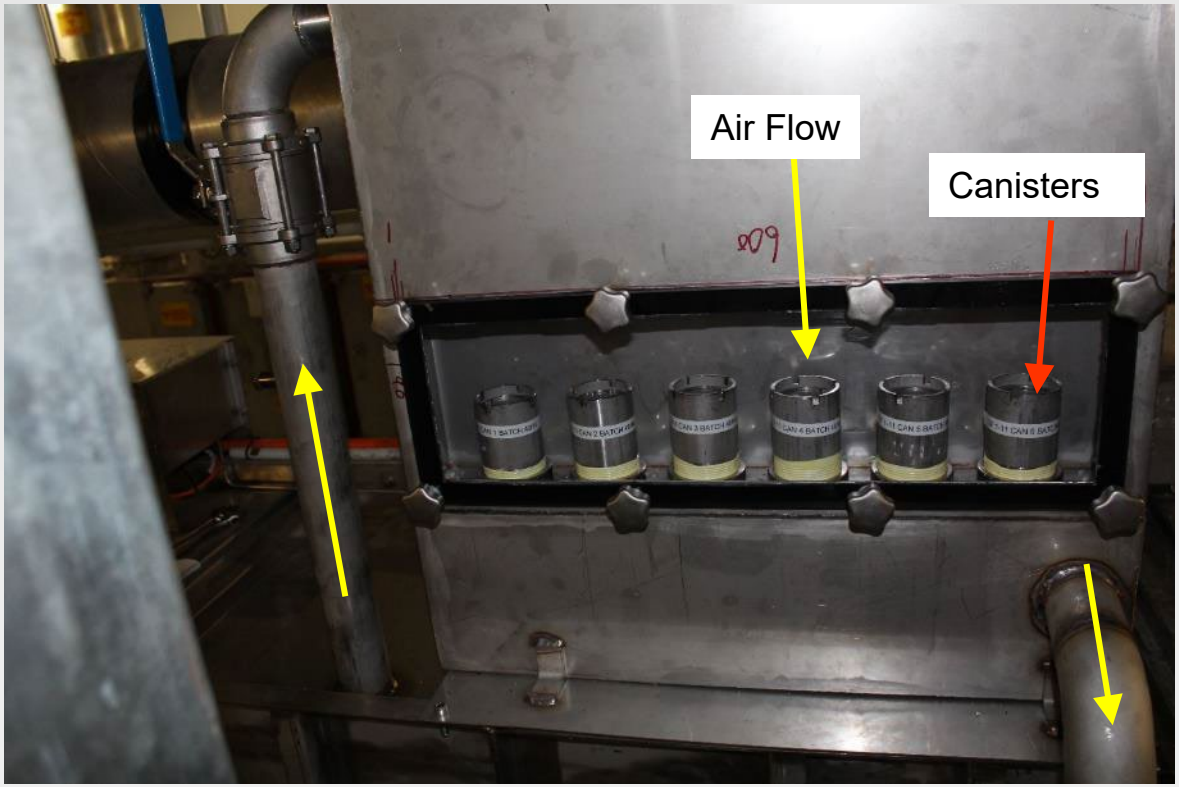
# Mk III Canisters Installation CAI

# Canister Box- CAI- Mark III

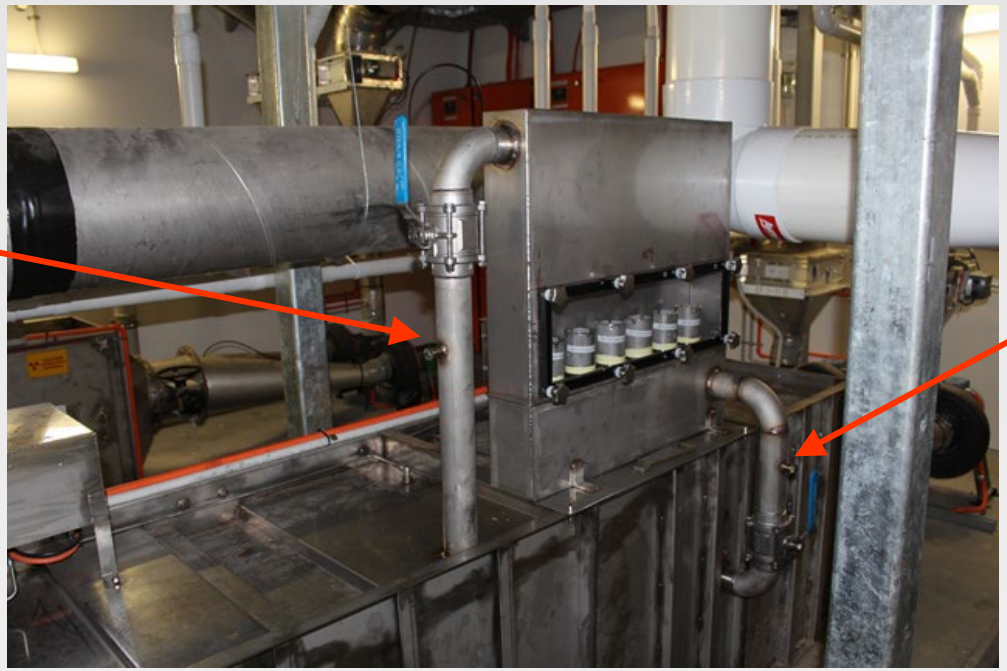
Vel Sampling = +/- 10% Vel Filter



# Six Mark III canisters installed in CAI



# Mark III Canisters installed in CAI



# Mechanical Efficiency of Carbon Filters

## CAI University of Queensland

**Table 3. Carbon Filters Mechanical Efficiency results. Maximum allowed penetration 1%**

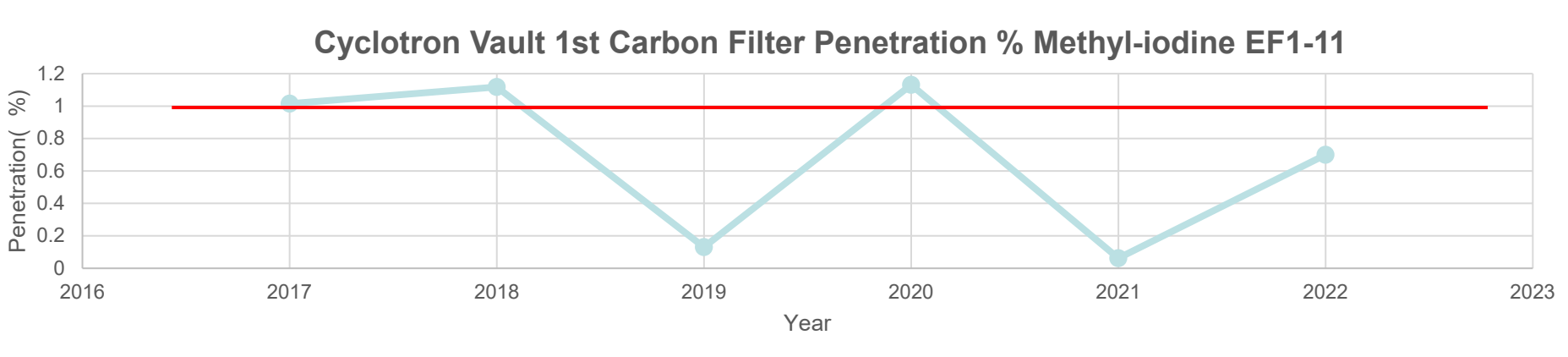
| | Cyclotron Vault | | Hot Cell Exhaust | | EF1-11 | EF2-6 |
|---|---|---|---|---|---|---|
| | EF1-11 | EF1-11 | EF2-6 | EF2-6 | | |
| | First Filter | 2nd Filter | First Filter | 2nd Filter | **Total (%)** | **Total (%)** |
| 2022 Pen % | 0 | 0 | 0 | 0 | **0** | **0** |
| 2021 Pen % | 0 | 0 | 0 | 0 | **0** | **0** |
| 2020 Pen % | 0 | 0.1 | 0.0067 | 0.21 | **0.1** | **0.3167** |
| 2019 Pen % | 0 | 0.015 | 0.004 | 0 | **0.015** | **0.0040** |
| 2018 Pen % | 0.198 | 0 | 0.058 | 0 | **0.198** | **0.0580** |
| 2017 Pen % | 0.09 | 0 | 0.018 | 0 | **0.090** | **0.018** |
| 2016 Pen % | 0.068 | 0 | 0.01 | 0 | **0.068** | **0.01** |
| 2015 Pen % | 0 | 0 | 0.016 | 0 | **0** | **0** |
| 2014 Pen % | 0 | 0.09 | 0 | 0.006 | **0.09** | **0.006** |
| 2013 Pen % | 0 | 0.09 | 0 | 0.006 | **0.09** | **0.006** |

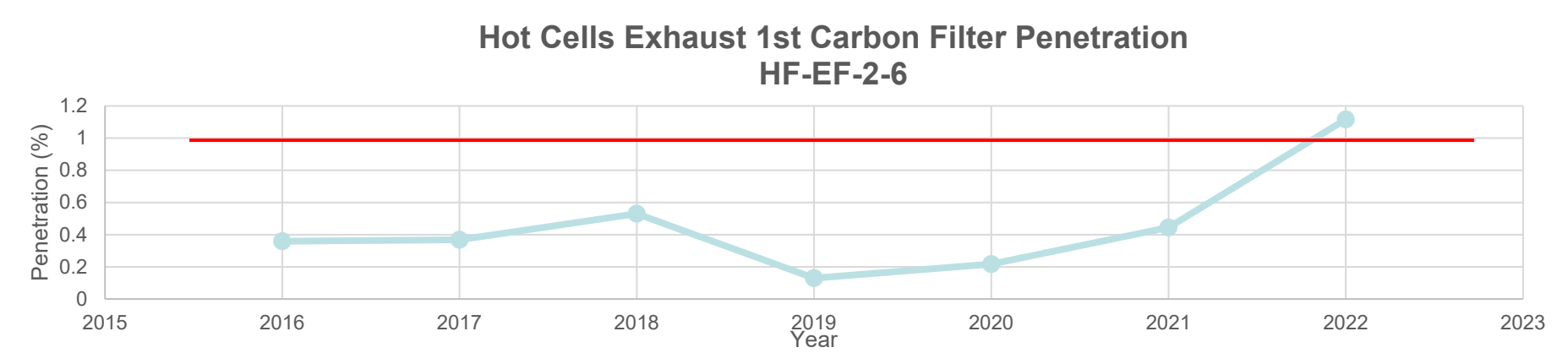
# Carbon Filters Test to ASTM 3803-89

**Table 4. Carbon ASTM 3803-89 Tests** **Maximum Recommended 1% penetration**

| | EF 1-11 First | | EF 1-11 2nd | | EF2-6 First | | EF2-6 Second | |
|---|---|---|---|---|---|---|---|---|
| 2022 Pen % | 0.7 | (+/- 0.006 | No Sample | | 1.116 | (+/- 0.008) | No Sample | |
| 2021 Pen % | 0.062 | (+/- 0.001 | 0.062 | (+/- 0.001 | 0.445 | (+/- 0.005) | 0.882 | (+/-0.008) |
| Carbon Certificates | 0.062 | (+/- 0.001 | 0.062 | (+/- 0.001 | No Sample | | No Sample | |
| Lot/Batch | 48/105 | | 48/105 | | No Sample | | No Sample | |
| 2020 Pen % | 1.131 | (+/- 0.007) | No Sample | | 0.217 | (+/- 0.003) | No Sample | |
| 2019 Pen % | 0.13 | (+/- 0.002) | 9.307 | | 0.13 | (+/- 0.002) | 0.939 | (+/- 0.012) |
| Carbon Certificates | 0.13 | | 0.57 | | 0.13 | | 0.57 | |
| Lot/Batch | 48/94 | | 72/03 | | 48/94 | | 72/03 | |
| 2018 Pen % | 1.118 | (+/- 0.014) | No Sample | | 0.53 | (+/- 0.010) | No Sample | |
| 2017 Pen % | 1.015 | (+/- 0.008) | No Sample | | 0.368 | | No Sample | |
| 2016 Pen % | 0.371 | | No Sample | | 0.359 | | No Sample | |

# Methyl-Iodine Penetration (%)



# Conclusions

Correctly design new filter housings with canisters, testing manifolds and bubble tight dampers.

Change prefilters at least in annual base to keep clean the HEPA Filters.

Periodically test the HEPA and carbon filters and be prepared for filter changes at any time.

Keep a trend of pressure increases through HEPA filters.

# Any Questions ?

## ANSTO Contact:

Luis Rudenas

Active Ventilation Engineer

lrx@ansto.gov.au

Phone : 011612971739 82
Mobile: 011612418288013