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Testing of Carbon Filters in Australian Nuclear Installations

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Carbon filter tests objectives

- Prevent reactor shutdown due to carbon filter failures
- Trained workshop personnel available at any time to refill carbon filters
- Easy to understand instructions to test filters by maintenance personnel
- New filter housing upgrades with modular designs of canisters and fire suppression
- Filtration system tested and reliable. Stack monitoring to check effectiveness

Adopted standards for assembling and testing filters at ANSTO

- ASME AG-1 Code on Nuclear Air and Gas Treatment
- ASTM 3803-89 Standard Test Method of Nuclear-Grade Activated Carbon
- ASME N510 -2002 Testing of Nuclear Air Treatment Systems
- ASME N509-2002 Nuclear Power Plant Air-Cleaning Units and Components

Test of carbon filters

- Injection and sampling manifolds properly designed
- Air distribution test
- Aerosol uniformity test
- Mechanical integrity test, pulses of 1 Bromobutane
- Advantage of gas pulse is less gas used and the test can be repeated immediately
- Gas pulse test complemented by laboratory test of installed canisters or by direct carbon sampling of filters

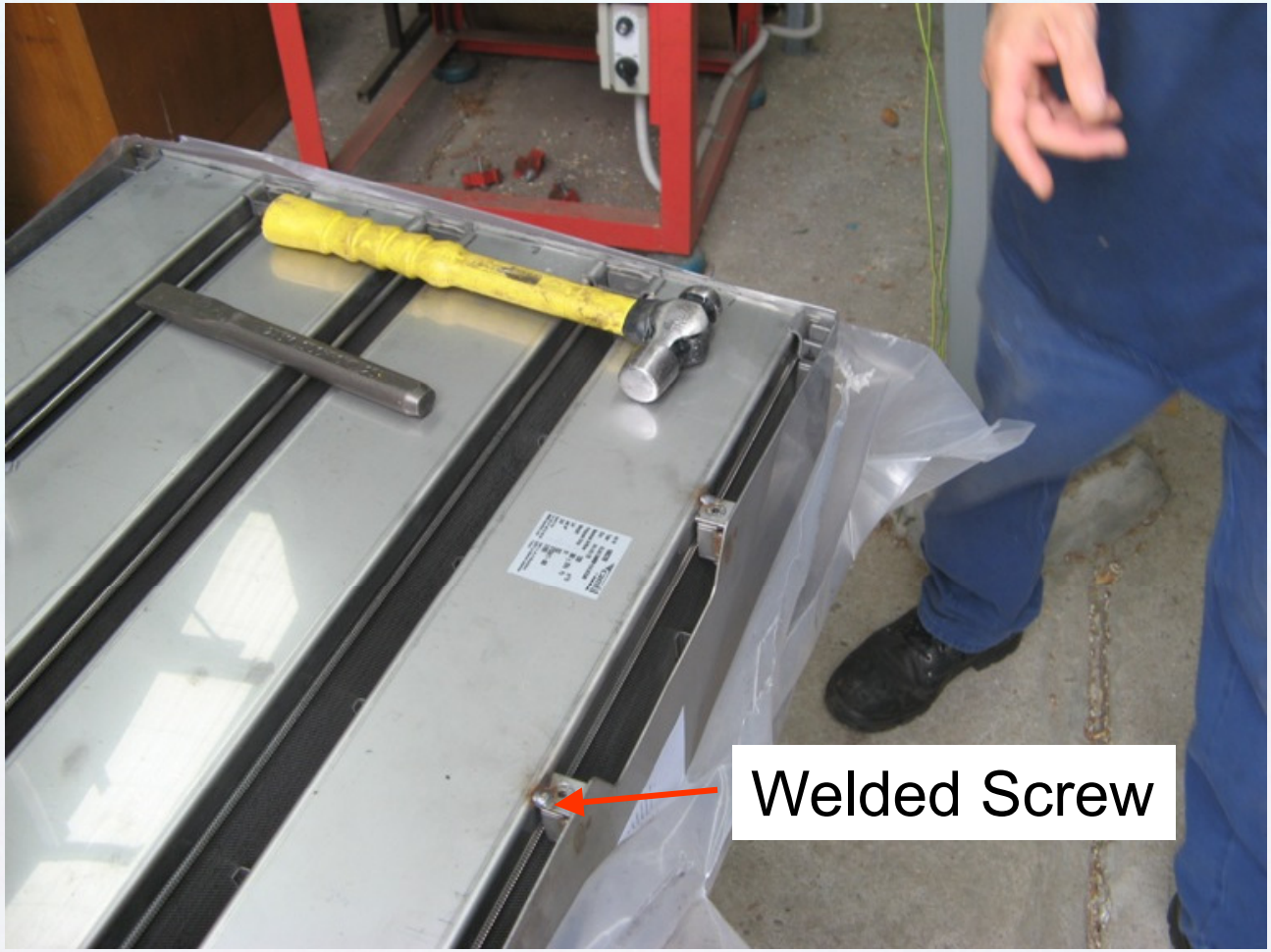
Response to carbon test results

- ASTM 3803-89 test failure requires carbon filters to be replaced
- Mechanical test failure requires filters to be reinstalled or replaced
- Availability of carbon with valid ASTM 3803-89 Certificate (5 years)
- Spare filters with valid certificate (5 years if never used)

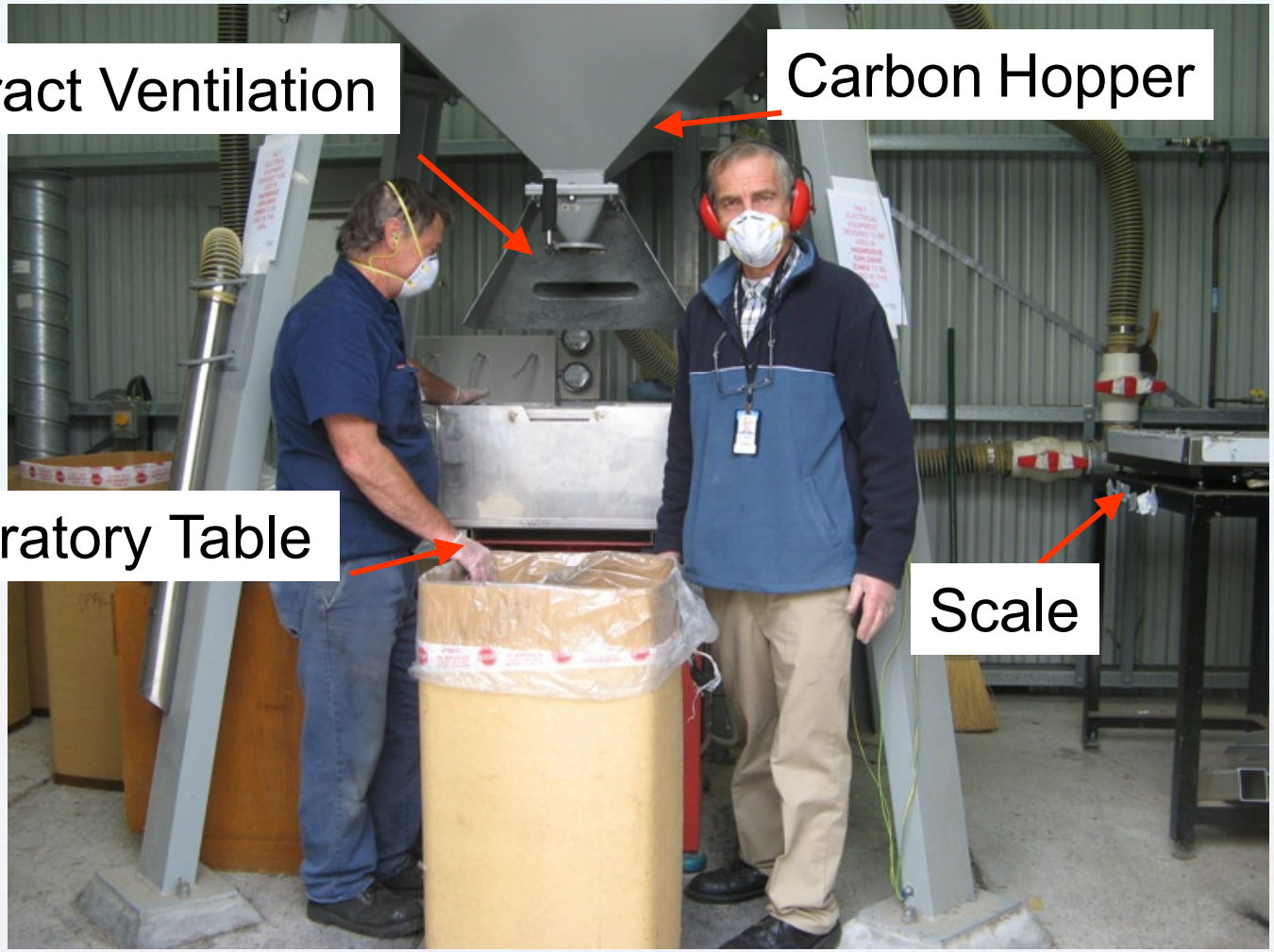
Carbon filters used at ANSTO

- SIAM filters size 17.5” X 17.5” and 10” carbon depth, capacity 100 cfm. Area= 2.2 Sq. Ft.
- B23 Filters 24” X 24” and 10” carbon depth, capacity 200 cfm. Area= 4 Sq. Ft.
- Type IV (Flanders V-Bed) 24” X 24” and 2” carbon depth, capacity 700 cfm. Area= 16 Sq. Ft.
- Type IV (Flanders V-Bed) 24” X 12” and 2” carbon depth, capacity 500 cfm. Area= 8 Sq. Ft.
- Type IV (Flanders V-Bed) 24” X 24” and 1” carbon depth, capacity 1000 cfm
- Canisters used at ANSTO, 2” or 10” carbon depth and 2” internal diameter

Carbon filter ready for refilling



Facility to assemble filters



Pouring carbon in the Filters

Removing air after filling filter

Crates designed for internal transport

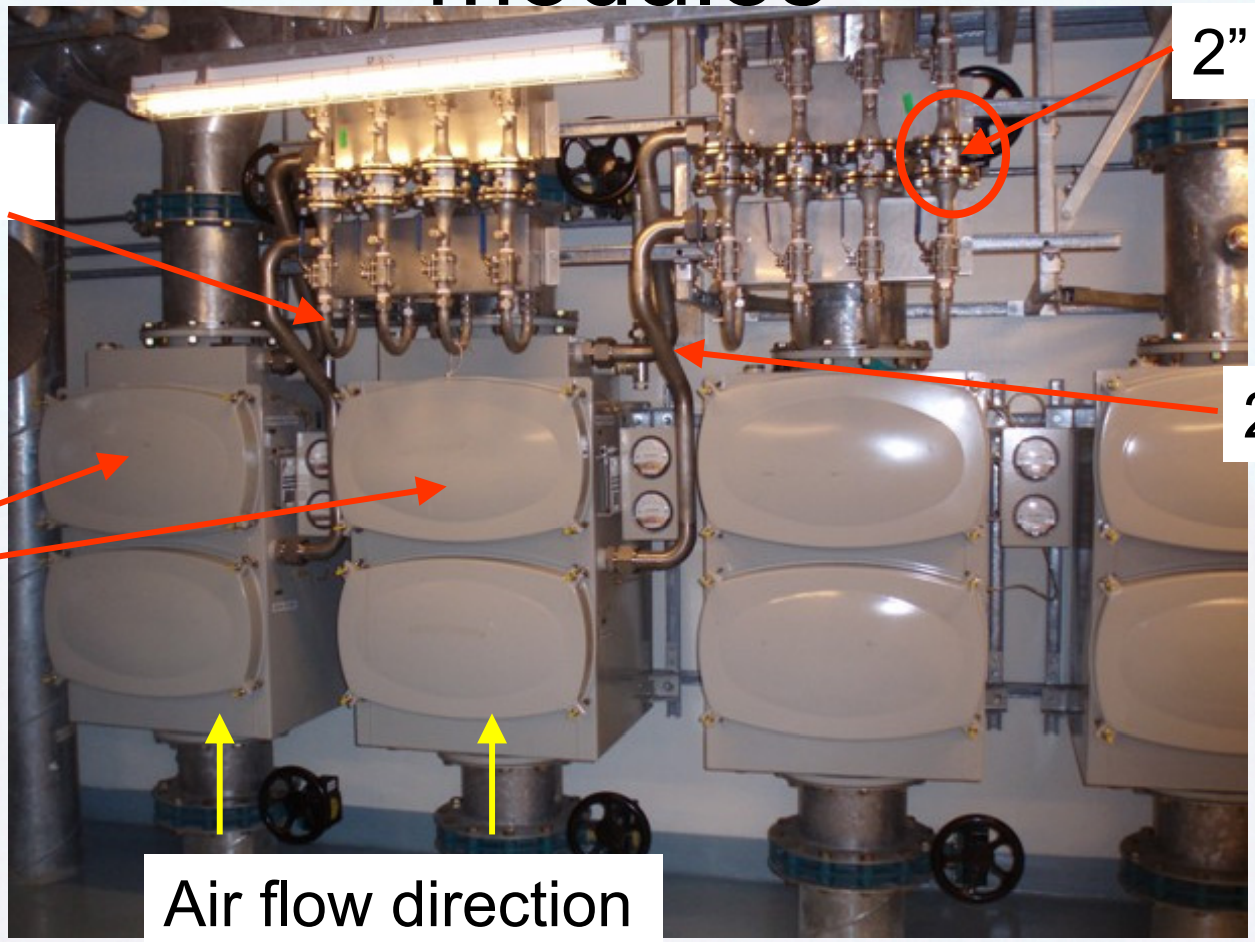
Confined space arrangement

Demountable rollers for filter installation

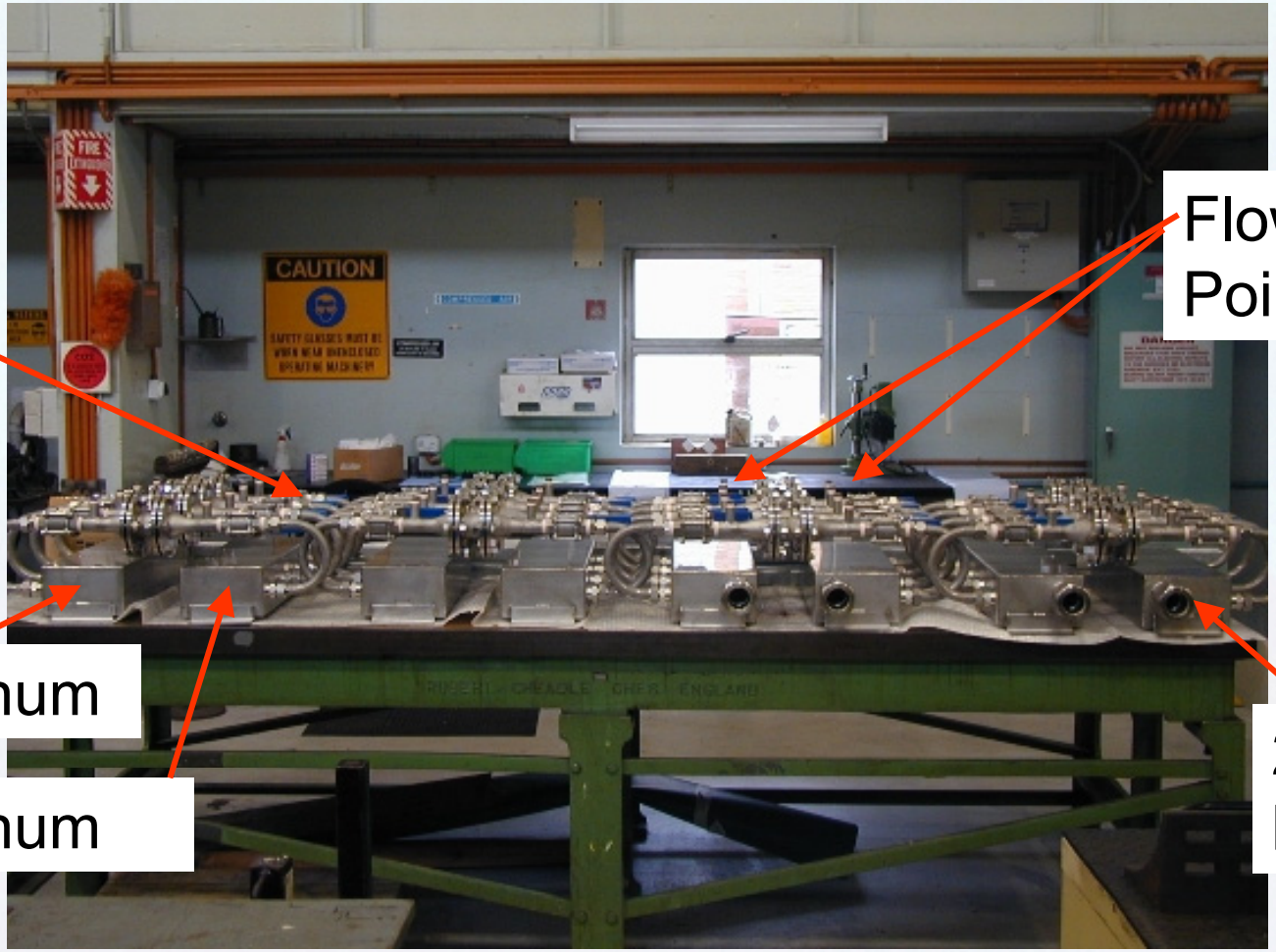
Filter handling in a confined space

ASTM 3803-89 test
Direct sampling from filter

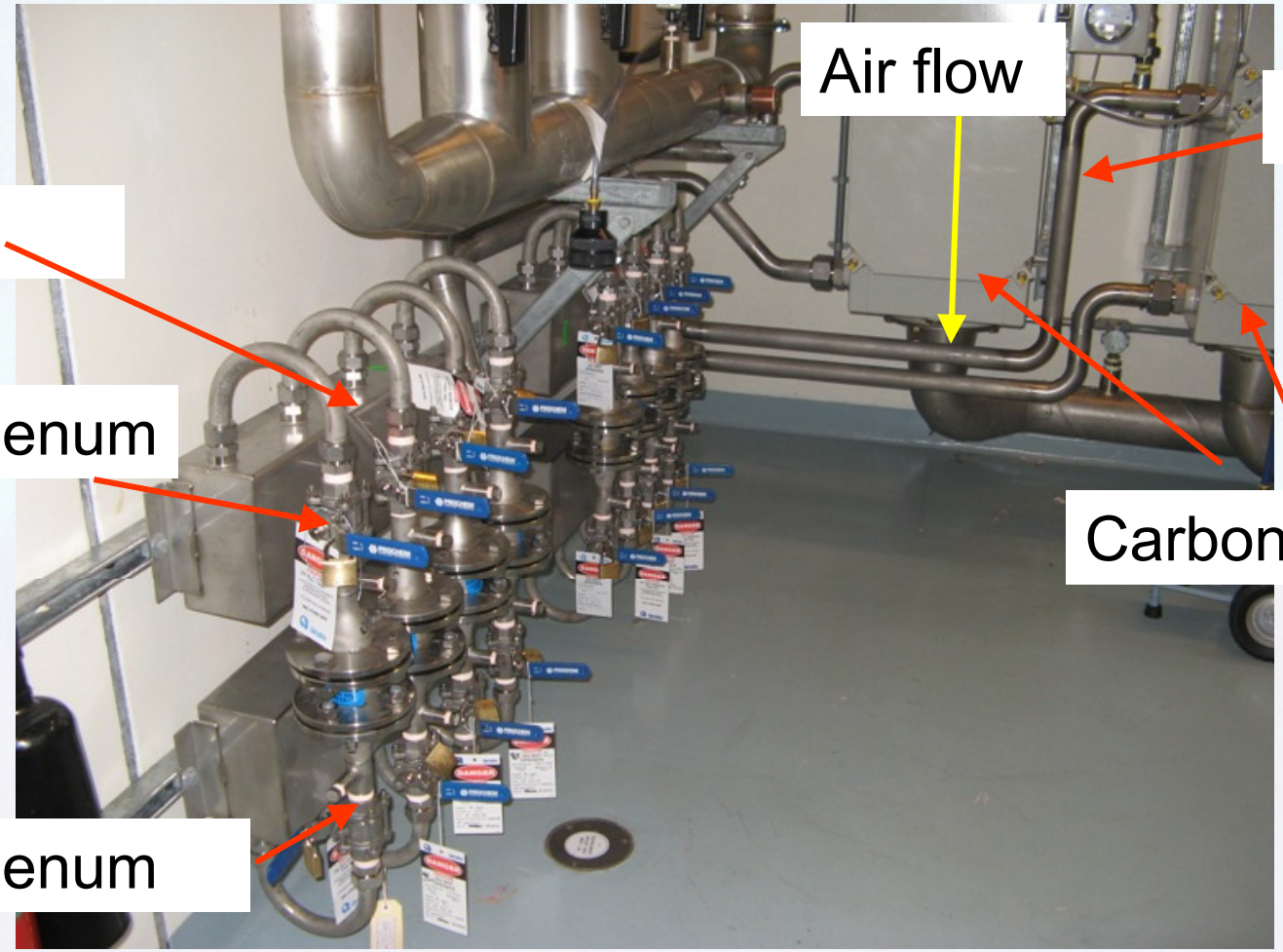
Two installed carbon canister modules



Canister preparation



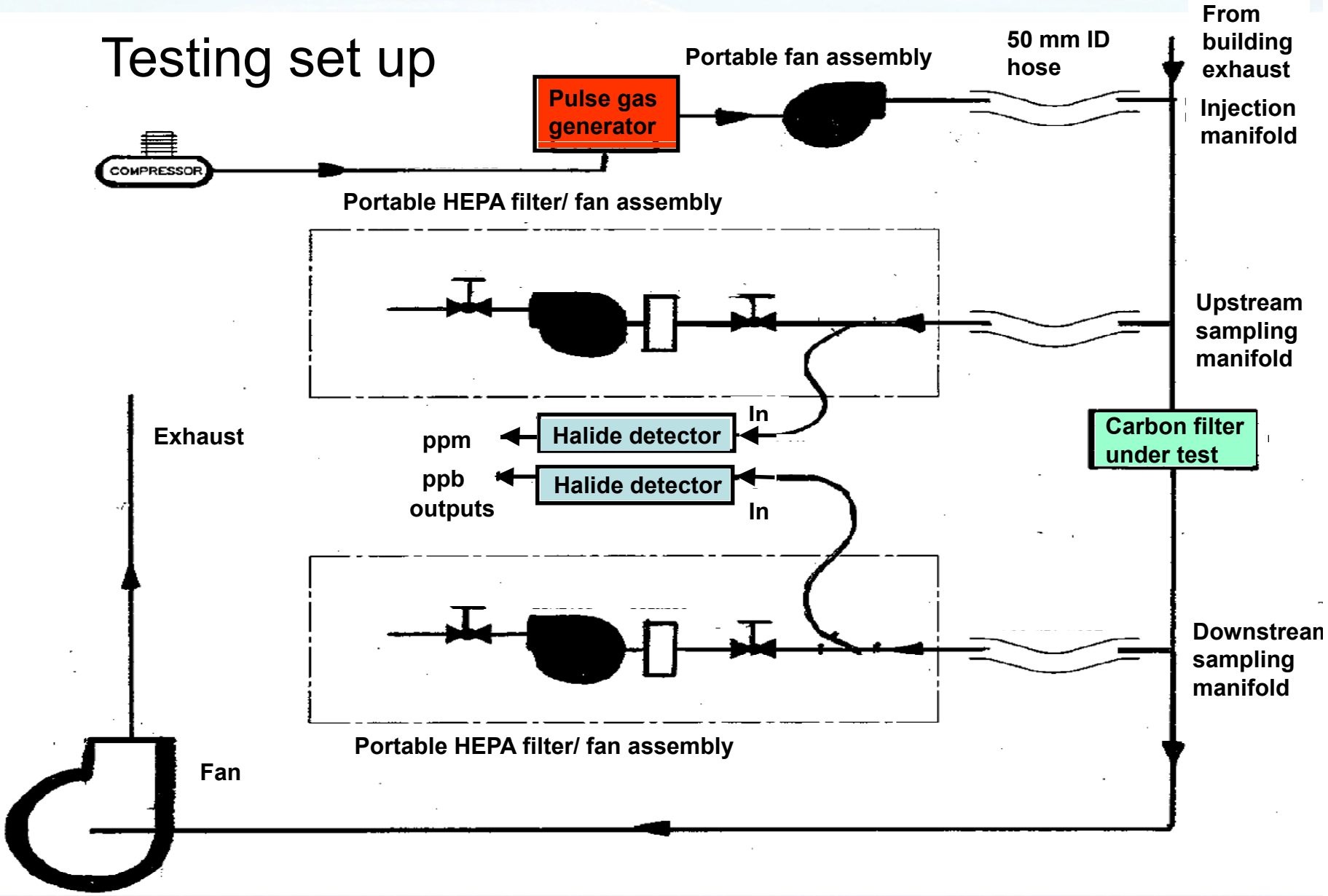
Different canister layout



Instruments for carbon testing

- NUCON Model HGPH Pulse Mode Halide Generator
- NUCON Model F-2000-HD ppm and ppb halide detector
- NUCON Model F-2000-BBD ppb halide detector
- NUCON Model F-1000-CR calibration rig to calibrate the halide detectors
- Calibration gases 200 ppb and 36 ppm of 1 Bromobutane with corresponding clean air cylinders supplied by NUCON.

Testing set up



Halide injection pulse test

- 1 ml of liquid 1 Bromobutane is equivalent to 223.8 ml of gas at 20 ^{o}C
- 2238 L/s of air flow has 100 ppm of 1 Bromobutane gas when 1 ml of liquid is injected in one second
- Always measure upstream concentration to ensure proper gas injection and calculate penetration. Penetration = 100*Cd/Cu
- Maximum allowed penetration at ANSTO is 1%
- The downstream concentration may exceed the instrument range when the carbon filter leaks

Copper testing manifold

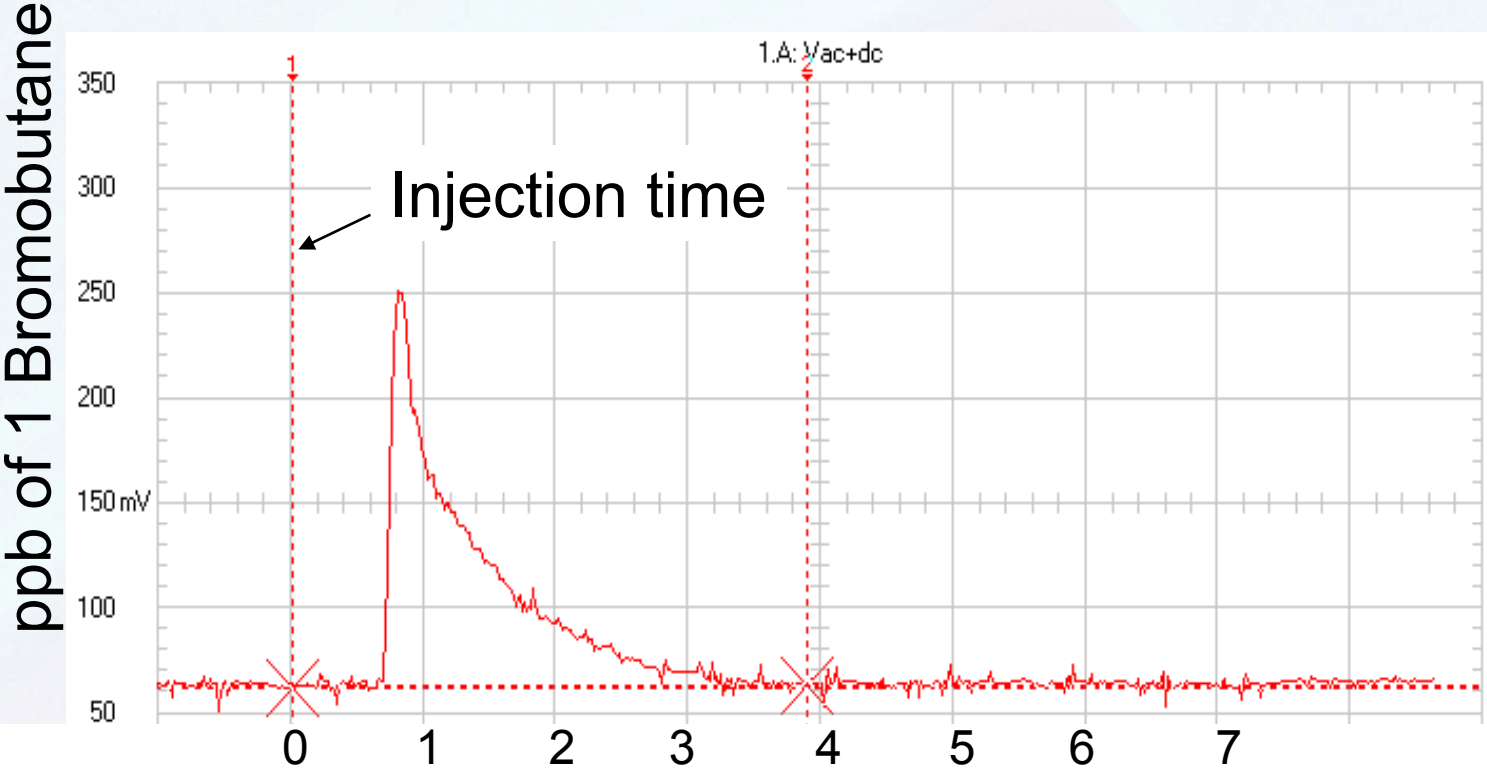
Fitting 2” BSP of internal diameter to be pop riveted to a duct

Installing the testing manifold

Calibration gases ppm and ppb of 1 Bromobutane with clean air cylinders

Gas detectors ppm and ppb

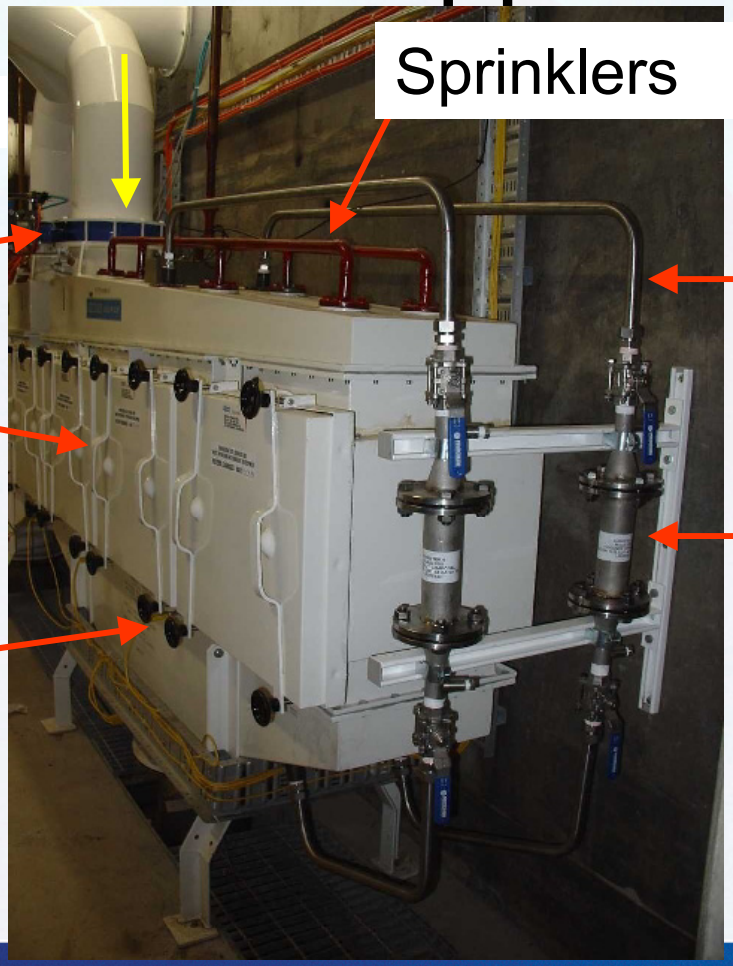
Gas leak investigation in a side removable plate of a new filter



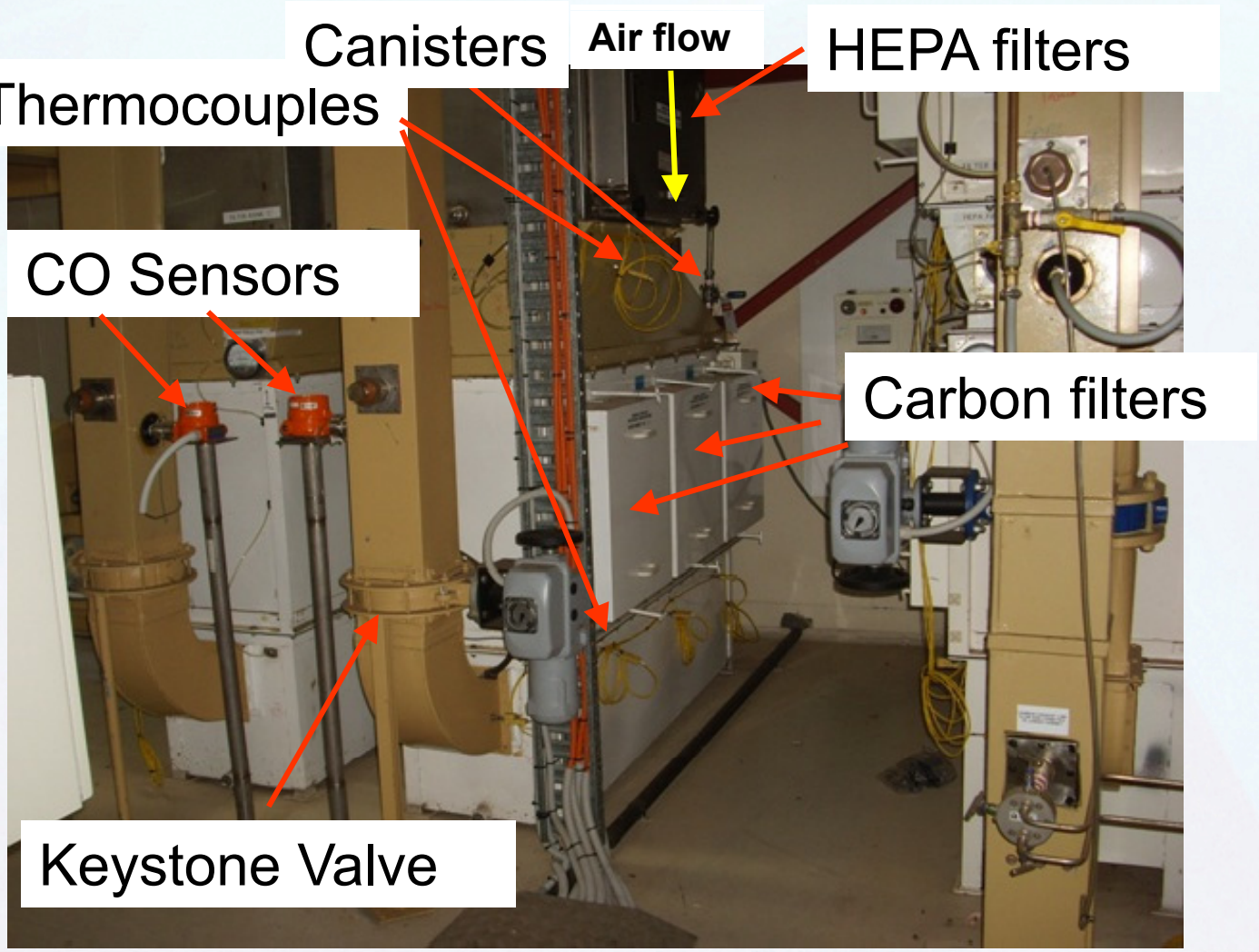
Carbon filter housing requirements

- Canisters for surveillance testing
- Injection and sampling manifolds
- Inlet and outlet plenums
- **Fire suppression**
  - Bubble tight dampers to isolate filters in case of fire or for maintenance purposes
  - Carbon Monoxide sensors
  - Thermocouples

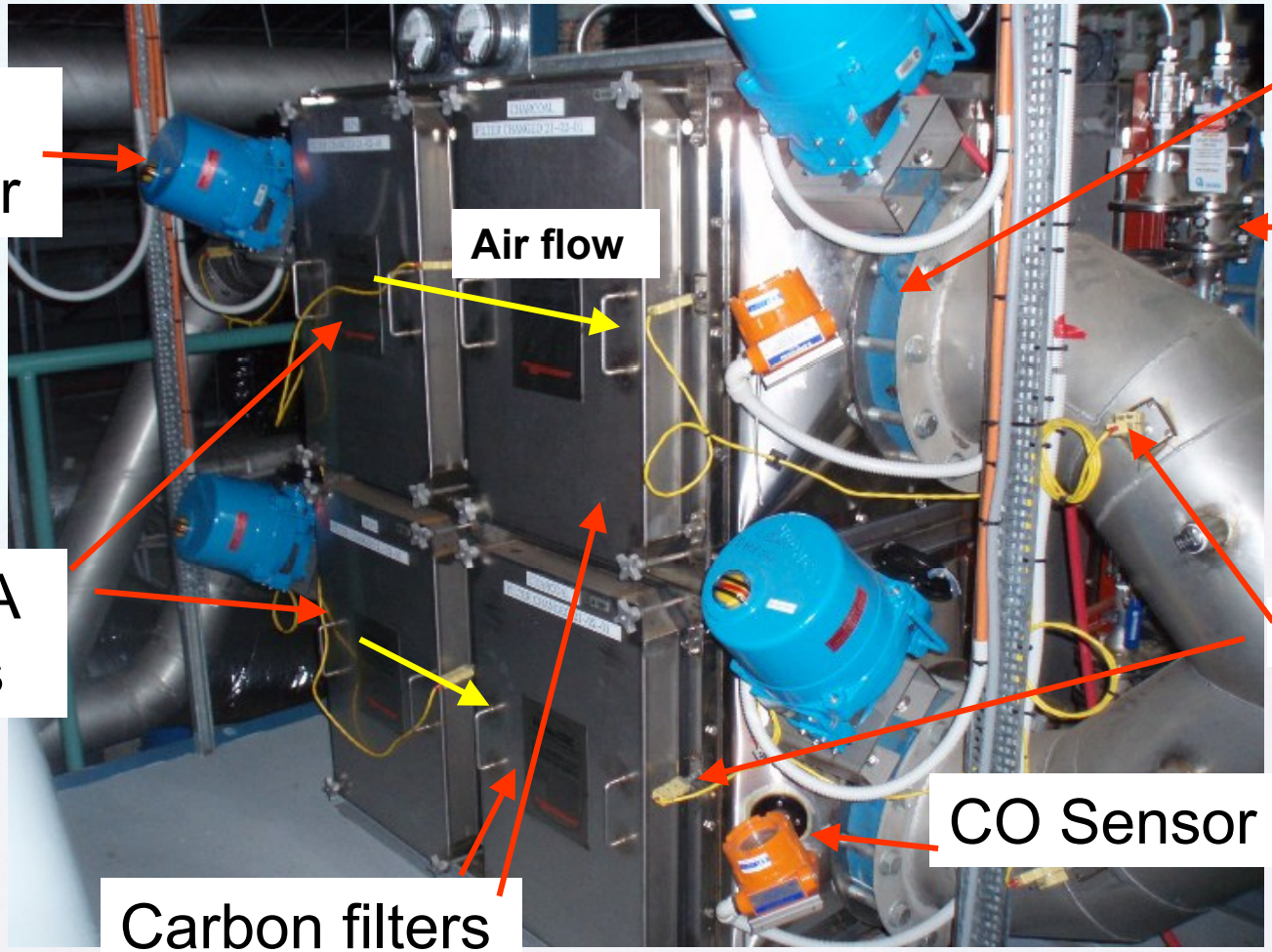
Thermocouple activated water flood for fire suppression



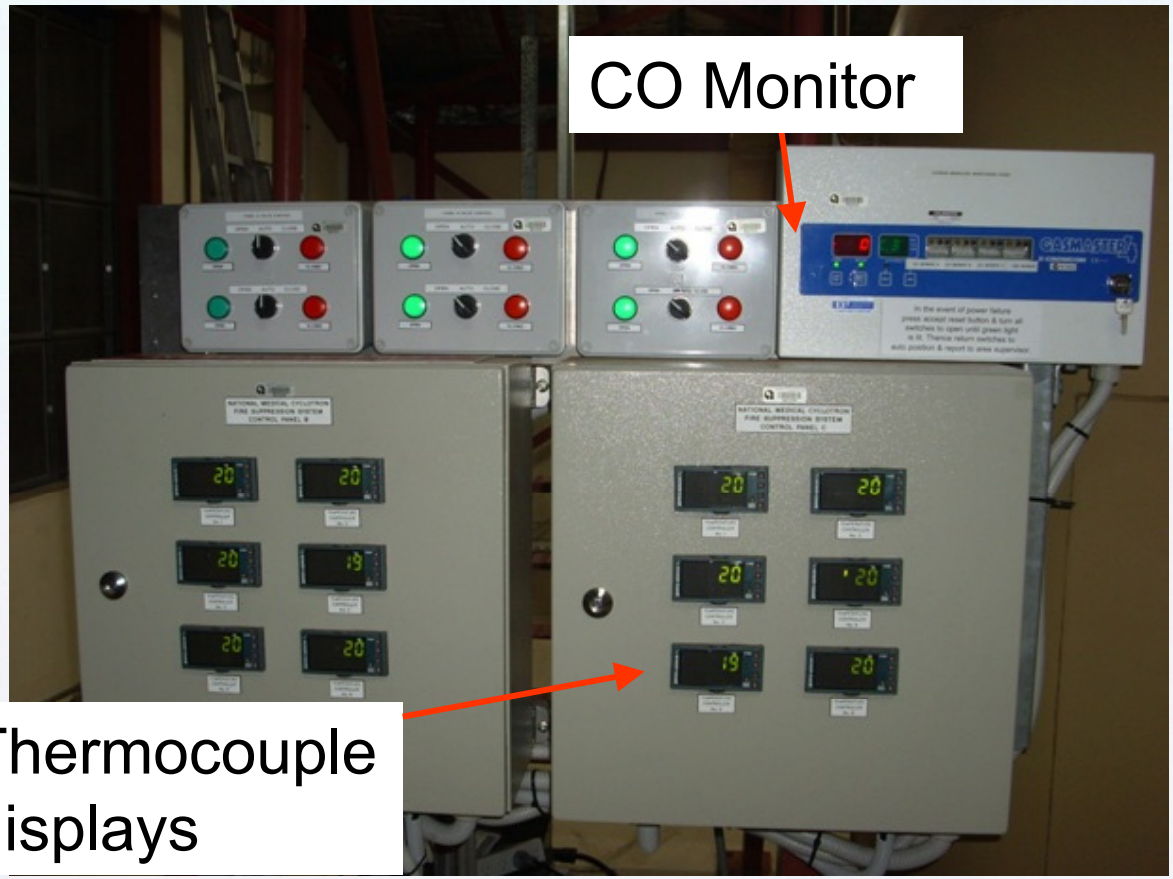
Fire suppression for Cyclotron



Fire suppression for Hot Cells



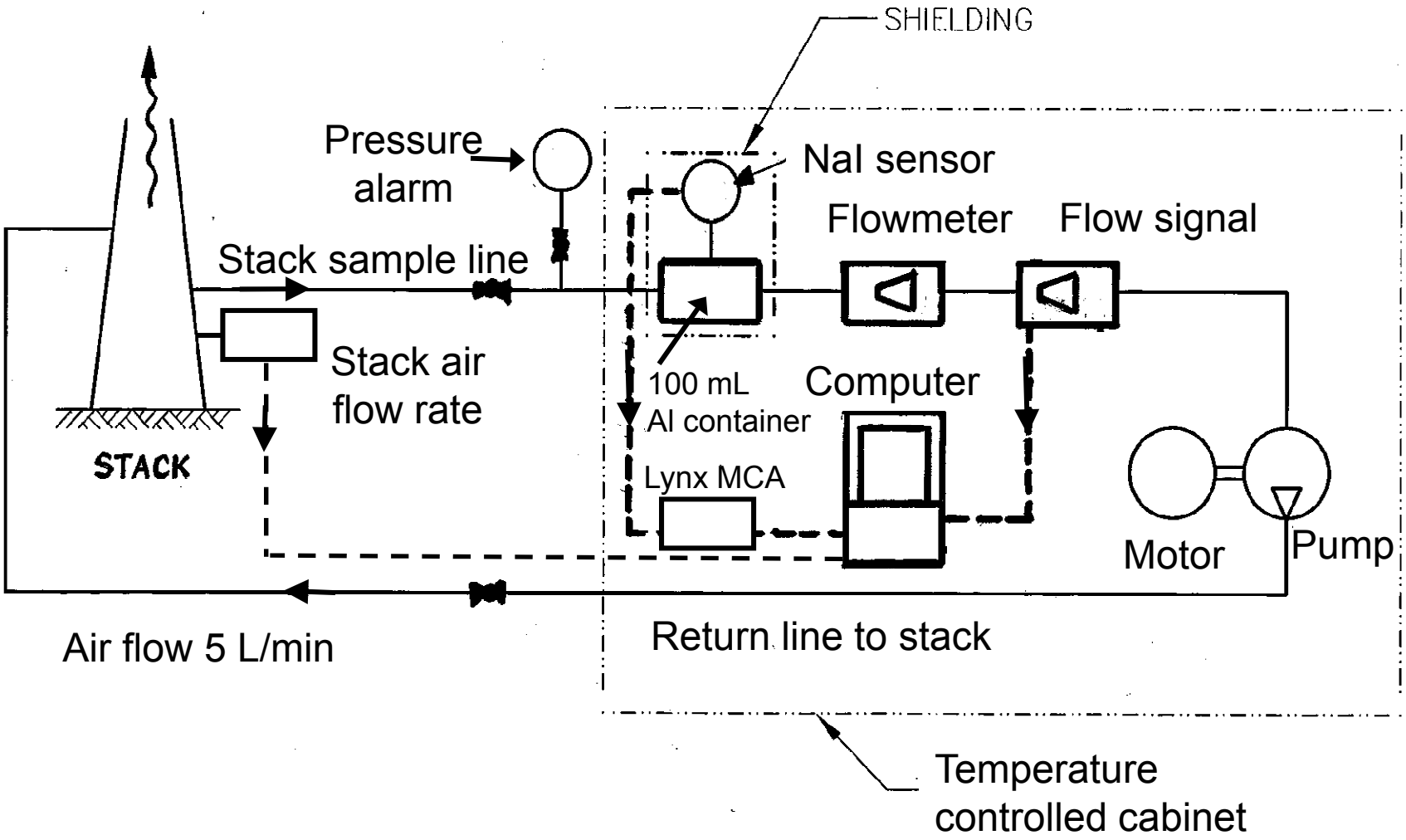
Fire suppression panel
CO and type K thermocouples



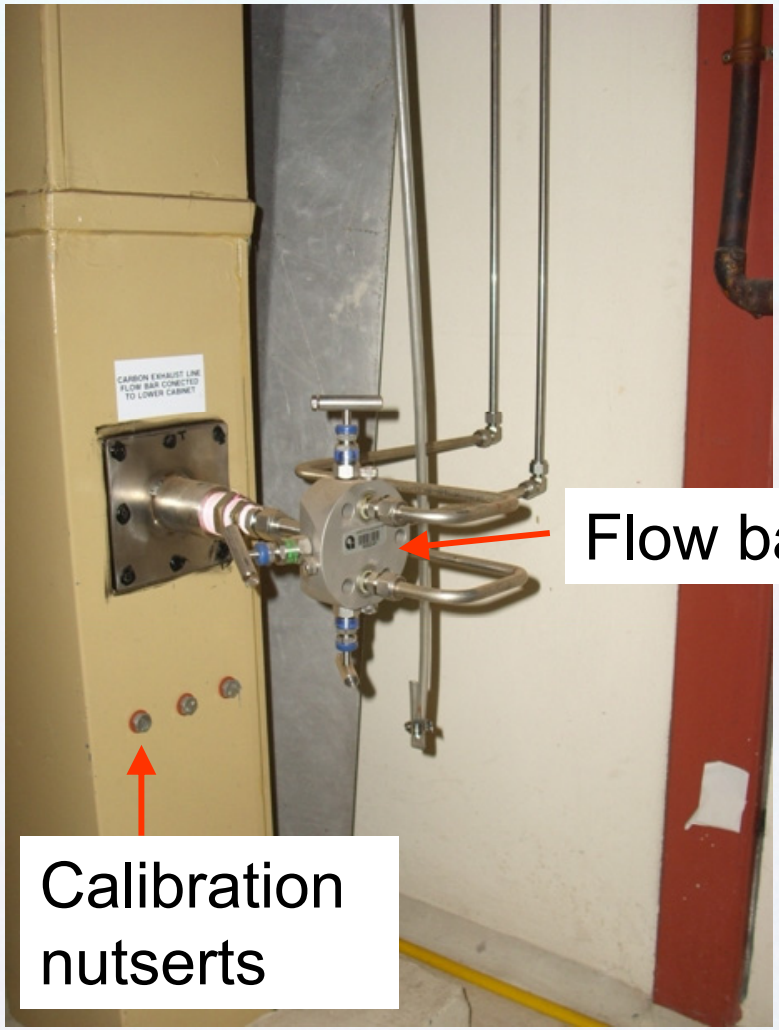
Stack monitoring

- Air flow rate monitoring using Flow Bar devices
- Off-line weekly monitoring using TC45 carbon cartridges for gases and Whatman filter papers for particulates
- Real time monitoring for noble gases using NaI sensors and a Canberra Lynx multi-channel analyser

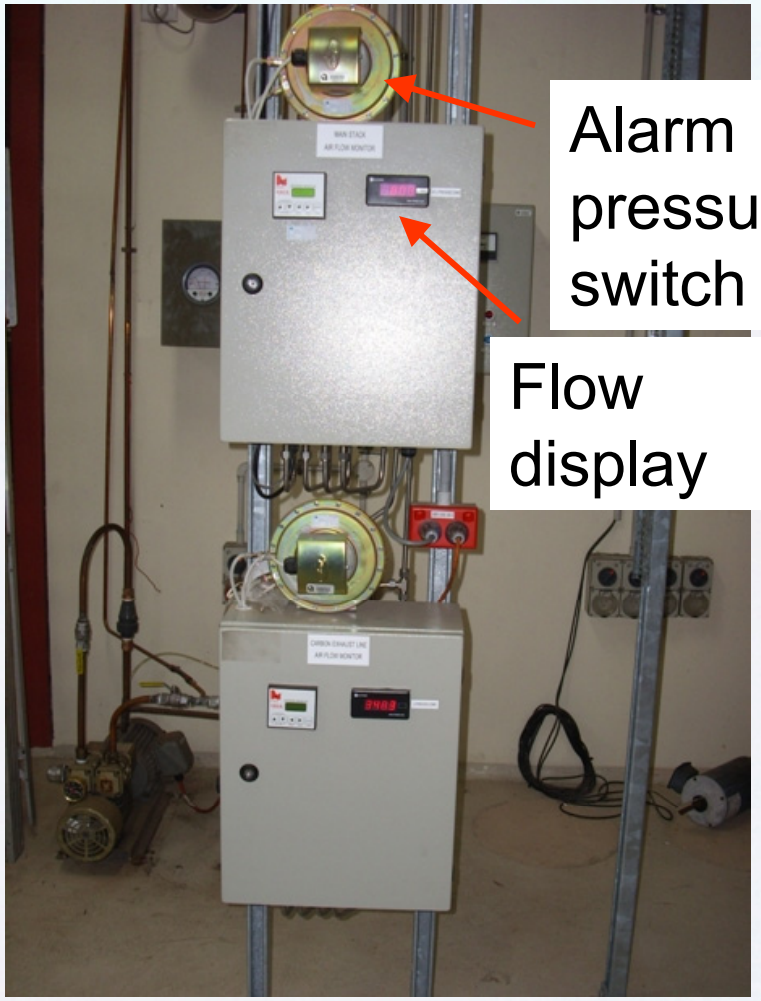
Equipment for stack monitoring



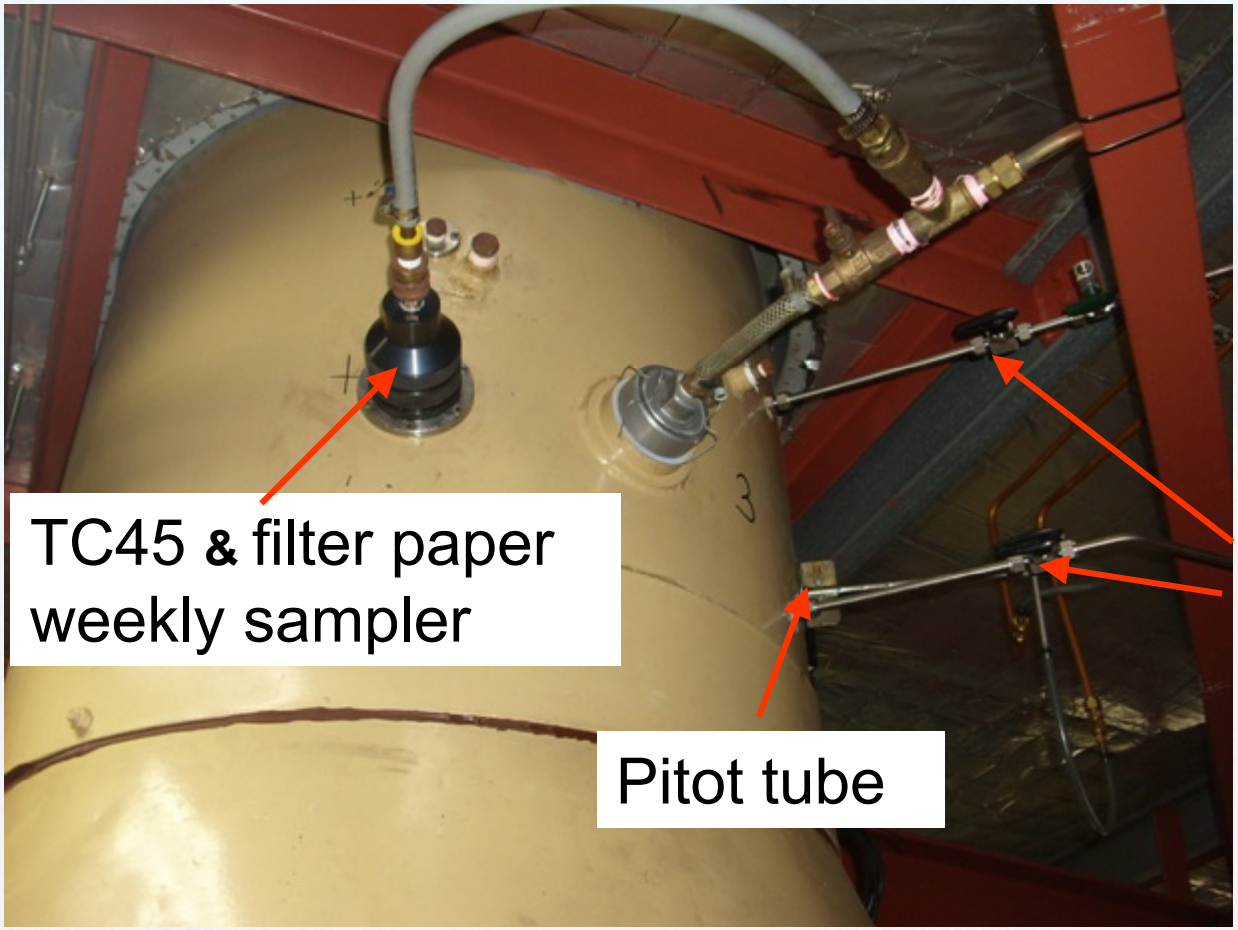
Air flow rate device



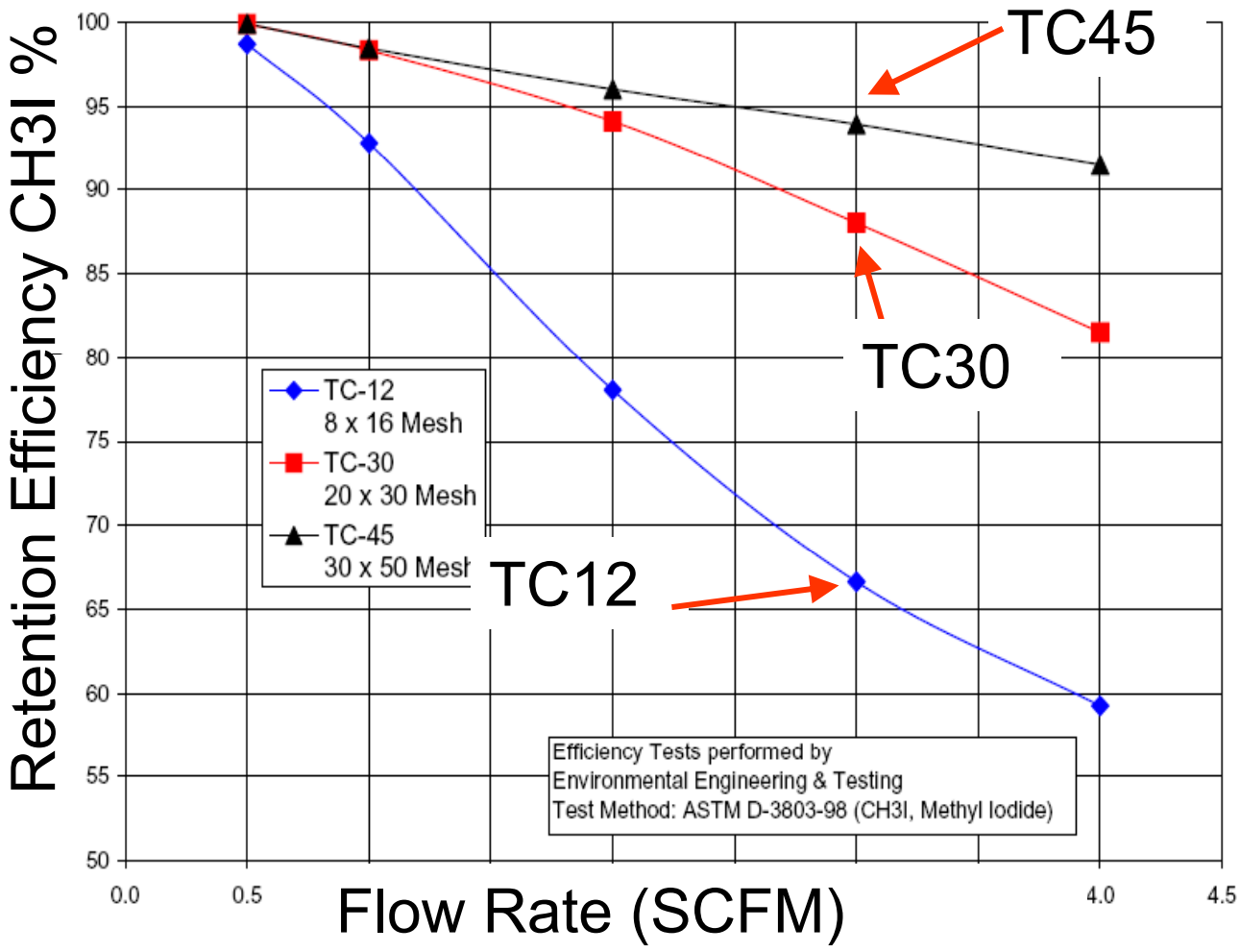
Display of stack flow



Stack sampling



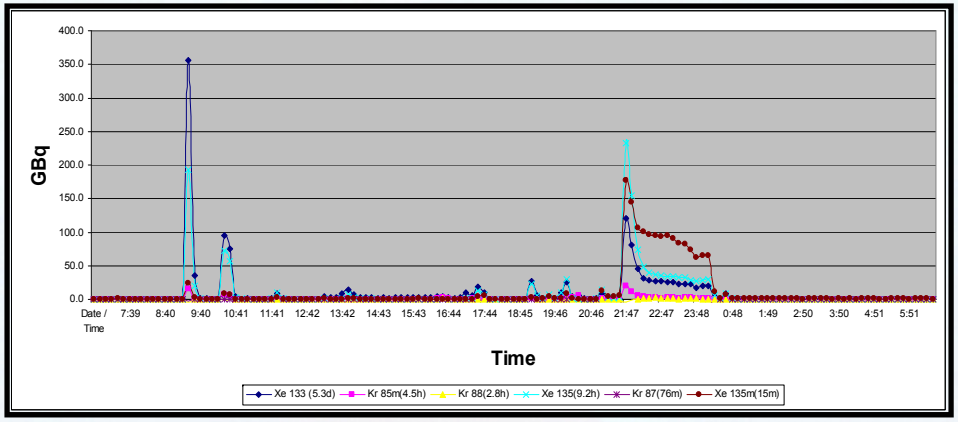
Performance of TC45 carbon cartridges

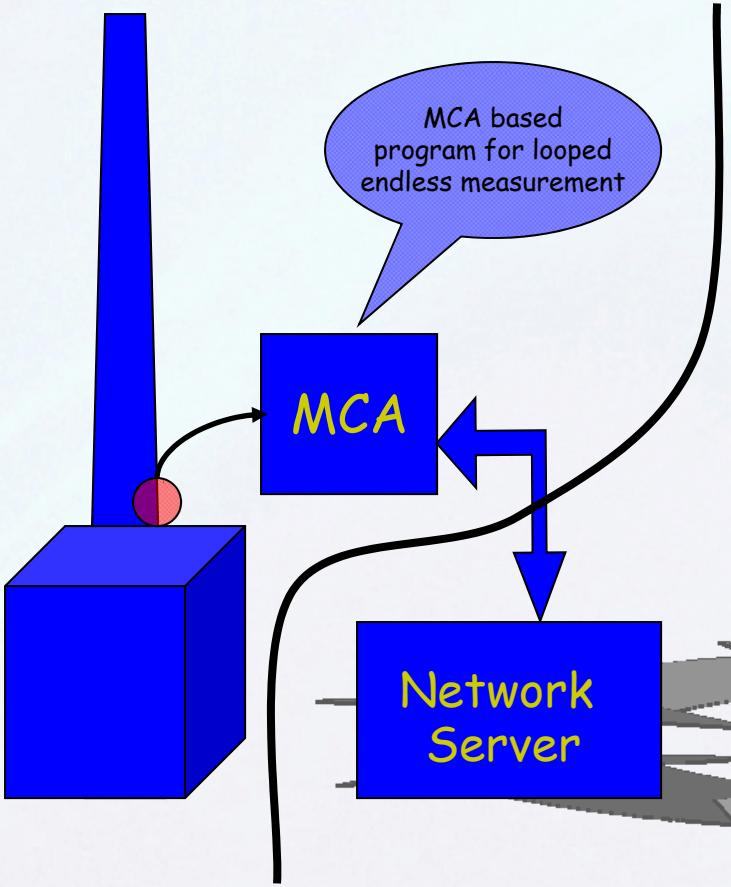


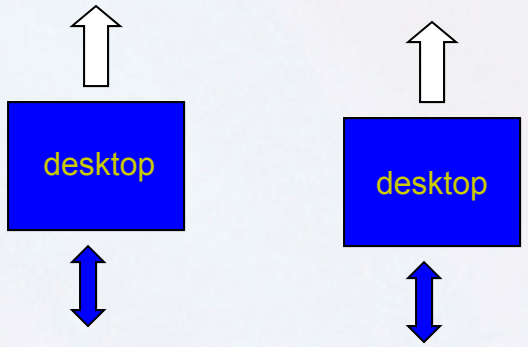
Reproduced from

HiQ data

Real time stack monitoring

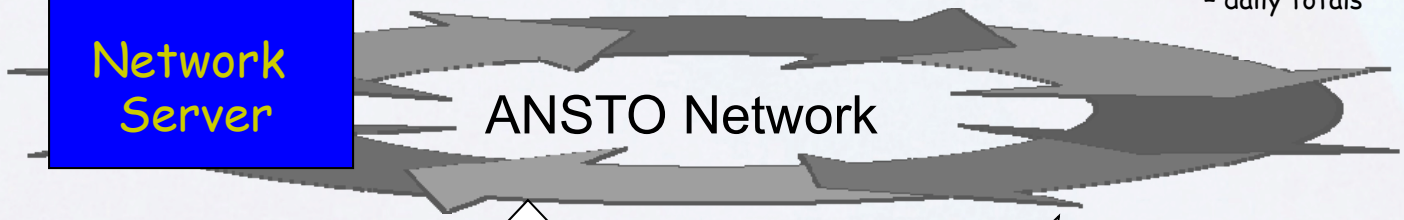


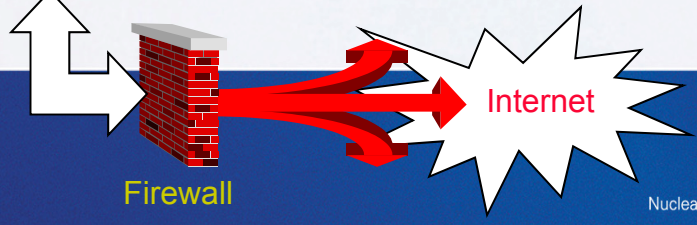




Internet Browser Based:

- Data Display
- Cumulative totals
- Data Base
- On-line data
- Spreadsheet format export
- E-mail notification
  - equipment failure
  - notification levels
  - daily totals





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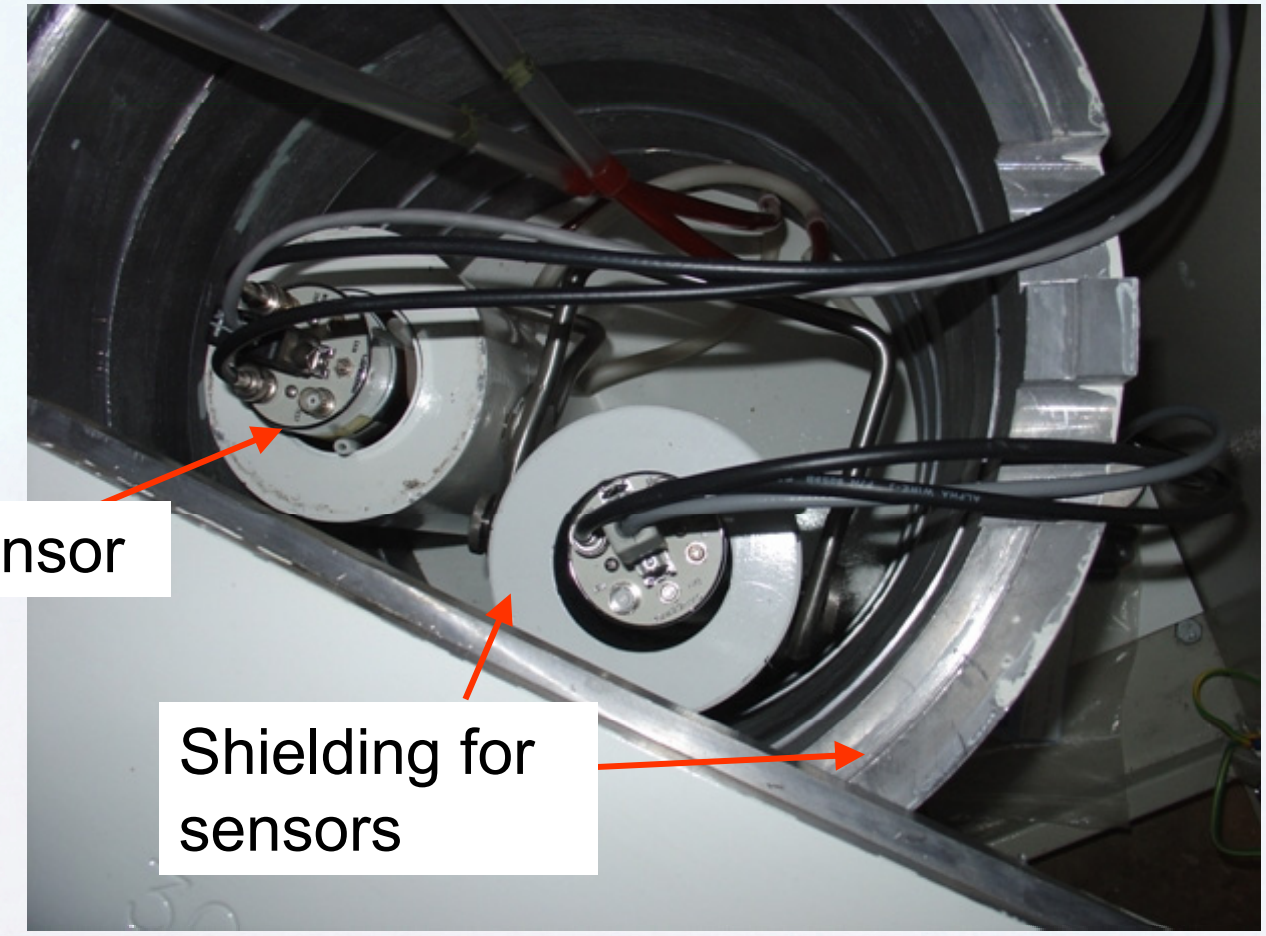
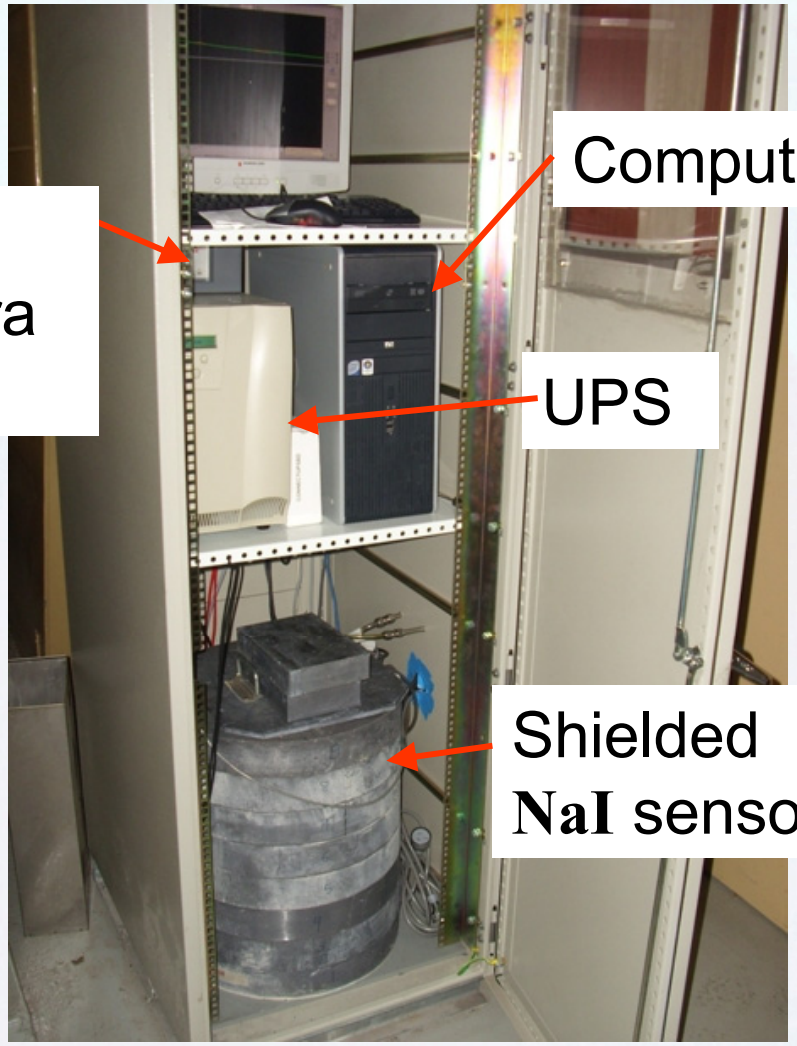
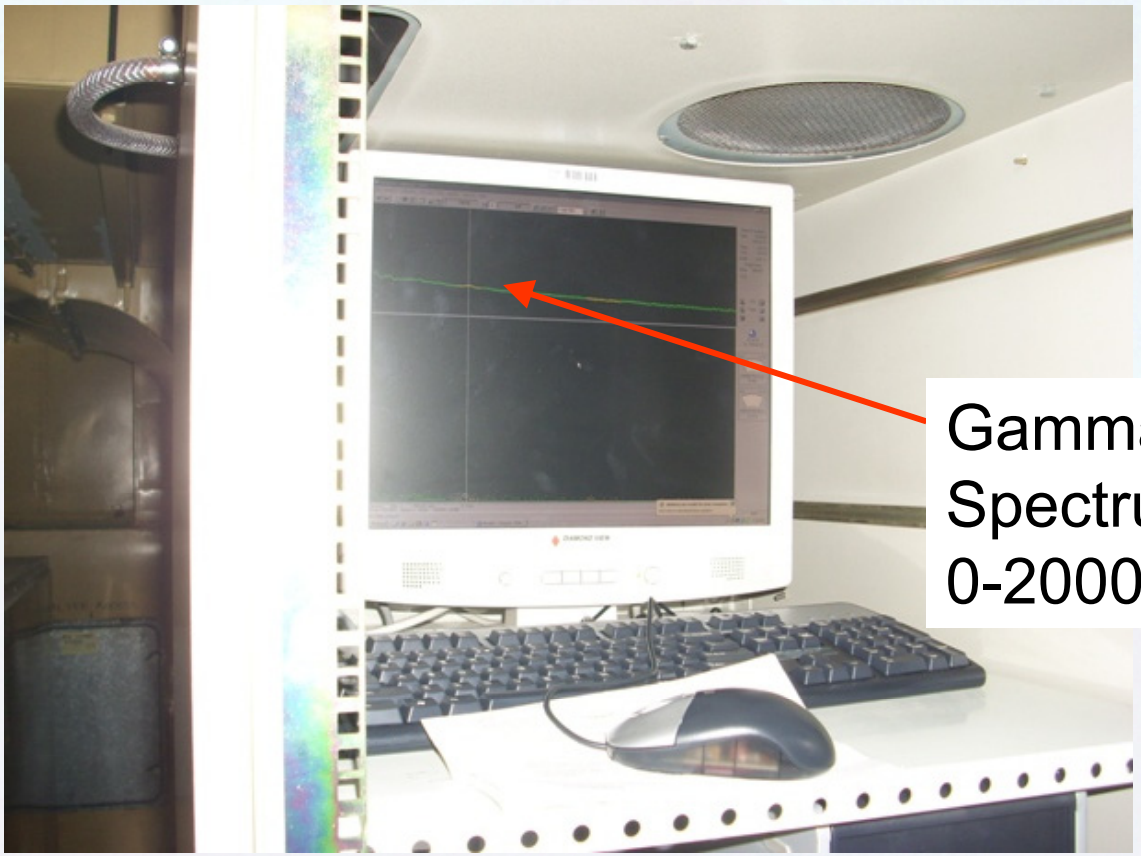
Top view of NaI sensors for real time stack monitoring



Cabinet for stack monitoring



Real time stack monitoring display



Conclusions

- Correctly design new filter housings with canisters, testing manifolds, bubble tight dampers and CO monitors
- Periodically test the carbon filters and be prepared for filter changes at any time
- Monitor filter performance with trends of weekly and real time releases through the stacks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