Site audit report Harwell, UK

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Summary: Measurements of physical aerosol properties at the EUSAAR site Harwell were audited by Dr. Thomas Tuch of the WWCAP on November 6th 2007. The site is located in on the grounds of a former nuclear research facility 51 34' 26.856 N 1 19' 18.495 W.

Fig. 1: Measurement site and aerosol inlets (front CPC, second SMPS with PM1 head)

The site is visited by an operator biweekly, which is not sufficient. Instruments should be checked at least once per week. Data are automatically transmitted to a data centre at the National Physics Laboratory (NPL). There was no written or electronic instrument log available at the site during the audit. Flow rates of the instruments are only calibrated once per year. The aerosol inlet at Harwell does not meet requirements for aerosol inlets at EUSAAR sites. During our audit only filter measurements were made for the EUSAAR program. The available particle size spectrometer was not working due to a defect of the CPC. An open running CPC has been installed recently. Measurements of EC/OC, scattering and absorption coefficients are not available.

Measurements of physical aerosol properties do not comply with EUSAAR quality standards.

Documentation: Manuals for the CPC and the SMPS were available at the site during the audit. A TSI calibration certificate was available for the total particle counter. There was no

written or electronic documentation of instrument maintenance and instrument performance available.
According to site operator such documentation is kept at the data centre. This documentation can, however, not be checked by the operators at the site. To verify instrument performance and measurement quality it is mandatory to have all documentation available at the site either in written form or as a detailed online log accessible form the site at any time.

Flow measurements/primary flow standard: A primary flow standard is not available at the site. According to the operators flow rates are calibrated once per year using a standard from NPL. The results of the last calibrations could not be inspected during the audit. During standard operation, flow readings from the instrument displays are checked visually only. This frequency of flow checks with a reference flow meter is absolutely not sufficient, because flow readings indicated by the instruments may (and have) become erroneous at any time. It is **mandatory** to verify instrument indicated flow rates at least on a monthly basis and after each maintenance of an instrument.

Aerosol inlet: A commercially available PM1 inlet (URG Cyclone) is used for measurements of the particle size distribution. This inlet is mounted approximately 50 cm above the top of the roof of the shelter. There is no secure access to the inlets on the roof. The aerosol passes through a vertical 3 meter copper tube with an OD of 1" at a flow of 16.67 l/min (virtual impactor, Fig.2). At the end of the tube 16 l/min are sucked perpendicular from the main sample line. A stainless steel adapter and conductive silicone tubing are used to connect the SMPS to the inlet. This connector is already corroded. A separate 5 m ¼" tube with a plastic funnel and a water trap is used for the total particle counter. There is no humidity conditioning of sample air, relative humidity and temperature and not measured.
Copper is not suitable for aerosol inlets because of its rapid corrosion. Stainless steel and conductive silicone tubes are the only materials suitable for aerosol inlets according to EUSAAR standards. Inlets need to be mounted at least 2 meters above the top of the roof to avoid disturbance of the local wind field by the building. Relative humidity and temperature need to be recorded continuously. If an rH of 50% is exceeded frequently a dryer needs to be installed in the aerosol inlet line.
The complete **inlet needs to be replaced** to meet EUSAAR standards. We recommend furthermore that the sample for the total particle counter should be taken from the sample line of the SMPS.

Fig. 2: Aerosol inlet at Harwell, with "virtual impactor"

Total particle number concentration: A TSI CPC 3022A S/N 554 has been installed recently at Harwell. It is connected to a separate inlet with a water trap.

The instrument is calibrated every year by the manufacturer (last calibration: June 30th 2007). Concentrations for parallel runs with a reference instrument prior to and after calibration have been reported by TSI upon request by NPL. While the instrument performed within specifications after calibration indicated concentration values prior to calibration were up to 63% lower in the intermediate and high concentration range. Such behaviour is typical for the pollution of the optics in the instrument. The large deviation shows that annual calibration of 3022A in polluted atmospheres is not sufficient.

To avoid more frequent calibrations we recommend using the second 3022A (which is normally used in the SMPS) as a reference during the one year period. Both instruments should be run in parallel on ambient aerosol every three months for few hours. These parallel runs should be done during periods of elevated aerosol concentrations to cover the intermediate and total scattering mode of this instrument (single particle count mode does typically not change during one year). Because the CPC of the SMPS is less subject to pollution, this instrument can be used to correct the readings from the total particle counting CPC. Both instruments must then be annually calibrated in a reference lab.

Flow rates and zero particle count rates were checked during the audit. Low flow of the CPC was measured at 0.311 l/min, which is in good agreement with the nominal value (0.3 l/min). High flow rate was found at 1.367 l/min (nominal 1.6 l/min). Because this deviation does not directly influence measured particle number concentrations this value is still acceptable. It

should, however, be noted that diffusional losses in the sampling line increase with longer residence time.
The initial check of the count rate with an absolute filter showed an elevated count rate of 0.21 cm^{-3}. This high zero count rate was due to a leak in the water trap. After removal of the water trap the count rate with the filter dropped to 0.

The CPC is currently in good working condition

Number size distribution: A new TSI SMPS with a long DMA model 308000 S/N 70718796 manufactured March 2007 is available at the site. The CPC 3022A used as counter had broken prior to the audit and had been sent to TSI for repair. Currently, the instrument uses TSI software for data acquisition. This software does not record flow rates and temperature from the build in sensors. The instrument has not yet been modified to comply with EUSAAR requirements. The following components need to be installed:

1. Aerosol dryer
2. Humidity sensor for the aerosol
3. Sheath air dryer
4. Humidity sensor for sheath air

A separate program may be used to read serial data on flow rates and temperatures from the serial port of the SMPS along with the additional relative humidities measured by the new sensors.
The SMPS has been tested with the CPC for total particle concentration measurements. Because this CPC did not have a scanning EPROM build in the output voltage could not be tested during the audit.
The aerosol flow rate indicated on the front panel of the SMPS was found at 0.5 l/min. The real flow rate was 0.291 l/min. This is due to the pollution of the nozzle of the pre-impactor of the TSI SMPS, which needs to be cleaned frequently. Because compressed air (as used up to date) is not sufficient to clean this nozzle an ultrasonic bath is needed to clean the impactor. Aerosol flow rates measured by the pressure drop over the impactor need to be checked with a reference flow meter each time the site is visited. A Dyson or similar dry flow meter is not suitable for this purpose because of its large pressure drop.
The measured sheath flow rate of 2.975 l/min was in perfect agreement with the 2.98 l/min indicated on the front panel of the instrument.

After repair of the CPC and required modification of the SMPS this instrument will be in good working condition.

Mass concentration measurements: A R&P Partisol sampler S/N 2025A212170001 is used for mass concentration measurements and chemical analysis. Unfortunately this sampler is located close to several trees and bushes. There is sufficient space between the two Digitel samplers in front of the station. The Partisol sampler should be moved to this location.

An adapter to measure the flow rate of this instrument was not available at the site. The flow rate could therefore not be checked.
Two TEOMS available at Harwell are unfortunately not part of EUSAAR network. They could not be audited because they are operated by a different group.

Conclusion: Currently the Harwell site does not comply with EUSAAR requirements. Necessary modifications can, however, be implemented in relatively short time. More frequent visits of the site (at least once per week) are necessary to improve data quality. We are, however, confident that the necessary steps will be taken in the near future. Thank you for your hospitality.