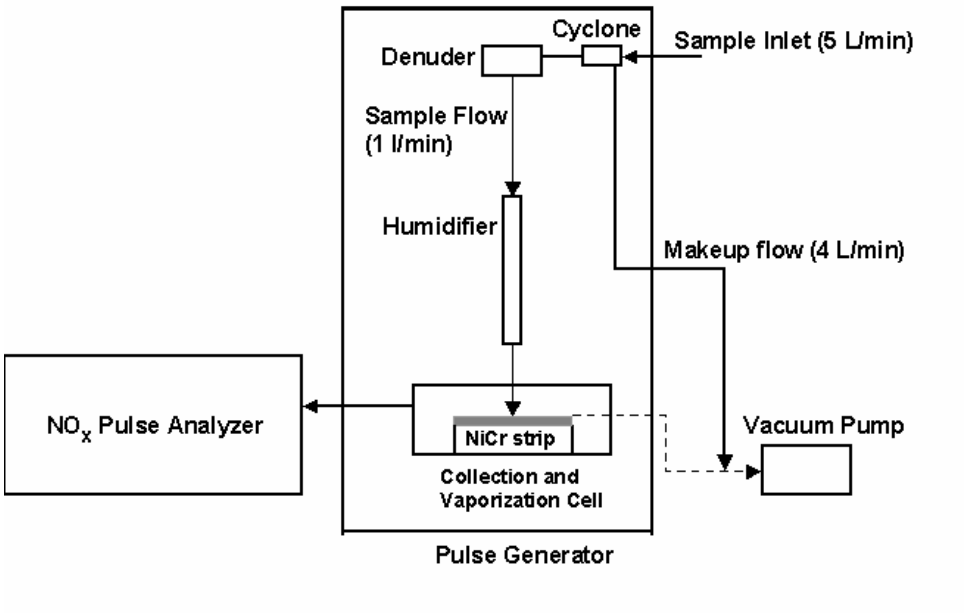
R&P Ambient Particulate Nitrate Monitor (8400N)



- The 8400N (manufactured by Rupprecht and Patashnick Co., Inc.) is a commercialized version of a prototype nitrate monitor described in (Stolzenburg, M.R., Hering, S.V., 2000. A New Method for the Automated Measurement of Atmospheric Fine Particle Nitrate. *Environmental Science and Technology,* 34, 907-914).
- The 8400N consists of a Pulse Generator, where sample conditioning, collection and flash vaporization takes place, and a NOx Pulse Analyzer (API Inc. Model 200A), where nitrogen oxides evolved from flash vaporization and nitrate reduction are quantified.
- Solid state temperature sensor is used to measure the ambient temperature.
- Inlet consists of a raincap, PM-2.5 sharp-cut cyclone and an activated carbon denuder
- Ambient air is drawn through the cyclone at 5 l min^{-1}. This flow is split into a 1 l min^{-1} sample flow for nitrate analysis, and a makeup flow.
- The sample flow passes through a honeycomb activated carbon denuder to remove potential gaseous interferences, and then through a Nafion humidifier, where the humidity of the sample air stream is raised. Typically RH inside the humidifier is greater 90% (however during the Summer 2001 campaign there were periods when RH inside the humidifier was below 80%).

- Wetted particles are collected by impaction onto a NiChrome flashing strip, which is mounted in a collection and vaporization cell.
- A full operational cycle of the instrument (typically 10-minutes long, but adjustable by the user) consists of a sampling and analysis periods. For Summer 2002 campaign, the sampling period was 515 sec.
- During the analysis period the sample flow bypasses the collection cell and the cell is purged with pure nitrogen from a cylinder. The nitrogen flows through the cell and into the Pulse Analyzer, yielding a baseline signal value. The strip with collected material is then heated by an electric current (~ 100 Amperes) from a battery, until an infrared cutoff is reached. Typical heating times are 65-90 ms for a flat strip (used during the Summer 2002 campaign, Queens College) and 90-120 msec for a formed strip (used during the Summer 2002 campaign, Whiteface Mountain and Winter 2004 campaign, Queens College). Collected particulate matter is flash-volatilized. Nitrate is reduced, and evolved nitrogen oxides (NOx = NO + NO_2) are carried into the Pulse Analyzer.
- The total flow passes through a molybdenum converter, where the NO_2 fraction of NOx is converted to NO. The analyzer then measures the total NOx concentration from the light intensity of chemiluminescent reaction of NO with ozone. The analyzer output is integrated over an analysis period of nominally 20 seconds. The NOx signal form the gas analyzer is converted to the mass concentration of particulate nitrate, using the pressure, temperature, sample time, sample flow, conversion factors and the baseline signal. The mass concentration of particulate nitrate, as well as the parameters needed to calculate the nitrate concentrations are stored in an internal 8400N data logger.
- Data post-processing included corrections for the aqueous calibration results, NOx analyzer cell pressure, analyzer audit results and dynamic filter blank readings.
- The instrument performed an audit of the gas analyzer every other day, using a standard NO gas (*Scott-Marrin*) from a cylinder. Concentrations of the standard gas was 5.4 ppm (Summer 2001 campaign, Queens College), 5.2 ppm (Summer 2002 campaign, Whiteface Mountain) and 4.98 ppm (Winter 2004 campaign, Queens College).
- The complete system was calibrated manually with aqueous standards, which were applied directly to the NiChrome strip with a microliter syringe. An aqueous solution of potassium nitrate was used for

the calibrations (100 ng NO_3/ 1μL solution). The aqueous calibrations were performed weekly and after each strip replacement. The resulting values of the "coefficient of theoretical conversion" were used for calculation of the particulate nitrate mass concentration.

- Dynamic filter blanks were measured by placing a Teflon (Summer 2001 campaign, Queens College), and Nylon (Summer 2002 campaign, Whiteface Mountain) filter between the cyclone and the carbon denuder. During Winter 2004 campaign (Queens College) several types of filters (Teflon, Nylon, Zefluor, HEPA, HEPA + Na_2CO_3 denuder) were used to measure blanks (not simultaneously). An average filter blank (calculated excluding obvious outliers) for the whole campaign was used for data adjustments.
- Operational parameters of the 8400N were checked daily.