

### **APEX 3 sampling probe setup**

At the one meter sampling location, there were 18 particle probes arranged along the slanted probe rake (Photo 1), alternatively with 18 gaseous probes along with the temperature and pressure sensors.



Photo 1. Particle and gas sampling probes held by the probe rake situated at 1 m behind the engine exhaust plain.

After each particle probe, a section of 0.5m to 2 m 3/8" SS tube (depending on the probe location along the rake) were followed by a 3m horizontal tubing section (3/8" SS tube) leading to a junction box where two particle sampling lines from adjacent particle probes were combined (Photo 2).

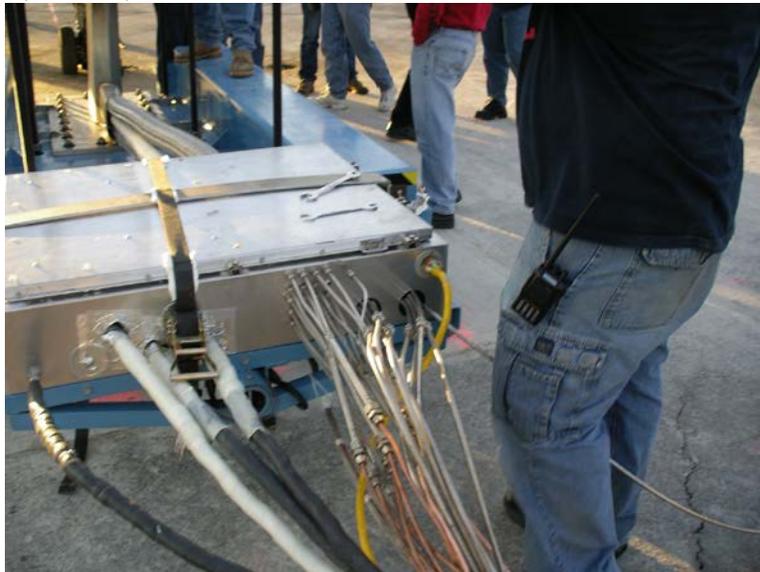


Photo 2 showing the junction box with 9 combined particle lines (SS) outlets, 9 dilution air lines (copper) and gaseous lines (heated).

The 9 combined particle sampling lines were then connected to a valve switching box through a section of 6 m 3/8" SS tubing (mostly horizontal depending on the height of the rake platform) with a graduate 90 degree bent (Photo 3). The function of the valve switching box was to remotely connecting one of the 9 particle sampling lines to the main particle sampling line (13m, 3/4" SS tube) that leading to the sample manifold in the NASA, which further distribute samples to various particle instruments in NASA, UMR and ARI trailers.



Photo 3. This photo shows the slanted sample probe rake, the sampling line junction box and the valve switching box. The sampling lines after the valve switching box were extending to the sample manifold in the NASA trailer.

At 1 m location, there was also a single sampling line (3/4" SS) (second bundle lines from the left in Photo 3), with N<sub>2</sub> passing through a loop pulling particles from a small hole at the probe tip location (Photo 4). The total length of this sampling line to the sampling manifold was about 22m.



Photo 4. Particle loop inlet, along with conventional particle and gas probes and temperature, pressure sensors on the 1 m sampling probe rake.

At the 15 m location (Photo 5), the particle sampling line was a  $\frac{3}{4}$ " SS tube with a total length of 22m with four 90 degree bents from the probe to the sampling manifold.



Photo 5. The front probes are at 15 m location. The back probes are at 30 m locations. The thinner line ( $\frac{3}{4}$ " SS tubing) at each location is leading to the NASA sample manifold and the thicker line (2" SS tubing) is leading to the EPA trailer.

At the 30 m location (Photo 6), the particle sampling line was a  $\frac{3}{4}$ " SS tube with a total length of 35m with four 90 degree bents from the probe to the sampling manifold.



Photo 6. Particle probes at 30 m sampling location. The thinner line ( $\frac{3}{4}$ " SS tubing) was leading to the NASA sample manifold and the thicker line (2" SS tubing) was leading to the EPA trailer.