

AAFEX-II Status Report #7 – 28 March 2011

Primary Activities: Conduct morning exhaust mapping experiment plus cold- and warm-phase JP-8 characterization studies

Weather: Sunny and clear all day; 48 F at 0430 warming to 64 F at 1430. Winds 5 to 15 from the west in the morning shifting to the WNW and NW in the afternoon.

Summary: After a fairly relaxing day on Sunday (Figure 1), participants began to arrive on site before 0400 in preparation for Engine Test Run 2, which had as its objectives to: 1) find the optimum locations for parking the 1 rakes, 2) characterize JP-8 emissions under cool ambient conditions, and 3) continue evaluating E-31 equipment performance. To identify sampling positions still in core combustor flow, but not contaminated with oil emitted from the central vent tube, the plan was to use the traversing probe rakes to examine emissions at 0, 4, and 8 inches off engine center line as the engines were run at 7, 30 and 65% power. Objective 2 would be addressed by measuring emission parameters at 1, 30, and 143 m behind the JP-burning engines as they were operated at 4, 7, 30, 65, 85 and 100% of maximum thrust. The E-31 group would have control of the left 1-m rake for the second half of the test matrix to evaluate their sampling methodology. Engines were started around 0635 (Figure 2) and testing continued until about 1040, with only a few glitches in the plan. Here are a few of our successes and shortcomings.

- Donnie reported that engine #3 ran beautifully throughout the test, despite having undergone a compressor stall on Saturday.
- The 1-m rake installations remained solidly intact throughout the high thrust runs—not so much as a single cable broke loose during almost 30 minutes at settings $\geq 85\%$!
- For both engines, particle emission samples collected at 0 and 4 inches off centerline were contaminated with oil whereas those from 8 inches outboard were relatively clean. Unfortunately, AFRL and E-31 probes were out of core flow in this position, so as a compromise, we adopted 6-inches outboard of center as the primary particle sampling position for both rakes—samples from these positions showed only slight oil contamination, mostly at low powers.
- Overall, particle emission values from the two inboard engines were similar to those observed during AAFEX-I and APEX-1 before that, indicating both that our installation is properly collecting exhaust samples and the engines are operating normally.
- Although most of the test went smoothly, the particle dilution system for the left 1-m rake did not work well at low engine powers. MST was able to get the suspect controller to work, but it remained a problem throughout the test.
- Changlie experienced pump problems on the gas sampling line, which necessitated an interruption in testing. The problem was diagnosed and fixed after the test.

- The downstream trailers were in perfect position to sample exhaust plumes during the morning run as several hours of data were recorded in both the NASA/ARI and MST vehicles (Figure 2 and 3).
- During the last 7 and 4% power runs, ARI sampled engine exhaust between the 30-m probes and taxiway fence to observe how the emissions change with age as well as effect background chemistry.
- Engines were idled back twice, once to allow taxiing aircraft to pass and another time to prevent bodily harm to a tardy participant.
- Participant instrument suites worked relatively well with two exceptions: Berk had a problem with his near-field PTRMS and AESO could not communicate with a particle sensor in DB2.0. Berk fixed the problem and the PTRMS was back on line for the afternoon tests; AESO was still tracking down their comm issue at the end of the day.
- The E-31 group learned a great deal, but still had a few issues to address to collect samples from the reference line.

Engine Test three was initiated around 1300 and as its objectives to characterize JP-8 emissions from engine #3 during the warmest part of the day. Temperatures ranged from 62 to 64 F during the test, and the northwesterly winds picked up a bit, but were still in range. Here are a few notes.

- The main sampling group repeated the second half of the morning's test matrix, recording PM and gas-phase data at 1 and 30-m behind each engine at 4, 7, 30, 65, 85 and 100% thrust. The PM emission parameters looked similar to the morning's observations.
- Although the northerly winds typically transported the exhaust plumes south of the fixed downstream sampling trailers, Aerodyne's mobile lab transected both engine plumes at various downwind distances to record detailed composition measurements at 4 and 7% power.
- E-31 participants still had trouble sampling from the reference probe and had trouble recording mass measurements because of plumbing problems.
- Most near-field experiments worked well, with the exception of one PM instrument fielded by AESO within DB2.0

Schedule for Tuesday:

-0515 pre-mission brief

-0600 engine start for a cold-phase HRJ test in engine #3

-1300 engine start for a warm-phase HRJ test in engine #3



Figure 1. With health-conscience Andreas looking on in disgust, it's man vs. food as Luke prepares to consume a six-egg omelet Sunday morning at Crazy Otto's in Lancaster.



Figure 2. Scene at camp AAFEX-II just before engine start for Test Run 2.

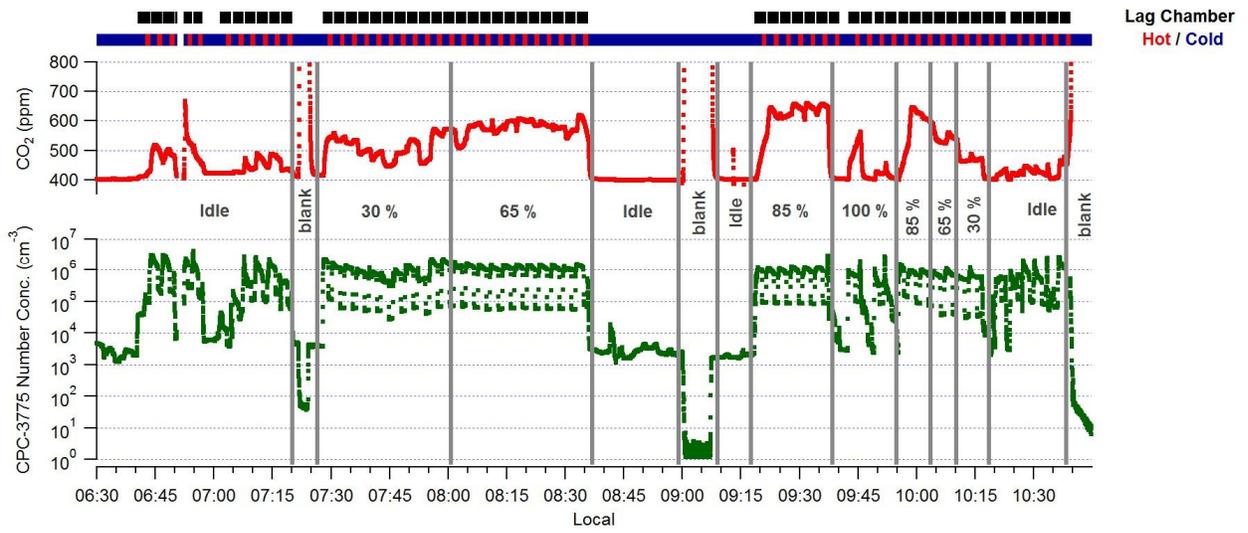


Figure 2. Time series of CO₂ and CPC number density recorded in the ARI/NASA trailer during the morning run. The CPC cycles between sampling heated (350 C) and unheated sample to determine total and nonvolatile particle concentrations.

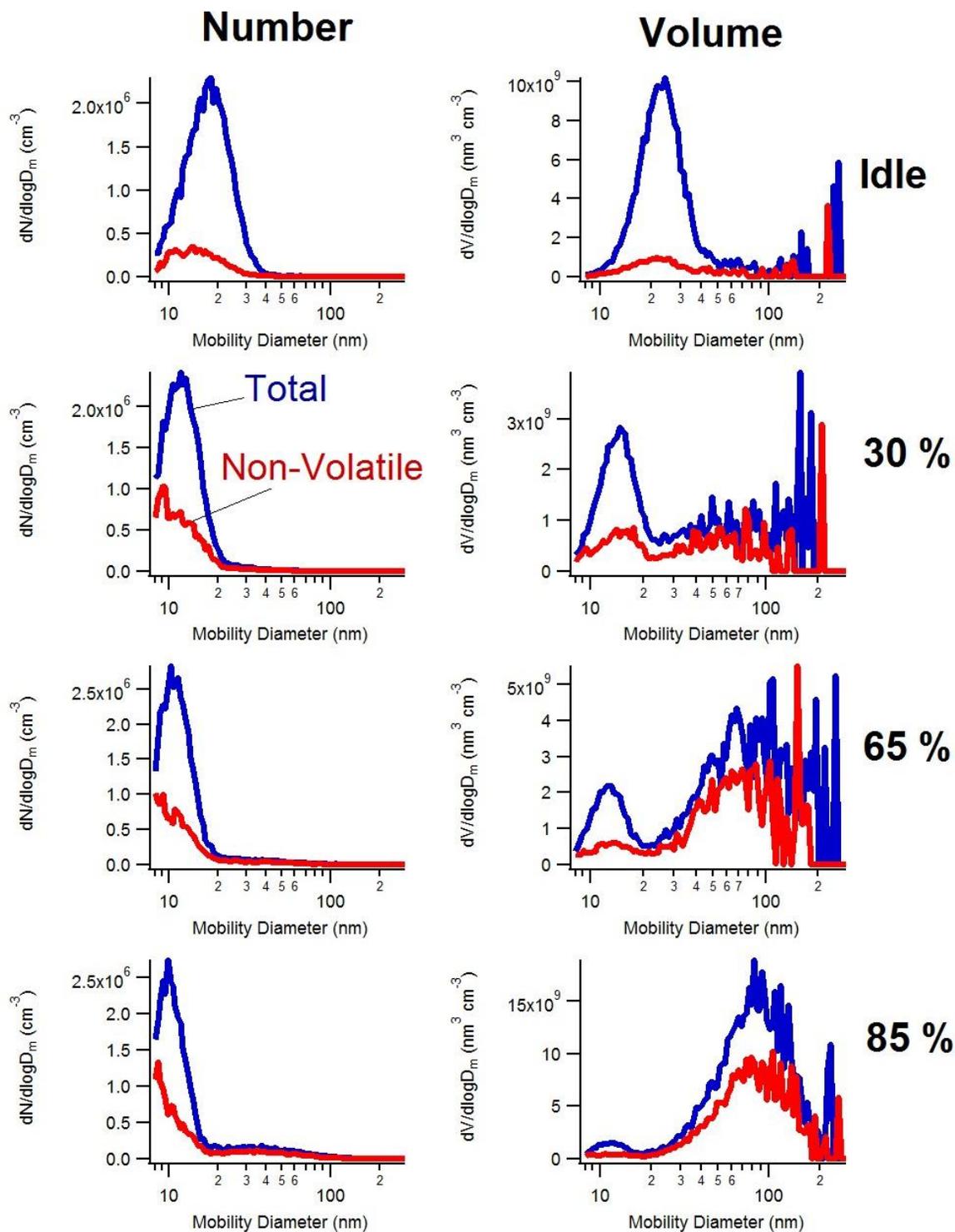


Figure 3. Total (blue) and nonvolatile (red) PM number (left) and volume (right) size distributions recorded at 143 m. Differences between the curves roughly represent volatile material that condensed within the aging exhaust plumes. (Plots courtesy of Luke Ziemba, see Figure 1).