

AAFEX-II Status Report #9 – 30 March 2011

Primary Activities: Test low sulfur FT fuel and 50:50 JP-8/HRJ Blend

Weather: Sunny and clear all day; 43 F at 0430 warming to 72 F at 1300. Winds very calm in the morning, then picking up with a strong northeasterly direction around noon.

New Participants: Steve Baughcum (Boeing)

Summary: Testing again got underway early in the morning with a 5:15 am pre-mission brief and a 6 am engine start. The objective of the first test was to characterize emissions from pure Sasol Fischer Tropsch Fuel (FT) as the first of a two-part fuel-sulfur experiment to investigate the role of sulfuric acid in regulating particle formation and growth in cooling aircraft exhaust plumes. The second phase will be conducted tomorrow morning and will involve burning the FT fuel doped with tetrahydrothiophene (Figure 1) to raise fuel sulfur content from near 0 up to around 1000 ppm.

Test Run 7 started at 6:02 am and followed the now standard AAFEX test matrix (Figure 2), including an initial ramp up in power from 4 to 100% with intermediate stops at 7, 30, 65 and 85% of maximum thrust to sample emissions from all rakes and inlet probes. After a short intermission at ground idle, thrust was quickly increased to takeoff (100%), then stepped downward, this time sampling only from 1 and 30 meters behind Engine #3. At low power settings, the Aerodyne Mobile Laboratory again profiled exhaust plumes on the apron behind the 30-m rakes (Figure 3).

Consistent with AAFEX-I findings, participants observed that burning FT fuel significantly reduced PM number and mass emissions relative to JP-8 combustion. However, EIs were not as low as measured in the previous experiment and there was some speculation that the fuel had degraded or been contaminated with JP-8 during transport. Changlie reported SO₂ emission values that were somewhat higher than AAFEX-I results, which lends some credence to the contamination conjecture. In any case, the test went off without a hitch and engines were shutdown around 9 am.

The second test (Run 8) was scheduled to begin at 10 am, which left an hour for refueling and bringing the Dryden photographer in for a group photo (Figure 4). AAFEX-II meteorologist, Scott Wiley, had predicted that winds would shift to the northeast after noon, so we hurried to get the run started on time. However, a heated line leading to Changlie's set of critical gas measurements (Figure 5) failed and had to be replaced (Figure 6) before tests could resume.

Test Run 8, a detailed characterization of JP-8/HRJ blend, did not begin until 10:45 am. By this time, light winds were starting to blow from northeast (recall that slightly stronger winds from this direction caused the #3 engine compressor stall last Saturday), which caused the cockpit crew to proceed very cautiously with the requested high power settings. Indeed, after reaching 65% power on the initial stepped ramp, winds exceeded limits and thrust was reduced to about

60%. Thereafter, the 85 and 100% power points were permitted only during a few short periods of relative calm. As a result, only about half the planned test points above 30% were recorded before winds strengthened and the experiment was aborted altogether. Despite the difficulties, enough data were obtained to indicate that the blend reduces PM emissions, but not nearly as much as does neat HRJ fuel (Figure 7). Because of the poor conditions, many participants left early and spent the afternoon pouring over data....or something similar (Figure 8).

Agenda for March 31, 2011

- Conduct high sulfur fuel experiment phase II
- Complete JP-8/HRB blend testing
- Design and conduct E-31 focused sampling



Figure 1. DAOF aircraft fueling crew dumping 1 of the 26, 500 gram bottles of foul-smelling tetrahydrothiophene (C_4H_8S) into the remaining 1400 gallons of sulfur-free, FT fuel.

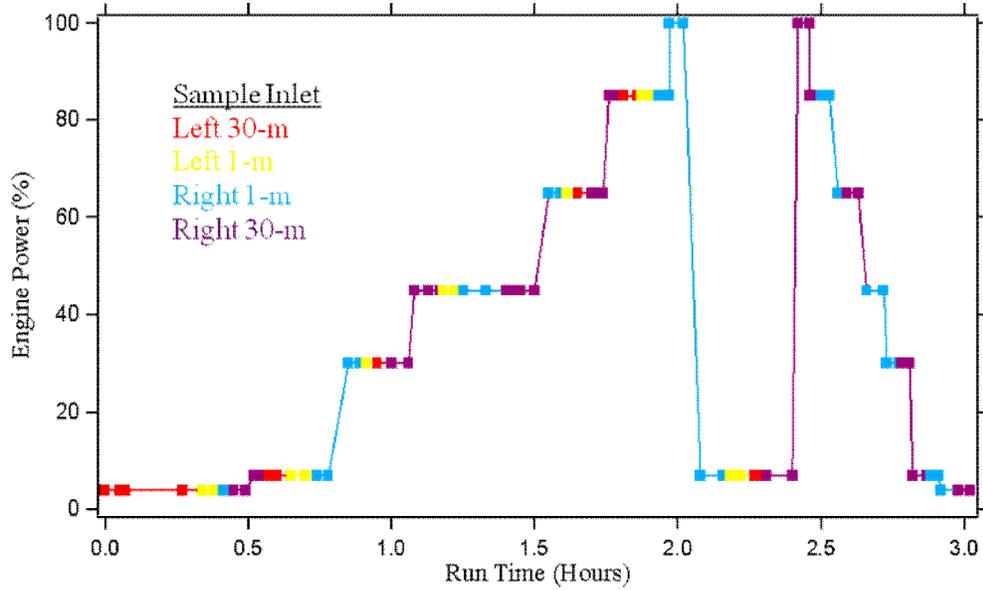


Figure 2. Plot of idealized standard fuel characterization test matrix. Sampling usually begins behind the left engine because it is the first to be cranked.

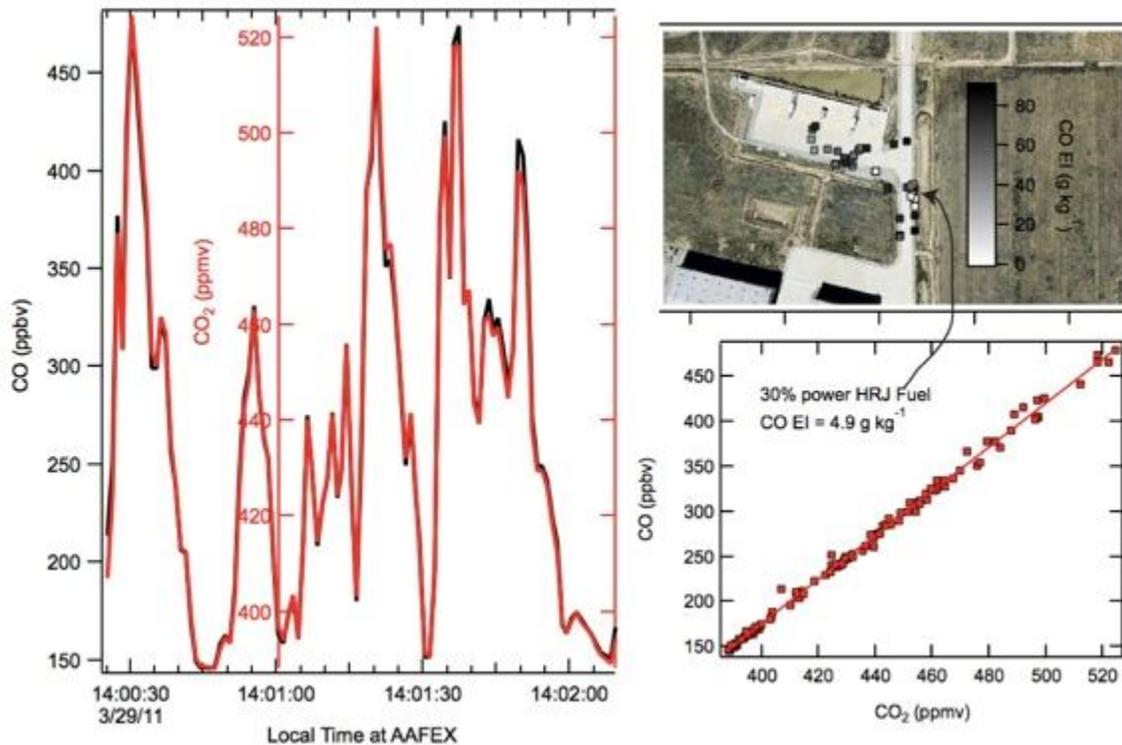


Figure 3. Downwind data recorded onboard the Aerodyne Mobile Laboratory during recent tests. Measurements from the vehicle at varying downwind distances will help build an understanding of how aircraft emissions impact air quality in communities surrounding airports and military airfields.



Figure 4. Team AAFEX-II.



Figure 5. Color-coordinated with his equipment and the AEDC trailer décor, Changlie carefully monitors output from his complex suite of gas-sampling instruments.



Figure 6. Brad threatens Gary with physical abuse if he doesn't quickly resolve the temp-trace heating problem so that testing can resume.

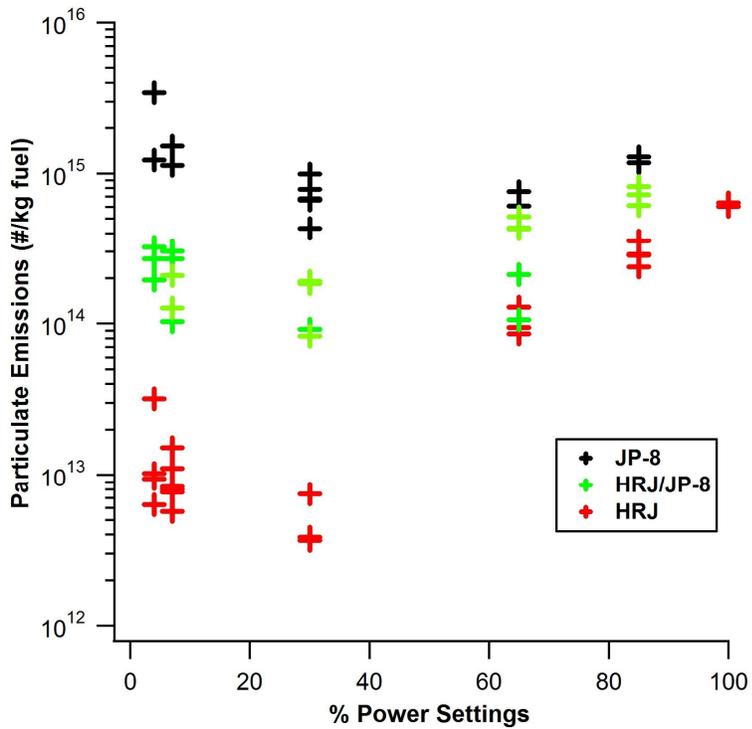


Figure 7. Particle number Emission Indices for JP-8, HRJ and the 50% blend of the two. Much of the spread is caused by changes in ambient temperature. **PRELIMINARY DATA—NOT FOR DISTRIBUTION**



Figure 8. AAFEX-II scientists kill time at BJ's Brewery as they eagerly await 3 am wakeup calls for another exhilarating day of emission testing.