AAFEX Status Report #11 – 30 January 2009

Primary Activities: FT1/JP-8 blend and FT2 warm-phase exhaust characterization tests

Weather: Calm and 33 F at 7 am; dry with clear skies; slight westerly winds around sunup which swung around to the NE by mid-morning; tail winds >10 mph precluded high power engine runs at times.

Summary: Participants seemed a bit more alert today at 4 am. It being the 4th day in a row of early testing, most folks have fallen into a routine of 6 pm dinners and 9 pm bedtimes. Even Jim Plant, the notorious late-riser of the LaRC team, appeared to have both eyes open at the 4:30 am briefing where Scott, the DFRC met-man, told us the wind situation looked bad for the afternoon. With this in mind we rushed to get two runs in before the weather closed us down. Here's an account of the day's events.

- In reviewing data from Thursday's tests, Aerodyne noticed irregularities in some of their measurements that could only be caused by leaking sample lines. An inspection of the valve box on the #2 engine-rake showed that its manifold had indeed developed a leak. After this was replaced, all lines were checked and found to pass the high pressure gas/ "snoop" test.

- Engine run #1 involved measuring the DC-8's emissions as it burned JP-8 in the #2 engine and a 50/50 blend of FT and JP-8 in #3. The blend was produced by adding 2500 gallons of JP-8 to a tanker containing an equal amount of FT, then re-circulating the tank contents through an external pump to ensure complete mixing; post mission analyses (Figure 1) should reveal that the blend had about 600 ppm S and 8-10% aeromatic content, or half that of the baseline JP-8 fuel.

- Tests started at about 6:15 am as Aerosol investigators sampled exhaust from the 30-m inlet as #3 was started and power of advanced to 30% of maximum thrust. As the FT fuel remaining in the fuel system from Thursday afternoon's test slowly burned out and was replaced by the blend, SO2 and volatile aerosol concentrations rose steeply and in tandem. Nonvolatile particle emissions also increased with proportion of JP-8, as did the total mass of condensed matter in the plume at 30 m. After SO2 emissions stabilized, power was reduced to ground idle and emissions were measured at 1 and 30 m at power settings of 4, 7, 15, 30, 45, 65, 85, and 100% thrust settings; after a brief intermission (Figure 2), a second set of data was collected for the #3 engine at the same power levels. Significant differences in particle emissions were seen between the pure FT and blended fuel at most power levels, as shown in Figure 3. The test concluded at 9:40 am.

- Around 10 am, participants noticed that the north-easterly winds were strengthening, so we quickened our pace of preparations to get the next engine runs started. Mike and his crack crew of mechanics (Scott, Donnie, Joe, Charlie, and Leo) had the blended fuel drained from

#3 main and replaced by FT2 (a coal-based fuel manufactured by Sasol) by 10:15; the APU was started for test 2 around 10:45, slightly over an hour after concluding the blend test.

- Repeating the morning's test plan, after initial startup investigators monitored emissions from #3, but this time saw SO2 and particle concentrations dropping as the remaining blended fuel burned out of the system as was replaced by FT2. At 30% power, SO2 dropped from 7 ppm to < 0.5 in a matter of 10 minutes; they eventually settled at a value that suggested the fuel contained about 25 ppm S, which was probably introduced during shipping and handling or from mixing with the remaining fuel in the #3 main. Again, emissions were measured behind at 1 and 30 m behind both engines across the full envelop of engine powers. Preliminary results indicate that the #3 engine actually emits fewer particles at low engine powers when burning FT2 than when burning FT1.

Figure 1. Scott (DFRC) collects a fuel sample that will be analyzed by the AFRL fuels lab for a variety of parameters including density, heat of combustion, aromatics, and sulfur. Note the puddle of oil beneath the engine.

Figure 2. John Kinsey’s worst fears realized: waiting lines at the port-a-potties!

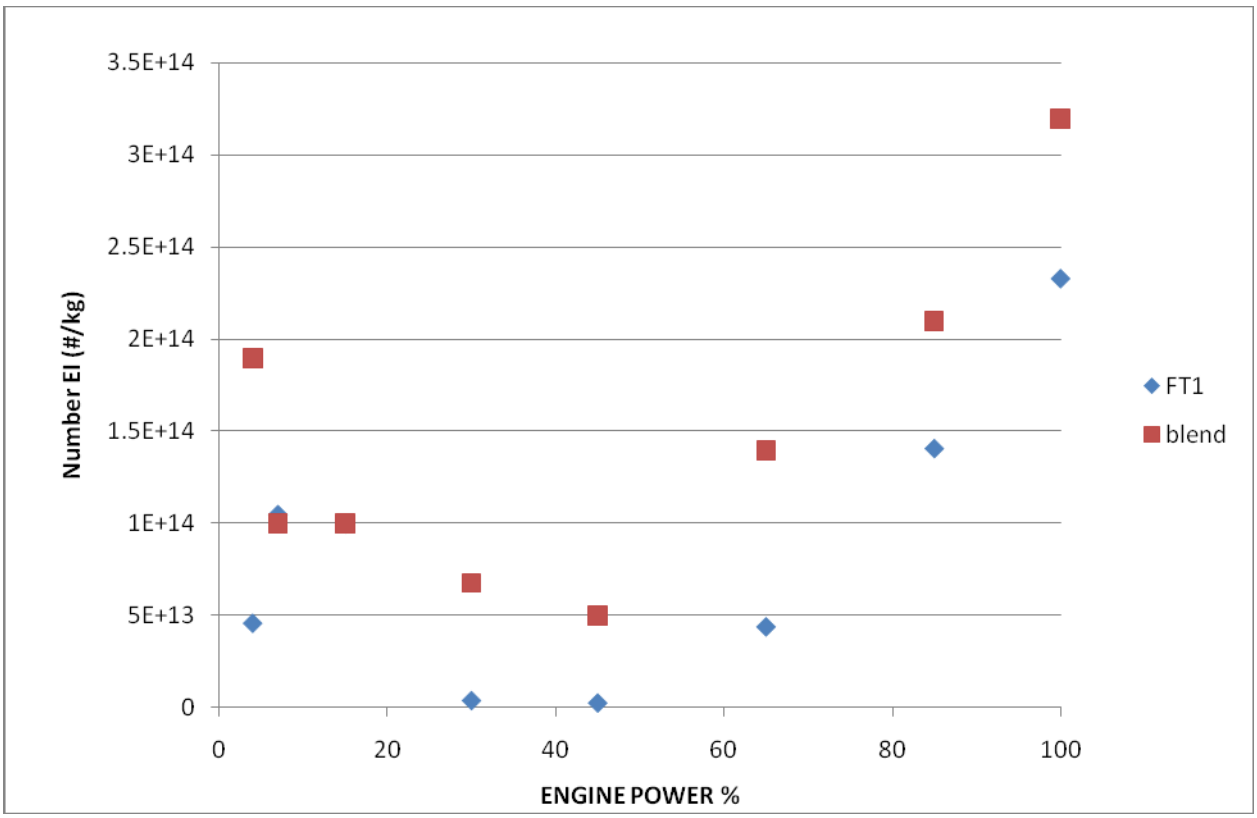

Figure 3. Comparison of nonvolatile particle emissions measured 1-m behind the #3 engine as it burned FT1 (blue) and blended FT/JP8 (red) fuels during tests conducted 1/29/09 and 1/30/09, respectively. Values will incease 5 to 30% after being corrected for sample density.
PRELIMINARY DATA, NOT FOR PUBLIC DISTRIBUTION

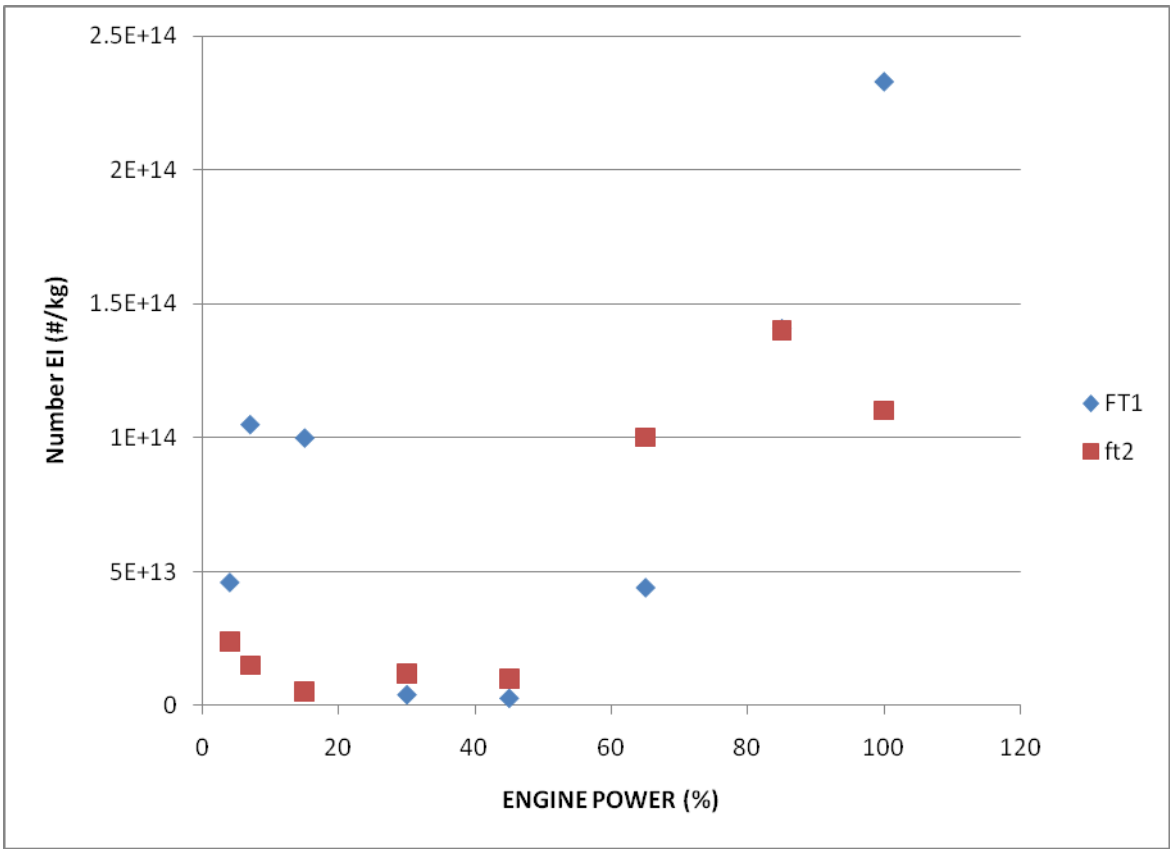

Figure 4. Comparison of nonvolatile particle emissions measured 1-m behind the #3 engine as it burned FT1 (blue) and FT2 (red) during tests conducted 1/29/09 and 1/30/09, respectively. Values will incease 5 to 30% after being corrected for sample density.
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