Summary of Discussion Items at Recent Burnthrough Task Group Meeting in Ottawa

Standardization of Stator Position

Additional testing by the Boeing Company has confirmed the findings of previous FAA testing with regard to the position of the internal H215 stator. The findings indicate that slight differences in the location of the stator can have a dramatic effect on the calibration (temperature and heat flux) profiles, and likely the actual test results. Boeing initially constructed a simple device that could be inserted into the end of the burner to measure the stator position/angle. The device was shipped to the FAA Technical Center in July, during which time the FAA's position/angle was indicated on the device, and shipped back to Boeing for comparison. Boeing used that information to adjust their stator position identical to the FAA's, and ran several tests to confirm the new location. Test results indicated heat flux and temperature profiles nearly identical to the FAA's. Following the initial comparison, Boeing developed a more sophisticated tool, which allows for a more precise measurement of the stator angle. Following the recent task group meeting, Boeing has agreed to visit the FAA Tech Center to compare critical elements of the test apparatus and procedure, and will finalize the design on the improved stator position tool. Devices can then be constructed with an indicator of the standardized stator position, and shipped to the participating labs.
Point of Contact: Steve Morgan, Boeing (425) 266-9949

Burner Heat Flux Mapping Re-Do

During the recent heat flux mapping exercise (completed by 5 of the 9 participating labs), heat flux measurements were taken at 21 locations, in an effort to produce a "map" that could indicate the hot or cold areas of the flame. This information was plotted using the topographic function in Excel, in which an isotherm chart resulted for each lab. The most recent results were slightly less irregular than those results obtained prior to the June meeting, but still very far from the anticipated outcome of highest heat flux in the central area of the flame profile.

The most recent mapping results indicated a variety of flame profiles, with only a few labs showing any similarity at all. It was discovered during the Task Group meeting that 2 of the 5 labs that reported data used a substantially larger backer board to mount the heat flux transducer. It is theorized that this difference alone may account for a portion of the discontinuity in the results. In addition, it was determined that many of the labs were also still recording the measurements slightly differently, in particular, the amount of time taken to allow the test rig to cool off between successive measuring locations.

Several possibilities exist for the continued dissimilarities in flame profiles from lab to lab, but the lack of a defined cool-down period between locations was likely one major cause. It appears that the areas immediately surrounding the burner equipment have a tendency to heat up over a period of time, and re-radiate that back to the heat flux transducer. As a result, the measured heat flux is likely influenced by the amount of time between trials. Lab F was extremely vigilant in allowing the apparatus and surroundings to cool between measurements, and obtained one of the more regular heat flux profiles as a result.

In an effort to eliminate the effects of re-radiated heat from the surroundings, a revised mapping procedure was recommended during the task group meeting, along with standardization of the heat flux transducer mounting board. The new mapping procedure requires a significant number of measurements be taken without shutting the burner off, to reduce the influence of temperature from the surrounding on the heat flux measurements. The recommended procedure requires the use of a 24-inch by 48-inch Kaowool™ board for mounting the heat flux transducer.

The revised standardized mapping methodology is recommended as follows:

First, in order to ensure that the heat flux transducer is being exposed in a similar manner, it is recommended that the device be mounted in the 24-inch by 48-inch Kaowool™ board supplied by the FAA Technical Center. This board will come with the 21 holes pre-drilled in the correct locations. An additional smaller (6-inch by 14-inch) Kaowool™ board will be supplied with a hole in the center, to mount the heat flux transducer. The small board/transducer will be moved from one location to the next, with the small board acting as a shield to prevent flames from passing through the uncovered holes in the large board (figure 1).

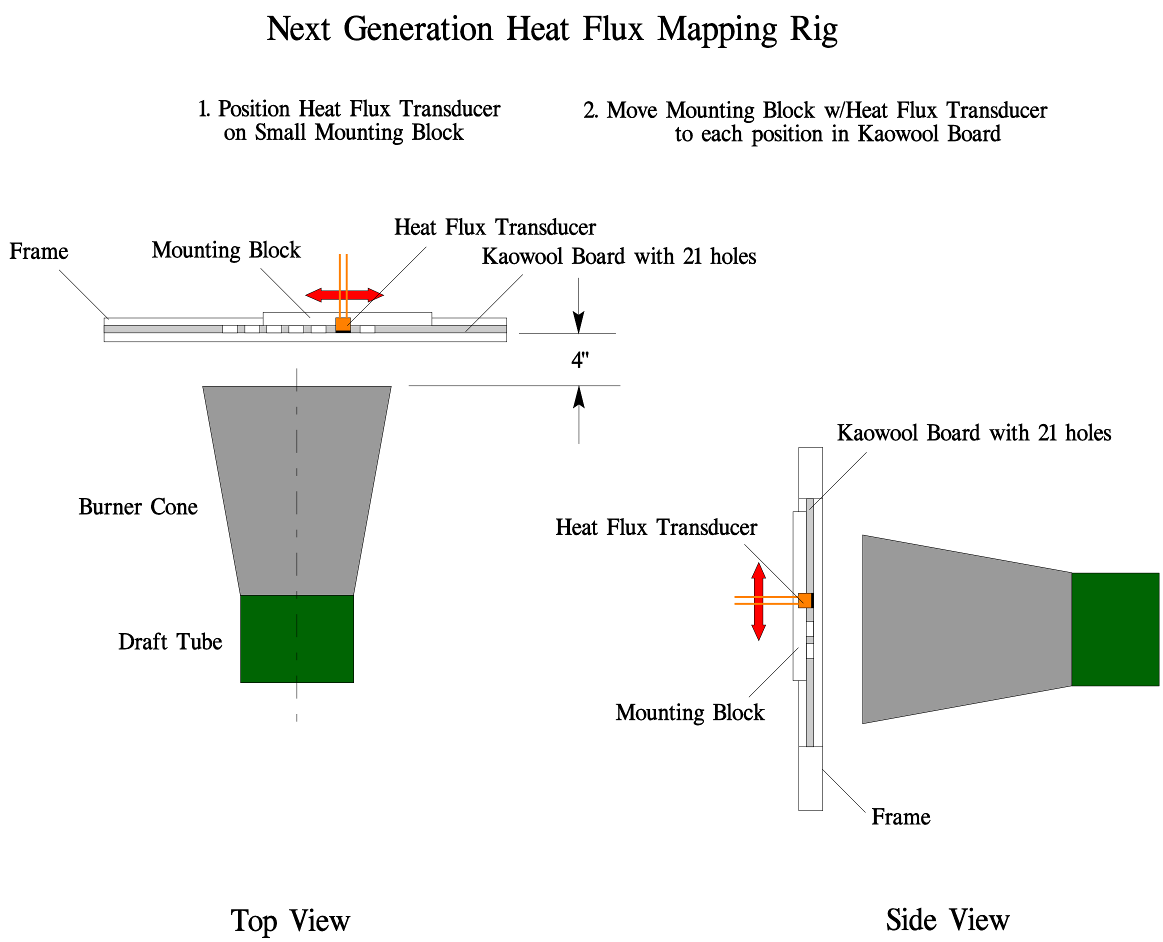

Figure 1. Next Generation Heat Flux Mapping Rig

Second, we recommend that 3 sets of 7 readings be taken without shutting the burner off. This will reduce the impact of heating/cooling from the surroundings on the flux measurements. This exercise may require additional personnel, since the transducer/small board will need to be repositioned manually, and must be held in place. Please use caution, and appropriate safety apparel.

To perform the mapping, first adjust the intake air velocity to 2150 ft/min as described below. Following a 2-minute warm up, swing the burner in front of the heat flux mapping apparatus, and allow 1 minute for flame stabilization. After the 1 minute stabilization, begin recording data once every second for a total of 30 seconds. Following this, remove the transducer from the number 1 position, dust off any accumulated soot from the face, and reinsert into position number 2. Simultaneously begin the 1-minute stabilization, followed by the data recording once every second for a total of 30 seconds. Repeat the above until all 7 positions are recorded. Shut burner off and swing away from the mapping apparatus. Allow at least 30 minutes for the surroundings to cool, and then repeat for the next set of tests (locations 8 to 14). Allow another 30 minutes cool down, then repeat for the last set of tests (locations 15 to 21). The heat flux is calculated by averaging the 30 data points for each location.

Lastly, just to be sure, let's make certain we're all using the same reference point for the mapping orientation. The chart shown in figure 2 is viewed looking INTO the burner. For example, if you are positioned directly in front of the cone, looking into the mouth of it, with flames bouncing off your chest, position #1 is on the top left. If you are situated behind the burner, sipping a margurita, where the switch box is located, then position #1 is on the upper right. You may also notice that the distance between each hole is now 1.5 inches, since it is not feasible to cut holes in the Kaowool™ at a 1-inch spacing.

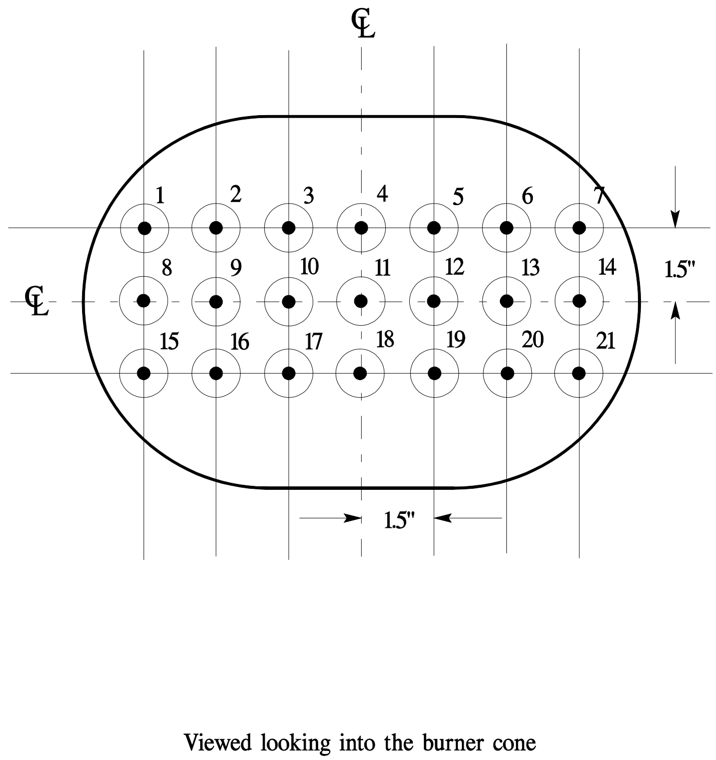

Figure 2. Heat Flux Transducer Positions for Mapping Burner Flame

Time permitting, the FAA Technical Center will also run additional heat flux mapping trials, to determine the feasibility of obtaining all 21 measurements during one test (instead of 3).

Point of contact: Tim Marker, FAA (609) 485-6469

Development of IR-Type Mapping Apparatus
Because of the uncertainty surrounding the accuracy of the heat flux transducer used to map the burner flame profile, an alternate mapping methodology was suggested. The alternate procedure would employ an infrared (IR) camera to capture a picture of the flame profile. This picture would be filtered using a layer of dot-printed Nextel ceramic paper in front of the camera. International Aero will begin development of a prototype testing apparatus that utilizes an IR camera, and will ship the device to the FAA following successful trials. If possible, this device could also be shipped to the other participating labs in the group, so that all labs have the opportunity to map their burner flame profile using this technology.
Point of contact: John Brooks, International Aero (360) 757-2376

Development/Construction of Standardized Air Inlet Control Device/Air Filter
Accufleet/Boeing have determined that the absence of intake ducting used to supply fresh air to the burner will significantly diminish the accuracy and life of the Omega air velocity meter. This is due to the combustion products being drawn back into the burner intake during testing, contaminating the air velocity meter blades, and possibly deteriorating the bearing surfaces prematurely. For this reason, an intake duct system was proposed (and standardized) prior to the June meeting, in which a 20-foot long, 4-inch flex duct was specified. Previous FAA tests have determined that different lengths of intake duct can impact the amount of air entering the burner, so it is critical that all labs strictly adhere to the intake duct specifications.

In addition, several labs raised concern over the usefulness of the present air damper mechanism, which is used to control the amount of air entering the burner. At the recent task group meeting, many labs expressed an interest in removing this mechanism in favor of a more precision component that could be mounted on the inlet of the 20-foot intake duct. This arrangement would allow better control of the inlet airflow, which is a key element in interlab correlation. One suggestion was to utilize a gate-type hand valve, which can be purchased at home center supply outlets, or hardware stores. The FAA Technical Center has agreed to design and construct such a device, and produce enough for all participating labs. The device will also incorporate an air filter to prevent ingestion of dust/soot. The group agreed to continue using the present air damper system until such time that a new device is designed, constructed, and shipped to their lab.
Point of Contact: Time Marker, FAA (609) 485-6469

Six Sigma Analysis
The Boeing Company has agreed to investigate the feasibility of applying Six-Sigma fault tree analysis to the mapping process, to determine if improvements can be made, or if the heat flux transducer is even accurate enough to allow for generation of a heat flux map.
Point of Contact, Steve Morgan, Boeing (425) 266-9949

Standardization of Intake Velocity Measurement (Reminder)
Testing conducted at the FAA Technical Center has shown that the position of the burner (facing the calorimeter, facing the thermocouples, or facing the test rig) can have a slight effect on the intake air velocity readings. For example, a reading of 2150 ft/min while the burner is in the warm-up position may result in a reading of 2100 ft/min when the burner is rotated into the test position. Recent round robin testing has confirmed the FAA's findings. For this reason, a standard methodology of measuring the intake air velocity follows:

1. Install Omega air velocity meter into intake airbox.
2. Install standardized length of intake duct onto airbox (see above).

3. Position burner either in the temperature measurement position, heat flux position, or test position, depending on which measurement will be taken.
4. Turn the blower motor ON, making certain that the fuel and ignitors are in the OFF position.
5. Adjust the damper position of the burner to 2150 ft/min intake velocity while monitoring the digital read-out. This may take some care, as the intake velocity will fluctuate somewhat during the adjustment.
6. After adjustment is complete, tighten the set-screw on the air inlet damper to prevent further movement
7. Rotate burner back to warm-up position, and resume with normal warm-up and testing.