TO: Dr. Patrick Tebbe & Dr. Saeed Moaveni DATE: April 4, 2009

FROM: Matthew Simones

RE: Thermocouple probe surface temperature measurement

The performance of the JQSS-18U-12 (ungrounded*) thermocouple probe during surface temperature measurement was investigated to determine the error associated with possible heat conduction along the probe sheath as warm air passes over it when installed inside a SolarWall. The experimental set up (Figure 1) in the lab consisted of mounting the JQSS probe and an Omega flexible tip surface probe (HPS-FSP-K-14E-12) on a mounting stand to elevate them from the lab bench. The probes and mounting stand were then positioned near a brick wall in the laboratory so that the tip of each probe was in contact with the wall. A hot plate was then positioned underneath the probes to simulate hot air passing over the probes as in the field. The use of the hot plate was justified since air velocities within the wall were assumed to be small (~10 cm/s). A J-type thermocouple was also hung on the thermocouple probes midway between the mounting stand and the wall to measure the air temperature passing over the probes. The JQSS and J-type thermocouples were connected to one Omega handheld thermocouple reader, and the flexible tip surface probe was attached to another.

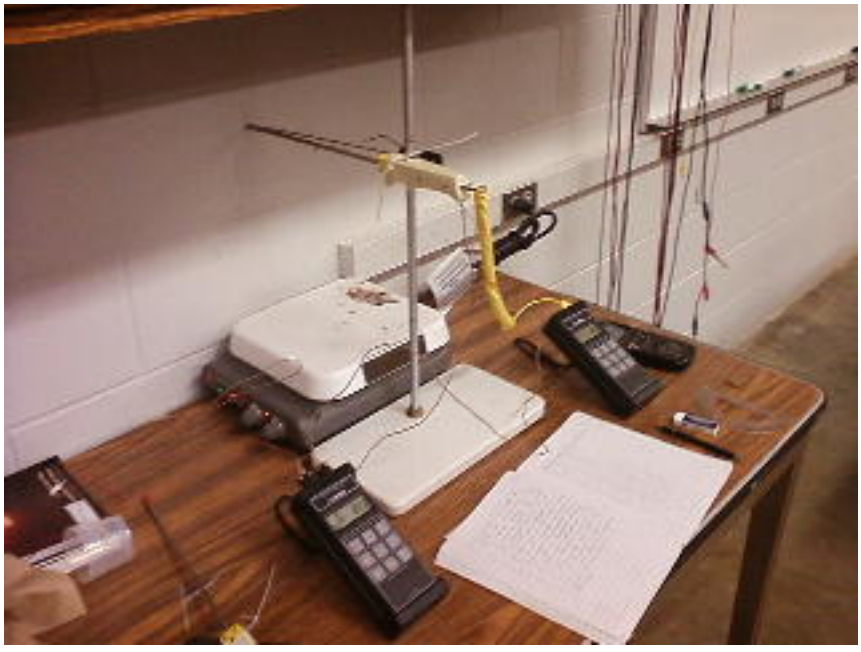

Figure 1 – Experimental apparatus including the JQSS and flexible tip probes, J-type thermocouple, hot plate, stand, and hand held thermocouple readers

* In this arrangement the thermocouple junction is separated from the probe tip by an electrically insulating medium

The hot plate was turned on and adjusted so that the air measured by the J-type thermocouple was slightly over 100 °F. The temperatures measured by the probes were then allowed to reach steady state conditions before taking temperature measurements. The acquired measurements are shown below in Table 1 and indicate that the JQSS probe was not picking up extra heat from the surrounding air. The JQSS probe was also indicating a temperature approximately 10 °F different from the flexible tip thermocouple probe. To investigate the accuracy of the probes they were calibrated in an ice-water bath. Since surface measurements from the tip of the JQSS probe were under investigation, the probe was not immersed in the ice water bath. Instead, the tip of the probe was held against a piece of melting ice on the lab bench. Simultaneously the flexible tip thermocouple probe was also held against the ice next to the JQSS probe. The temperature measured by the flexible tip thermocouple probe was 32.3 °F while the JQSS probe was measured 72.2 °F, clearly showing error under surface temperature measurement.

The results from the performance of the JQSS-ungrounded probe show that it is not suitable for surface temperature measurement for the SolarWall application. It is suggested that a JQSS-grounded type thermocouple probe be examined in the same manner described above. This probe is manufactured such that the thermocouple junction is in contact with the probe, giving a more accurate surface temperature measurement. No grounded-type probes were found in the experimentation lab, and would have to be ordered for testing.

Table 1 – Surface temperature measurements for the JQSS and flexible tip thermocouple probes, and the heated air temperature measured using the J-type thermocouple

JQSS (°F)	Flexible tip (°F)	Air Temp. (°F)
75.5	87.1	106.1
75.4	87.1	103.5
75.6	87.1	106.1
75.5	87.2	102.4
75.5	87.2	102.8
75.5	87.2	104.3
75.7	87.2	107.3
75.6	87.2	105.4
75.7	87.3	103.1
75.8	87.3	103.6
75.7	87.3	107.1
75.8	87.4	106.7
75.7	87.3	104.6
75.7	87.5	103.6
75.8	87.5	103.1
75.7	87.4	103.4
75.6	87.6	102.9
76.1	87.6	105.0
75.7	**87.3**	**104.5**