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January 07, 2002

Lab No. 173245.0

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Reference: Resistance to Heat Flow of R-32 Cellulose, R-30 Fiberglass and R-13.3 Polyurethane Foam Insulation Under Air Infiltration Conditions

Accu-Test Labs was supplied with a test apparatus designed to demonstrate the resistance to heat transfer of three different thermal insulation materials. The test apparatus is also equipped with a fan, which creates a positive pressure on the heated side of the test apparatus. This positive pressure simulates air infiltration through the walls of a home or commercial building during a low wind speed condition. Accu-Test Labs was asked to operate the test apparatus and chart the temperature change on the side of the insulation that was opposite the heat source.

The test apparatus is shown in Figure 1. At the bottom of the test apparatus is the heating chamber and heat source, which consists of three 150-watt flood lamps. On the right side of the fixture is a small fan, which is designed to create a positive air pressure in the lower heating chamber. The three chambers that contain the insulation are each approximately 10 7/8" wide * 12 3/4" high * 11 1/4" deep. The heated chamber and insulation chambers are divided by a 3/4" thick particleboard partition. This particleboard partition has a 1 3/4" diameter hole in the center of the partition, which allows the infiltration of the heated air from the pressurized lower chamber. The chamber on the far left contains 11" of loose cellulose. The middle chamber contains 10 1/2" of unbacked fiberglass and the chamber on the right contains 3 1/2" on sprayed polyurethane foam (Sealection 500, half-pound polyurethane foam used). The top particleboard cover of each insulation chamber also has a 1 3/4" diameter hole. A clear plastic tube was inserted into each top hole. Figure 1 shows the test apparatus with the fan operating. A Kestrel 2000 wind speed meter was used to determine the velocity of the air leaving the top hole. The air velocities recorded were 6.6 MPH through the unbacked fiberglass insulation, 2.2 MPH through the loose cellulose and 0 MPH through the polyurethane foam. A ping-pong ball was placed inside each tube and the air flow through the cellulose and fiberglass insulation caused the ping-pong balls to float at top of the tube. The ping-pong balls in the left tube (cellulose) and middle tube (cellulose) floated at the top of each tube. The ping-pong ball in the center tube (fiberglass insulation) had the highest elevation in the tube. The ping-pong ball in the polyurethane tube remained at the bottom of the tube. The R-values listed on Plexiglas window for each insulation material were as follows: R-32 for the loose cellulose, R-30 for the unbacked fiberglass and R13.3 for the sprayed polyurethane foam. Figure 2 shows the test apparatus with three calibrated Fluke Model 51II digital thermometers. The type "K" thermocouples were inserted approximately 1 inch below the center of the top vent hole. Figure 3 shows the test apparatus with the lights on. The three Fluke digital thermometers were placed in operation and all three thermocouples recorded 66.6 °F in each insulation chamber. The fan and lights were placed in operation and temperature measurements were recorded every one-minute for the first 16 minutes, then every two minutes until thirty minutes had elapsed and then every five minute until sixty minutes had elapsed. The test was discontinued after sixty minutes. Figure 4 shows a graph that plots temperature rise versus elapsed time.

The decision was made to perform a second heating test with the air flow reduced to 4.5 MPH through the fiberglass insulation and 1.5 MPH through the cellulose insulation. The same apparatus and time parameters were used and the results of the second test are shown in Figure 5.

Our findings, when using this test apparatus and with two air infiltration rates, are as follows.

1. The chamber above the 3 1/2" of Sealection 500 half-pound polyurethane foam had the lowest temperature increase.
2. The chamber above the 10 1/2" of fiberglass insulation had the greatest temperature increase.
3. The highest airflow was through the fiberglass insulation.
4. The loose cellulose insulation had a slightly lower airflow than the fiberglass insulation.
5. We did not record any airflow through the polyurethane insulation.

We can conclude that under these test conditions, the Sealection 500 half-pound polyurethane foam will have better insulating properties than R-30 unbacked fiberglass or R-32 loose cellulose.

Philip Kirk
Accu-Test Labs

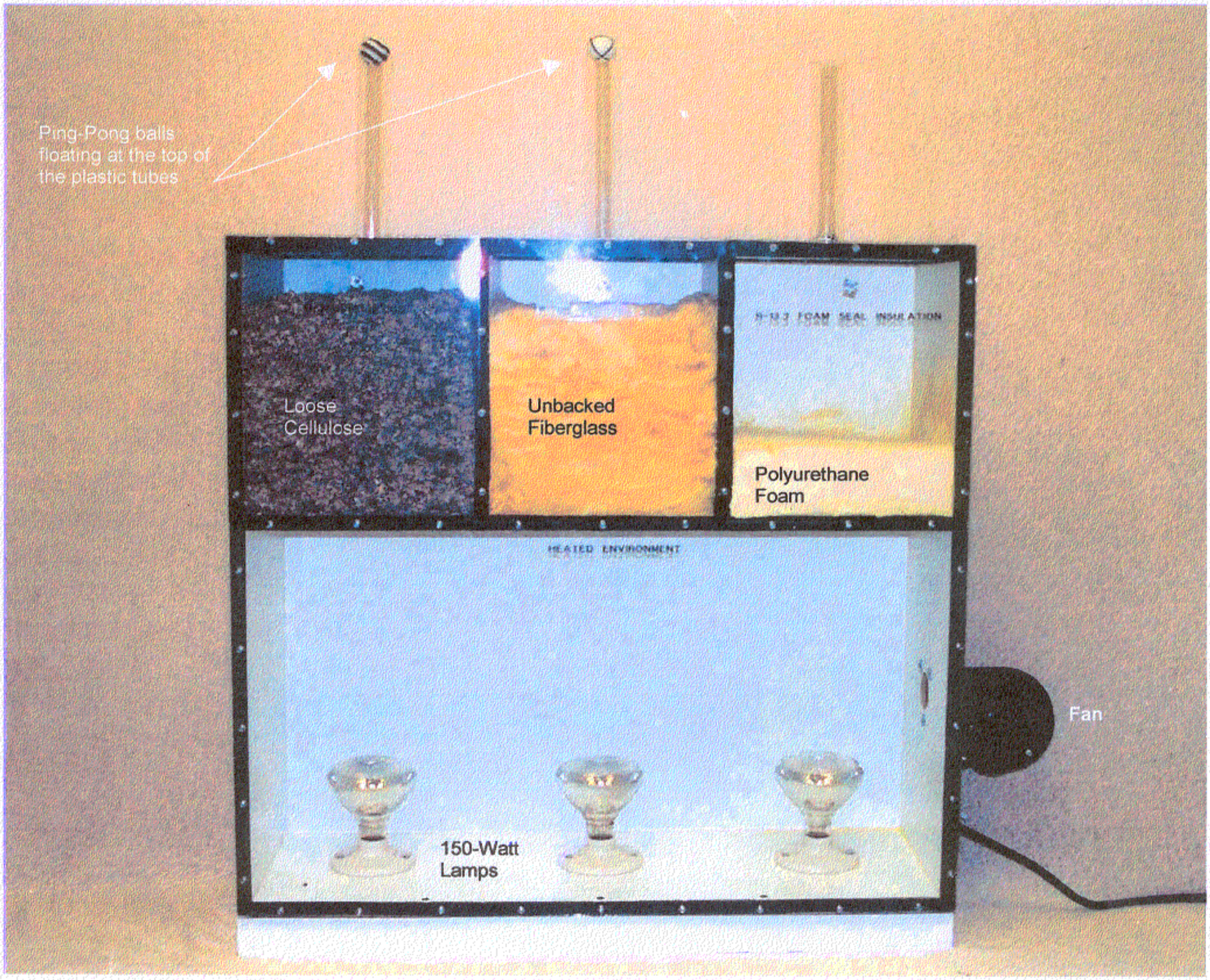

Figure 1
Test Apparatus with the Fan Operating

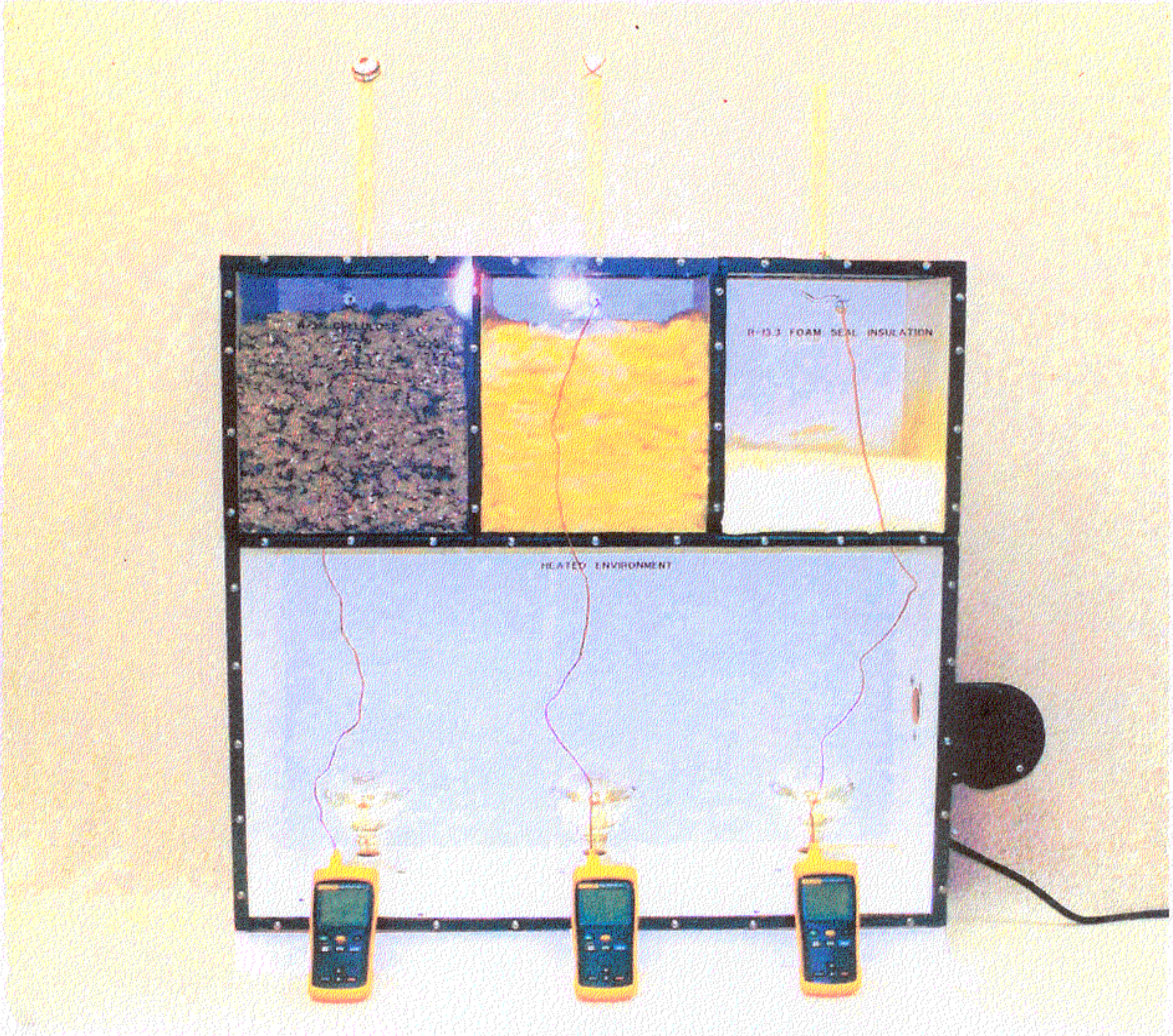

Figure 2
Test Apparatus with Fluke Model 51 II Digital Thermometers and Type K Thermocouples

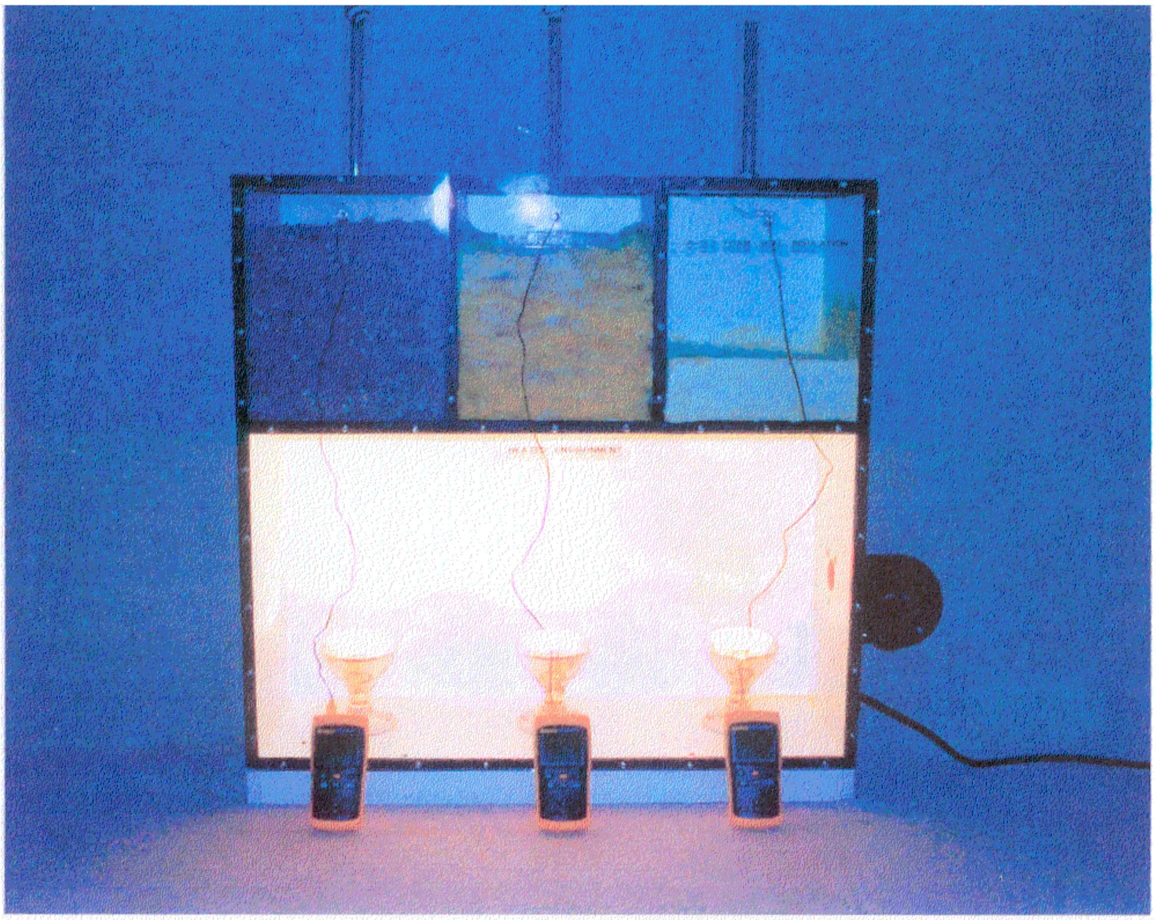

Figure 3
Test Apparatus with the Fan and Lights Operating

Figure 4
Temperature Rise in the Air Space Above the Three Insulation Materials
(Positive Air Pressure on the Heated Side)

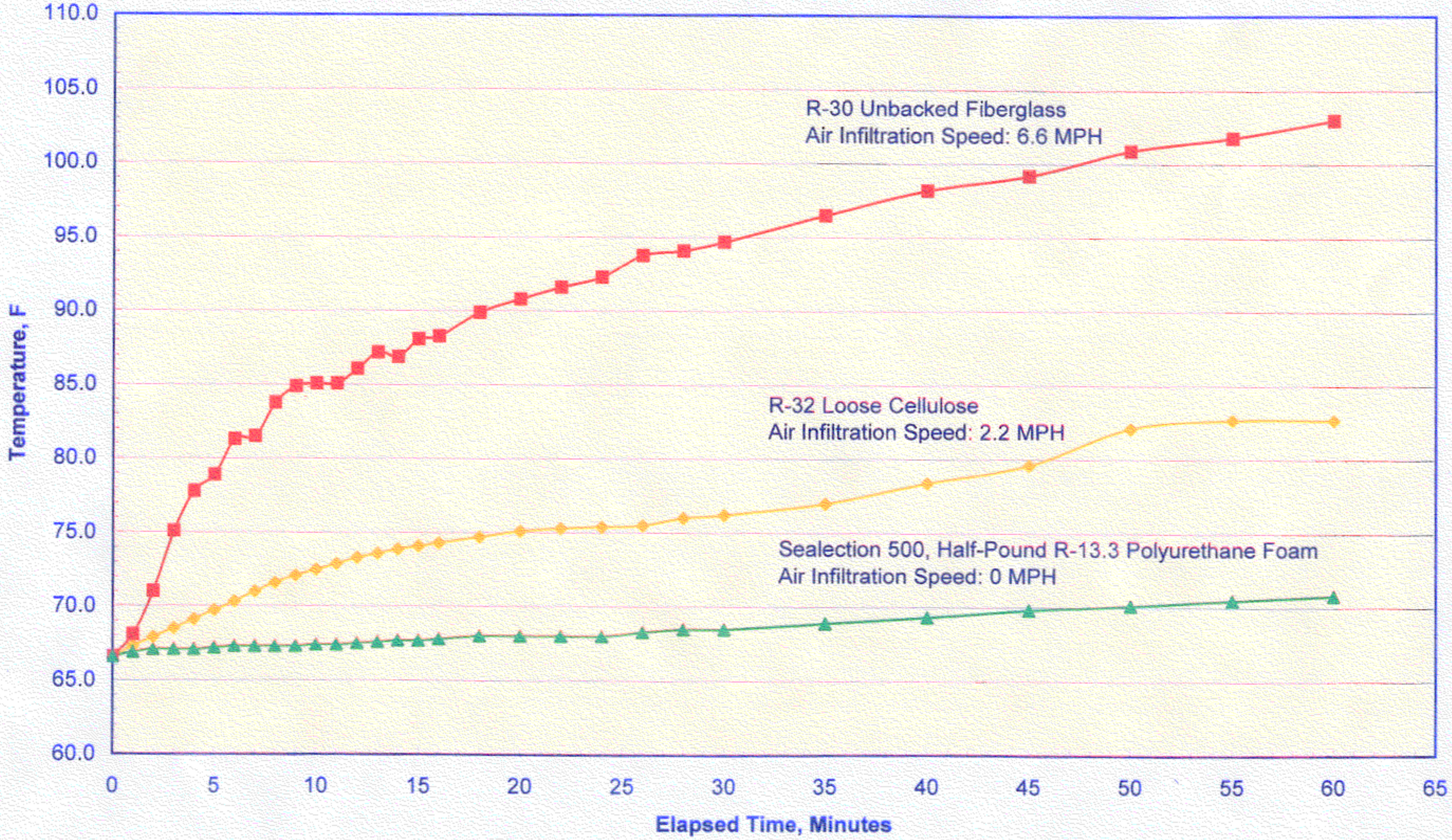

Figure 5

Temperature Rise in the Air Space Above the Three Insulation Materials (Positive Air Pressure on the Heated Side)