Karges-Faulconbridge, Inc.
Engineers

ENERGY ANALYSIS COMPARISON REPORT
(AK DUCT vs. INSULATED PVC DUCT)

Date:	May 11, 2009
Performed By:	John A. Clark, PE
	WI No. 23440-006
KFI Project No.:	09-171.00

EXECUTIVE SUMMARY

Karges-Faulconbridge, Inc (KFI) received a request from CDC Enterprises, Inc to do an independent analysis of the data from the Stork/Twin City Testing Corporation report dated November 3, 2008, titled "Temperature Performance Test of AKDUCT Plastic vs. PVC Ducting by Coheat Test Methodology."

The object of our analysis was to determine Thermal Duct Efficiency (TDE) by calculating the ratio of heat input to heat output in BTU's per hour. The heat loss (in BTUs/HR) during the test through 40 feet of 12-inch round AK Duct and the heat loss through 40 feet of 12-inch round insulated PVC ducting was compared to the fuel input of the propane burned (page 6) during a 24 hour test period. The Stork test data (Duct Surface Temperatures of PVC Versus AK Duct) on page 5 and (Flow Test with Thermo-Anemometer CFM's) on page 7 was used to determine the heat loss of the duct run samples. The insulated PVC duct was surrounded on 4 sides with two –inch thick pieces of R-10 extruded polystyrene foam insulation. This insulation is as required for the standard referenced design in Wisconsin Codes.

Formula used for Heat Loss (sensible):

> BTU/HR= 1.02 x cfm x change in air temperature
> 1.02 is a constant based on the specific heat of the test air (0.24) and the density (0.71) in the test site of Mora, Minnesota (1,010 ft above sea level).

The test values used from the Stork Report are as follows:

> Mean Average Duct Surface temperature of PVC versus AK Duct Table (page 5).
> Mean Average Outlet Air Temperature, C from the above table.
> Flow Test with Thermo-Anemometer at 800 CFM at Register 1, Position #2 (page 7).

The flow test temperatures are from the Mean Average Temp over 24 hrs column. The inlet temperatures were measured 12-inches from the plenum. The outlet temperatures are Mean Average Outlet Temperatures at Register 1. Note that the Mean Average Outlet Temperature is almost the same between Registers 1 & 3. These temperatures were taken to maintain the test room at 75 degrees F with the furnace fan running at the 800 cfm setting.

670 West County Road B
St. Paul, MN 55113-4527
www.kfiengineers.com

PVC Duct Temperature Difference: 42.5ºC -38.1ºC: 108.5ºF- 100.4ºF= 8.1ºF
AKDuct Temperature Difference: 41.4ºC – 35.0ºC: 106.52ºF- 95.0ºF = 11.52ºF

Heat Loss from PVC Duct:
1.02 x 1373 fpm x 0.785 SF (12-inch duct area) x 8.1 degrees F=8,905 BTU/HR loss

Heat Loss from AK Duct:
1.02 x 1353 fpm x0.785 SF x 11.52 degrees F=12,480 BTH/HR loss

Test fuel input for PVC duct: 4,008,070 BTU/24 hours= 167,003 BTU/HR
Calculated duct heat loss during the 24 hour test period=8905 BTU/HR
The heat output= 167,003 BTU/HR-8905BTU/HR= 158,098 BTU/HR
Thermal Efficiency= output/input= 158,098 BTU/Hr/167,003 BTU/HR=0.947 (95%)

Test fuel input for AKDuct: 3,140,720 BTU/24 hour test period=130,863 BTU/HR
Calculated duct heat loss during 24 hour test period=12,480 BTU/HR
The heat output=130,863 BTU/Hr-12,480 BTU/HR=118,383 BTU/Hr
Thermal Efficiency=output/input=118,383 BTU/HR/130,863 BTU/HR= 0.905 (91%)

Note: the sand temperature from the PVC test was 17.1ºC (62.78ºF) and the sand temperature from the AK Duct was 24.3ºC (75.74ºF). The difference in sand temperature can be explained that the AK duct test used more, but shorter fan cycles (page 10) to maintain the test set point of 75ºF and when the fan was “off “ the heat in the still duct transferred to the sand over the 24 hour test period.

CONCLUSION

The rate of heat loss was reasonably close (95% to 91%) for both of the test ducts over the 24-hour test period. The Stork test also noted that less propane fuel was used over the 24-hour test period to maintain the 75ºF set point of the test room. Although the Stork test was not designed to determine the heat transfer comparison, we do conclude that the AK Duct has essentially the same thermal characteristics as the PVC installed with exterior R-10 thermal insulation configuration.