February 26, 2004

Mr. Mac Mattoon
B&F Power Vac. Inc.
PO Box 737
Lewiston, ID 83501-0737

RE: HRS efficiency analysis 2003-2004

Clean Heat Recovery Coils at E/P Building HVAC System

Prepared by Richard Nagy,
PE, Resource Conservation Manager, University of Idaho

General Project Description:
This project involved cleaning the Heat Recovery System (HRS) coils, which are part of the Heating Ventilating Air Conditioning (HVAC) system serving the Engineering & Physics (E/P) Laboratory Building at the University of Idaho. Cleaning the HRS coils improved the heat transfer efficiency of the HRS, reducing the amount of heat required by the HVAC system during cold weather.

The HVAC system serving the E/P building is run 24 hours per day, 365 days per year. This system supplies a constant 35,700 cubic feet per minute (cfm) of 100% outside air, which is heated or cooled as required to condition the various laboratories, classrooms, and office rooms in the building. All the return air from this system (27,000 cfm) first passes through the HRS and is then exhausted to the outside. The HVAC system supply air temperature setpoint varies from 55 degrees Fahrenheit to 63 degrees Fahrenheit, with cooler air supplied during warm weather. Each area served by this system also has a zone-heating coil controlled by a local thermostat.

The HRS is a passive system (no pumps or motors), which consists of two coils connected by heat pipes. One coil is located in the exhaust air stream (return air), and the second in the outside air intake air stream (supply air). When the return air (RA) is warmer than the outside air (OA), heat is transferred from the RA to the OA to reduce the amount heat required to condition the OA before it is supplied to the building. By-pass dampers are controlled to divert the airflows around the coils as necessary to prevent overheating the OA to a temperature warmer than the supply air temperature setpoint.

Analysis of Savings

Measuring HRS efficiency:

For the purpose of this analysis the HRS efficiency is defined as the actual heat recovered divided by the ideal maximum possible recoverable heat. For this type of system the maximum possible recoverable heat would occur if the temperature of the Return Air leaving the HRS (TRA_leave) was reduced to be equal to the temperature of the Outside Air entering the HRS (TOA_enter) by the time it left the HRS. Where entering or leaving is relative to the HRS.

The heat recovery efficiency is therefore calculated as: Eff = [OAcfm x (TOA_leave – TOA_enter)] / [RAcfm x (TRA_enter – TOA_enter)]. Where OAcfm is the Outside Air flow (equal to the Supply Air Flow), and RAcfm is the Return Air flow (all of which is exhausted).

Prior to cleaning the HRS, temperature data loggers were installed to monitor the three required temperatures at 10-minute intervals for several days during the heating season. During this period the average efficiency was found to be 42.3%.

The HRS coils were then cleaned by B&F Power Vac Inc., and the efficiency was again data logged for several days. During this period the average efficiency was found to be 77.7%.

Estimating Annual Savings:

The annual reduction in heating energy due to cleaning the HRS was calculated using ten-year average hourly temperature data from the nearest airport weather station. The total amount of heat saved due to increasing the HRS efficiency from 42.3% to 77.7% for this average year was calculated to be 1,905 million Btu, which results in $7,145 savings at the university's current heating cost.

Additional Savings Opportunities:

The University of Idaho is considering cleaning other HVAC system coils in order to improve system efficiencies. In addition to other HRS coils, HVAC system heating and cooling coils may be cleaned to increase heat transfer and reduce fan energy. Improving heating and cooling coil heat transfer will in general not save energy, but it will improve occupant comfort at peak loads, by restoring system full heating or cooling capacity. However, the coil cleaning would save fan energy if the fans are controlled to maintain airflows or duct static pressure, as they would be for a variable air volume (VAV) system. In the case of a VAV system, the fan speed is typically controlled to maintain a fixed duct static pressure near the end of the supply air distribution ductwork. As the coils get dirty, the pressure drop across the coil increased and the fan must speed up and work harder to maintain the duct static pressure setpoint. Ignoring change in fan efficiency with changing speed, an increase system pressure of x% will increase fan energy by x% raised to the 3/2 power. For example a 10% increase in system pressure will increase fan energy by 15.4%.