**Petition for Declaratory Statement**
**Before the Florida Building Commission**
**December 29, 2015**

Company: Stan Weaver & Company
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# DS 2015-154

Statute(s), Agency Order(s) and/or Code Section(s) on which this Declaratory Statement is sought:

**C403.2.6 Energy recovery ventilation systems.** Where the supply airflow rate of a fan system exceeds the values specified in Table C403.2.6, the system shall include an energy recovery system. The energy recovery system shall have the capability to provide a change in the enthalpy of the outdoor air supply of not less than 50 percent of the difference between the outdoor air and return air enthalpies, at design conditions. Where an air economizer is required, the energy recovery system shall include a bypass or controls which permit operation of the economizer as required by Section C403.4.

**Exception:** An energy recovery ventilation system shall not be required in any of the following conditions:

> **7. Systems requiring dehumidification that employ energy recovery in series with the cooling coil.**

The intent of this petition is to clarify that a wrap-around heat pipe meets the exception C403.2.6.7.

**Background**
Stan Weaver & Company is a manufacturer's representative of air distribution products for central Florida. One of the manufacturers they represent is Heat Pipe Technology (HPT) who manufactures heat pipes that are used in air handler units as an energy savings device.

Having heat pipe included as an exception in C403.2.6 Energy recovery ventilation systems is a major point of emphasis with Florida engineers and owners. It allows engineers to design HVAC systems, include a heat pipe, and not have to provide an additional energy recovery system. It saves the building owner the expense of two heat recovery systems. Heat pipes are a proven technology and have been successfully operating in projects around the world for many years.

**History of HPT Heat Pipe Technology**

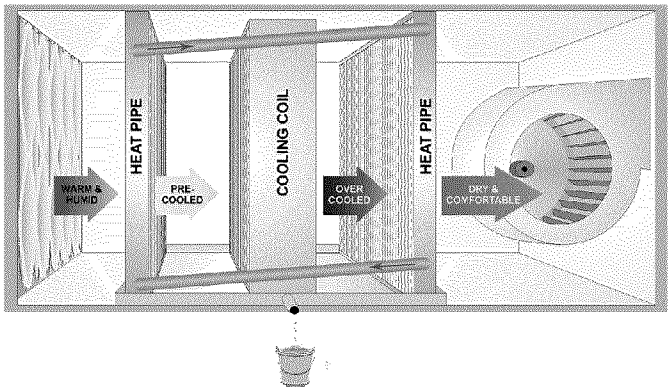
HPT was founded in 1983 with a grant from the Department of Energy for a project to begin research on new uses for heat pipe technology. Heat pipes are passive-heat-transfer devices that were previously used in various applications ranging from orbiting satellites to the Alaskan Pipeline ground spikes. By applying the principle of heat pipes to air conditioning systems, efficiency was greatly enhanced in both dehumidification performance and energy utilization, with moisture removal increased by 30 to 50%.

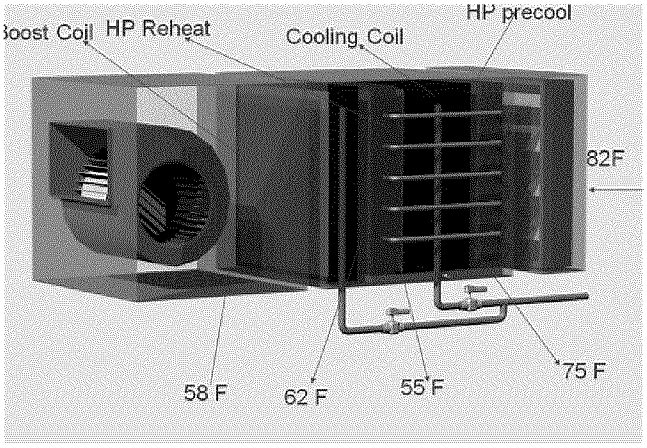
Additional research and development followed to determine how to lower fabrication costs. This task was performed by HPT under a three-year, $500,000 contract with NASA's Kennedy Space Center. The outcome of that effort was a new generation of heat pipe technology, costing one third the price of the existing aerospace heat pipes, while still offering the same level of performance.

This revolution shattered the price barrier that restricted the widespread commercial implementation of heat pipes, and it yielded a rapid return on investment for building owners, often in as little as a year. Projects soon proved the technology could be applied on virtually any scale, while being commercially viable and practical to implement.

**Wrap-Around Heat Pipe – Dehumidification Device**

Heat pipes can be used in series with a cooling coil as a means of dehumidifying the outside air before it enters the coiling coil. The heat is then "wrapped around" the cooling coil and transferred downstream to re-heat the air as shown in the diagrams below. A heat pipe is a closed circuit device without the requirement of any power source. Thus the heat pipe can transfer energy with the only energy loss being the relatively small pressure drop across the heat pipe coil and corresponding fan energy requirement.




An example of the energy savings of a wrap-around heat pipe is shown on the below psychometric chart. The enthalpy savings (Btu per Pound of Dry Air) is represented below and shown as both Precool and Reheat.

**Total energy savings from pre-cooling and re-heat** can be expressed as:

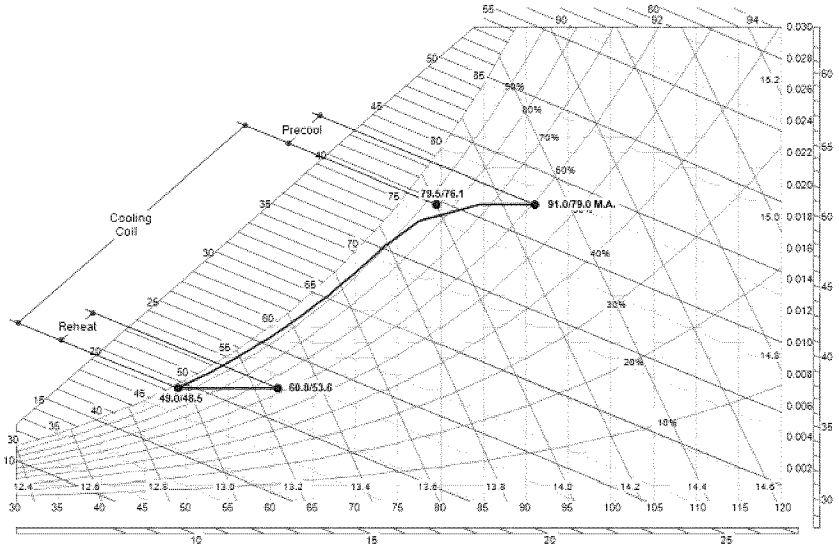
$h_t = 4.5\ q\ dh$

*where*

*$h_t$= total energy savings (Btu/hr)*

*q = air volume flow (cfm, cubic feet per minute)*

*dh = enthalpy difference from Precool/re-heat (btu/lb dry air)*



## A selection and payback analysis for a current design under consideration

A school in central Florida is being evaluated requiring:

- 100% OA unit with constant 20,000 CFM
- 52 F off the cooling coil
- no more than 65 F supplied after reheat
- supplemental reheat is via hot water

Assumptions:

- Chiller has efficiency of 20 EER (or 0.600 kW/ton)
- utility rate is $0.10/kWh
- hot water costs $1/therm (therm = 100,000 Btu's)
- AHU fan is 70% efficient and motor is 90% efficient
- Temperatures and hours based on Tampa bin data for one year
- AHU operates 24/7/365

At the first/uppermost bin (where OA is between 90 F and 95 F)…

**Cooling Savings** = Tons removed X Chiller's kW/ton X Tampa's cooling hours X Utility Rate
= 22 tons x 0.600 kW/ton x 157 Hours x $0.10/kWh = $209

**Heating Savings** = Free Reheat X Utility Rate … Free Reheat = 265,746 BTUH = 2.66 Therms/hour
= 2.66 Therms/hour X $1/Therm X 157 Hours = $417

**Fan Penalty** = (Airflow X Total Static Pressure X Utility Rate X Hours) / (Constant X Fan & Motor Efficiencies)
= (20,000 CFM X 0.37" X $0.10/kWh X 157 hours) / (8,522 X 0.7 X 0.9) = $22

**NET Savings (for 90F-95F bin) = $209 + $417 - $22 = $604**

Then calculate for each bin and sum to get NET Annual Savings = **$16,965***
* See attached Bin Analysis for breakdown.

If this standard 2-row DHP is budgeted for $25,000 and annual savings are $16,965…

Payback is less than a year and a half

**Question:** **If an air handling unit is provided with a wrap-around heat pipe (for dehumidification), is it acceptable to not provide an Energy Recovery Ventilation System per paragraph C403.2.6.7?**

**Summary:**

Petitioner respectfully believes the answer to the question outlined above is yes, if a wrap-around heat pipe coil is used, it is acceptable to not provide an Energy Recovery Ventilation System per paragraph C403.2. A wrap-around heat pipe is commonly viewed as a dehumidification device that employs energy recovery in series with the cooling coil. Many Florida engineers are already implementing wrap-around heat pipes as an exception in compliance with C403.2.6.7. We are seeking clarification on this matter.

Wrap-around heat pipes have been successfully applied as an energy savings dehumidification device for many years. Heat pipes are passive-heat-transfer devices requiring minimum maintenance and service. The typical payback to the building operator is generally 1 to 3 years. If heat pipe is supplied on a project, the building operator should not be penalized and have to provide a second energy recovery device.

David A John, P.E.
December 29, 2015

SelectPlus™ Design Software
Heat Pipe Selection and Optimization on Demand

| | |
|---|---|
| Project Name: | DHP Payback for School |
| Prepared For: | |
| Prepared By: | Drew Elsberry (hpt-drew) |
| | Heat Pipe Technology |
| Date: | 12/28/2015 2:18 PM |
| HPT Project: | 47593 |

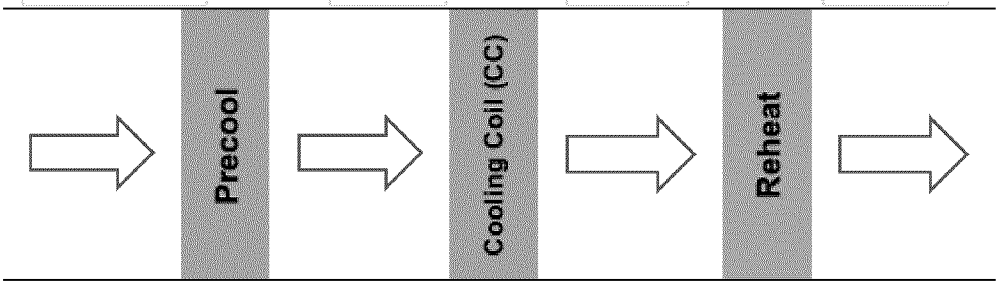
| Qty: | Model: | Tag: | AHU Tag: | Order Code: |
|---|---|---|---|---|
| 1 | DHP | DHP | AHU | DU-AMG-20212A-07500-08500-1200X-XXX |

## Air Properties

Air Type:Standard

Elevation: 0ft

| | Outside Air | Returned Air | Mixed Air (Standard) | Precool Leaving | Reheat Entering | Reheat Leaving |
|---|---|---|---|---|---|---|
| CFM | 20,000 | | 20,000 | | | |
| DBT (°F) | 95.00 | | 95.00 | 82.05 | 52.00 | 65.16 |
| WBT (°F) | 77.99 | | 77.99 | 74.63 | 52.00 | 57.33 |
| RH(%) | 47.3 | | 47.3 | 71.2 | 100.0 | 62.4 |




## Coil Performance

| | | | |
|---|---|---|---|
| Pressure Drop (in. H2O) | 0.19 | | 0.18 |
| Face Velocity (SFPM) | 451.80 | | 451.80 |
| Temperature Gain/Loss(°F) | 13.00 | | 13.20 |
| Sensible Effectiveness | 30.13 | | 30.60 |
| Heat Transferred (BTU/h) | 288,539 | 1,507,106 | 288,539 |
| Condensation (lbs/hr) | 0.0 | 772.9 | |

## Coil Design

| | | | |
|---|---|---|---|
| Fin Height (in.) | 75.00 | | 75.00 |
| Fin Length (in.) | 85.00 | | 85.00 |
| Face Area (SF) | 44.27 | | 44.27 |
| No. of Rows | 2 | | 2 |
| Tube OD (in.) | 1/2 | | 1/2 |
| Fins per inch | 12 | | 12 |
| Fin Type | Standard | | Standard |
| Fin Material | Aluminum | | Aluminum |

Refrigerant: R410a

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## DHP Bin Analysis

| | Precool | Reheat |
|---|---|---|
| Fin Height (in.) | 75.00 | 75.00 |
| Fin Length (in.) | 85.00 | 85.00 |
| Face Area (SQFT) | 44.27 | 44.27 |
| Face Velocity (SFPM) | 451.8 | 451.8 |
| Max Pressure Drop (in. H2O) | 0.19 | 0.18 |
| No. of Rows | 2 | 2 |
| Fiins per Inch | 12 | 12 |
| Fin Material | Aluminum | Aluminum |
| Fin Type | Standard | Standard |

Heat pipe installed as retrofit

| | |
|---|---|
| Cooling | Electric |
| Heating | Hot Water |
| Cooling EER | 20 |
| Electric Rate | $0.1/kwh |
| Hot Water Rate | $1.0/Therm |
| Burner Efficiency | 75% |
| Motor Efficiency | 90% |
| Fan Efficiency | 70% |
| Refrigerant | R410a |

TAMPA INTERNATIONAL AP, FL@M-F: 0-24 Sat: 0-24 Sun: 0-24
@Months: All.

| | |
|---|---|
| RER: | 201.68 |
| Rate of Return: | NA |

| Outside Air | | | Return Air | | Mixed Air Entering | | | Precool Heat Pipe | | |
|---|---|---|---|---|---|---|---|---|---|---|
| CFM | °F DB | °F WB | CFM | °F DB/ °F WB | Total CFM | °F DB/ °F WB | %RH | Rate BTU/h | Cond. lbs/hr | Leaving °F DB/ °F WB |
| 20000 | 91.6 | 77.8 | 0 | 0.0 / 0.0 | 20000 | 91.6 / 77.8 | 54.4 | 265746 | 0 | 79.7 / 74.7 |
| 20000 | 87.8 | 76.2 | 0 | 0.0 / 0.0 | 20000 | 87.8 / 76.2 | 59.1 | 240495 | 0 | 77.0 / 73.3 |
| 20000 | 82.3 | 73.9 | 0 | 0.0 / 0.0 | 20000 | 82.3 / 73.9 | 68.0 | 202911 | 0 | 73.1 / 71.4 |
| 20000 | 76.9 | 72.3 | 0 | 0.0 / 0.0 | 20000 | 76.9 / 72.3 | 80.7 | 171176 | 19.3 | 70.1 / 70.1 |
| 20000 | 72.6 | 68.3 | 0 | 0.0 / 0.0 | 20000 | 72.6 / 68.3 | 80.5 | 138005 | 0 | 66.4 / 66.3 |
| 20000 | 68.1 | 63.8 | 0 | 0.0 / 0.0 | 20000 | 68.1 / 63.8 | 79.8 | 107464 | 0 | 63.2 / 62.2 |
| 20000 | 62.8 | 58.5 | 0 | 0.0 / 0.0 | 20000 | 62.8 / 58.5 | 77.6 | 72310 | 0 | 59.5 / 57.2 |
| 20000 | 57.2 | 53.3 | 0 | 0.0 / 0.0 | 20000 | 57.2 / 53.3 | 78.0 | 34709 | 0 | 55.6 / 52.7 |
| 20000 | 52.3 | 48.2 | 0 | 0.0 / 0.0 | 20000 | 52.3 / 48.2 | 74.9 | 1931 | 0 | 52.2 / 48.2 |
| 20000 | 47.5 | 43.7 | 0 | 0.0 / 0.0 | 20000 | 47.5 / 43.7 | 74.2 | 0 | 0 | 0.0 / 0.0 |
| 20000 | 43.2 | 38.6 | 0 | 0.0 / 0.0 | 20000 | 43.2 / 38.6 | 66.2 | 0 | 0 | 0.0 / 0.0 |
| 20000 | 38.3 | 34.2 | 0 | 0.0 / 0.0 | 20000 | 38.3 / 34.2 | 66.2 | 0 | 0 | 0.0 / 0.0 |
| 20000 | 32.6 | 27.8 | 0 | 0.0 / 0.0 | 20000 | 32.6 / 27.8 | 53.0 | 0 | 0 | 0.0 / 0.0 |
| 20000 | 28.6 | 24.0 | 0 | 0.0 / 0.0 | 20000 | 28.6 / 24.0 | 48.6 | 0 | 0 | 0.0 / 0.0 |

| Cooling Coil | | | Reheat Heat Pipe | | | Run Time | Savings | | Fan Cost | Net Savings |
|---|---|---|---|---|---|---|---|---|---|---|
| Rate BTU/h | Cond. lbs/hr | Leaving °F DB/ °F WB | Rate BTU/h | Leaving °F DB/ °F WB | % RH | h/year | Precool $/year | Reheat $/year | $/year | $/year |
| 1514615 | 828 | 52.0 / 52.0 | 265746 | 64.1 / 56.9 | 64.7 | 157 | $209 | $417 | $22 | 604 |
| 1396036 | 773 | 52.0 / 52.0 | 240495 | 63.0 / 56.5 | 67.4 | 778 | $936 | $1871 | $108 | 2699 |
| 1243922 | 714 | 52.0 / 52.0 | 202911 | 61.3 / 55.8 | 71.6 | 1523 | $1545 | $3090 | $210 | 4426 |
| 1145693 | 686 | 52.0 / 52.0 | 171176 | 59.8 / 55.2 | 75.3 | 1780 | $1523 | $3047 | $252 | 4318 |
| 865954 | 505 | 52.0 / 52.0 | 138005 | 58.3 / 54.6 | 79.5 | 1139 | $786 | $1572 | $155 | 2203 |
| 587116 | 314 | 52.0 / 52.0 | 107464 | 56.9 / 54.1 | 83.6 | 1190 | $639 | $1279 | $161 | 1757 |
| 285157 | 110 | 52.0 / 52.0 | 72310 | 55.3 / 53.4 | 88.6 | 893 | $323 | $646 | $120 | 848 |

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| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 79229 | 0 | 52.0 / 51.1 | 34709 | 53.6 / 51.8 | 89.0 | 523 | $91 | $182 | $70 | 202 |
| 91030 | 80 | 52.0 / 46.3 | 1931 | 52.1 / 46.3 | 64.8 | 387 | $4 | $7 | $51 | (40) |
| 0 | 0 | 52.0 / 52.0 | 0 | 0.0 / 0.0 | 0.0 | 167 | $0 | $0 | $22 | (22) |
| 0 | 0 | 52.0 / 52.0 | 0 | 0.0 / 0.0 | 0.0 | 139 | $0 | $0 | $18 | (18) |
| 0 | 0 | 52.0 / 52.0 | 0 | 0.0 / 0.0 | 0.0 | 69 | $0 | $0 | $9 | (9) |
| 0 | 0 | 52.0 / 52.0 | 0 | 0.0 / 0.0 | 0.0 | 12 | $0 | $0 | $2 | (2) |
| 0 | 0 | 52.0 / 52.0 | 0 | 0.0 / 0.0 | 0.0 | 3 | $0 | $0 | $0 | 0 |
| **Totals:** | | | | | | **8760** | **$6055** | **$12111** | **$1201** | **$16965** |

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| 1 | DHP | DHP | AHU | DU-AMG-20212A-07500-08500-1200X-XXX |

**Psychrometric Analysis**

| | |
|---|---|
| Airflow: | 20000 CFM |
| Outside Air: | 95.0/78.0 ºF DB/ ºF WB |
| Precool Entering: | 95.0/78.0 ºF DB/ ºF WB |
| Precool Leaving: | 82.1/74.6 ºF DB/ ºF WB |
| Reheat Entering: | 52.0/52.0 ºF DB/ ºF WB |
| Reheat Leaving: | 65.16/57.33 ºF DB/ ºF WB |