



Application Data

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INTRODUCTION

This book describes the Aero energy recovery section (see Fig. 1 and 2) for the 39MN/MW air handler. It details the features, benefits and selection procedures and provides specific guidelines to ensure an effective energy recovery ventilation (ERV) system design for the Aero 39MN/MW air handler.

This guide provides a detailed overview of energy recovery ventilation — the history, technical issues, and application for indoor and outdoor air-handling units. Review it carefully prior to starting the design process.

Please contact the 39 Series Application Group (airsideapplications@carrier.com) for additional design support or to get answers to technical questions that go beyond the scope of this guide.

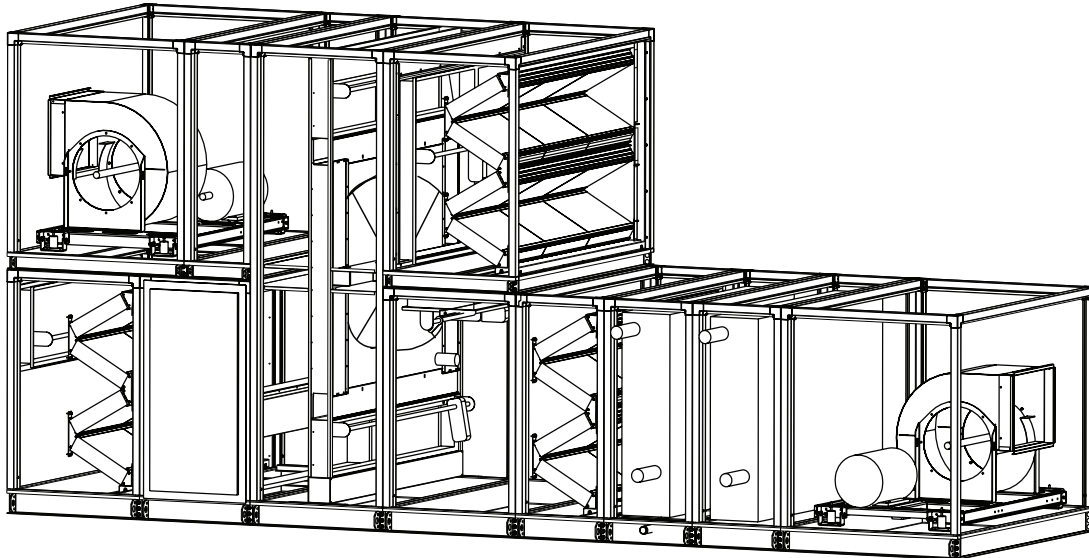


Fig. 1 — 39MN Indoor Unit with Energy Recovery Section

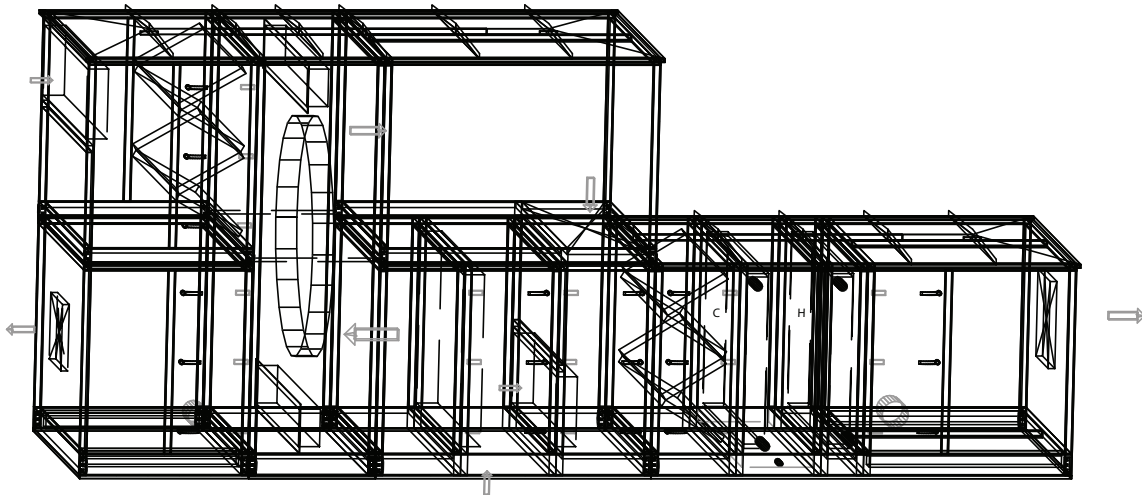


Fig. 2 — 39MW Outdoor Unit with Energy Recovery Section

Why Energy Recovery Ventilation?

Providing a comfortable and healthy indoor environment for building occupants is a primary concern for HVAC (heating, ventilation and air conditioning) design engineers. ASHRAE (American Society of Heating, Refrigeration and Air-Conditioning Engineers) Standard 62-2010, Ventilation for Acceptable Indoor Air Quality, contains ventilation design and evaluation requirements for commercial and residential buildings. This standard, which is referenced in part or whole by all building codes in the United States, recommends that outdoor air quantities be increased from 5 cfm per person to 15 cfm per person (20 cfm per person in an office environment) to avoid adverse health effects.

With half of all illnesses attributable to indoor airborne contaminants, the EPA (Environmental Protection Agency) has declared indoor-air quality a public health priority. Ventilation with outdoor air is the only strategy that can reduce the levels of all indoor pollutants. This strategy, in general accordance with the dilution principle, is shown in Fig. 3.

Although many building owners, architects and engineers recognize the benefits of introducing more outside air into a conditioned space, many are concerned about the impact on equipment and operating costs.

The energy recovery ventilation section provides the solution to the ASHRAE 62-2010 mandate. It pre-cools and dehumidifies the outdoor air during the cooling season and preheats and humidifies the outdoor air during the heating season. As a result, the outdoor air quantity can be increased from 5 to 15 cfm per person without increasing energy costs.

First-cost savings associated with the reduction in the heating/cooling plant typically pays for the energy recovery system installation.

As shown in Fig. 3, each time the ventilation rate doubles, the result is a 50% reduction in the concentration of all constant source air pollutants evenly mixed within the space. At 1.0 ACH (air changes per hour), pollutant concentrations are reduced by a factor of 5, as compared to no ventilation.

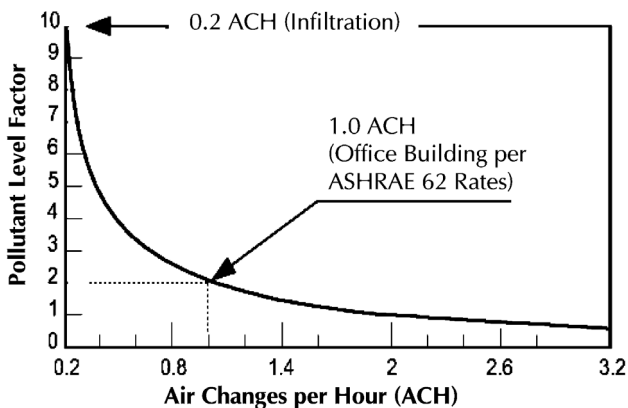


Fig. 3 — The Dilution Principle

AERO® 39MN/MW ENERGY RECOVERY SECTION FEATURES AND BENEFITS

The energy recovery section consists of several components, configured depending upon the application. The components inside the energy recovery section may include some or all of the following:

- Total energy recovery wheel (may be referred to as an enthalpy wheel or energy wheel)
- Exhaust fans
- Preheat coils
- Bypass dampers
- Filter mixing boxes
- Airflow measuring device

The energy recovery sections use a unique parallel plate energy transfer matrix design that optimizes the energy recovery surface area for a given diameter and depth of wheel used. In addition, a polymer film matrix offers ideal properties that limit counterproductive axial heat conduction. This combination achieves the required performance in a thin, lightweight configuration.

The desiccant-coated enthalpy wheels are corrosion resistant. The desiccant material is permanently bonded to the polymer matrix allowing the wheel to be easily washed.

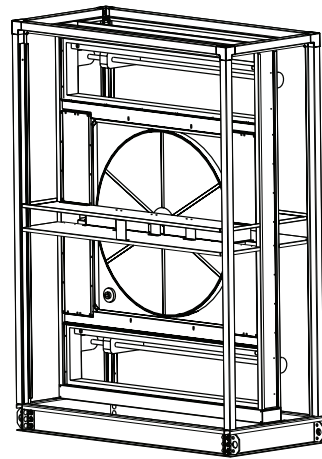
Key energy recovery wheel features and benefits include:

- All welded, stainless steel wheel assembly is independent of the heat transfer media for corrosion resistance and long service life.
- Removable wheel segments allow for easy cleaning or replacement.
- Permanently bonded silica gel desiccant enables long life.
- Laminar flow, self cleaning matrix means less maintenance.
- Washable wheel segments extend the life expectancy and sustain unit effectiveness.
- High maintenance applications can use a “spare set” of segments to minimize downtime and service.
- Carrier energy recovery wheels are UL (Underwriters Laboratories) recognized and AHRI (Air-Conditioning, Heating and Refrigeration Institute) 1060 certified for quick approvals.
- Reduced loads at design can significantly reduce the size of the chiller/boiler plant.
- Reduced design loads and operating costs result in the equipment paying for itself in a short period of time.
- Increased ventilation allows for improved indoor air quality.
- Energy efficient ventilation reduces operating costs.

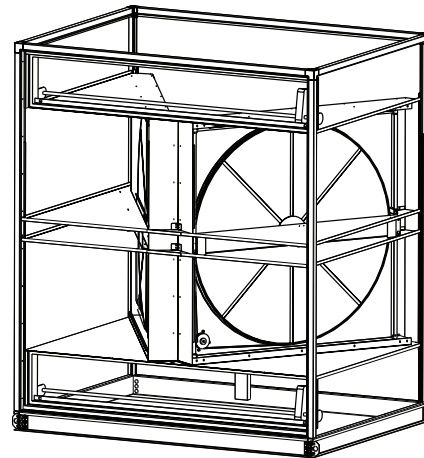
The Aero total energy recovery wheel pre-cools and dehumidifies the outdoor air during the cooling season and preheats and humidifies the incoming outdoor air during the heating season. As a result, the ventilation air quantity can be increased without significantly increasing operating costs.

CARRIER TOTAL ENERGY RECOVERY SECTION AND WHEEL CONSTRUCTION

Energy recovery sections in 39MN/MW unit sizes 17 (except size 17 with 10 in. base rail height) and below will ship fully assembled; because of shipping limitations, unit size 17 with 10 in. base rail height and larger unit sizes will ship unstacked. The ERV sections are available with a single wheel for sizes 03-61 and double wheel for sizes 06-61. See Fig. 4. Single wheel ERV sections sizes 03-61 as well as double wheel ERV sections sizes 06-14 come equipped with one removable panel on each side of the section. Double wheel ERV sections sizes 17-61 have multiple access panels on each side of the section, allowing easy access for service.



SINGLE WHEEL
ERV SECTION



DOUBLE WHEEL
ERV SECTION

Fig. 4 — Single Wheel and Double Wheel ERV Sections

The energy recovery wheels consist of a welded stainless steel hub and a spoke and rim assembly, which is independent of the heat transfer matrix. The heat transfer matrix is contained in patented energy transfer segments, removable from the wheel without requiring tools. See Fig. 5. The Aero energy wheel uses a unique parallel plate geometry and polymer film substrate to provide an optimized heat exchanger design. The polymer film construction is not subject to corrosion in coastal locations or swimming pool areas.

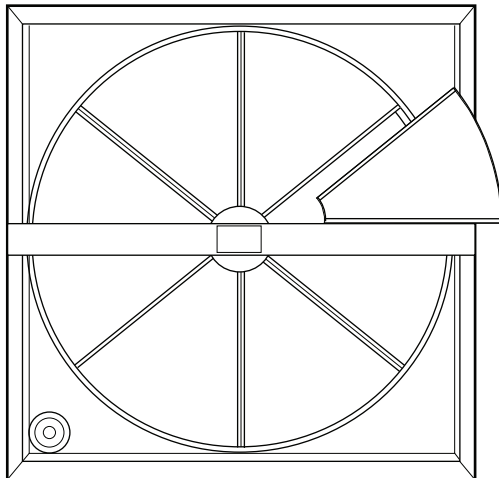


Fig. 5 — Total Energy Recovery Wheel

Silica Gel Technology

The Aero 39MN/MW energy recovery wheels use the desiccant material known as silica gel, which is a highly porous solid adsorbent material that structurally resembles a rigid sponge. It has a very large internal surface composed of myriad microscopic cavities and a vast system of capillary channels that provide pathways connecting the internal microscopic cavities to the outside surface of the sponge (see Fig. 6). Silica gel enthalpy wheels transfer water by rotating between 2 airstreams of different vapor pressures. The vapor pressure differential drives molecules into/from these cavities to transfer moisture from the more humid airstream to the drier airstream.

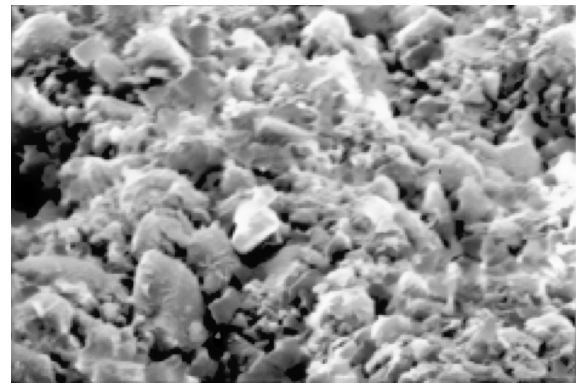


Fig. 6 — Microscopic Image of Silica Gel

ADSORPTION: SILICA GEL VS. MOLECULAR SIEVE

Figure 7 shows the characteristic curve for adsorption of water on silica gel. It shows the percent weight adsorbed versus relative humidity of the airstream in contact with the silica gel. The amount of water adsorbed rises linearly with increasing relative humidity (rh) until rh reaches near 60%. It then plateaus at above 40% adsorbed as rh approaches 100%. For contrast, the curve for molecular sieves rises rapidly to plateau at about 20% adsorbed at 20% rh.

The graph shown in Fig. 7 explains the following application considerations:

- Molecular sieves are preferred for regenerated applications such as desiccant cooling and dehumidification systems that must reduce the processed airstreams to very low relative humidities.
- Silica gel has superior characteristics for recovering space conditioning energy from exhaust air and handling high relative humidity outside conditions.

The transfer of water by adsorption/desorption is not dependent on temperature. Therefore, the silica gel enthalpy wheel works to reduce latent load at difficult part load conditions.

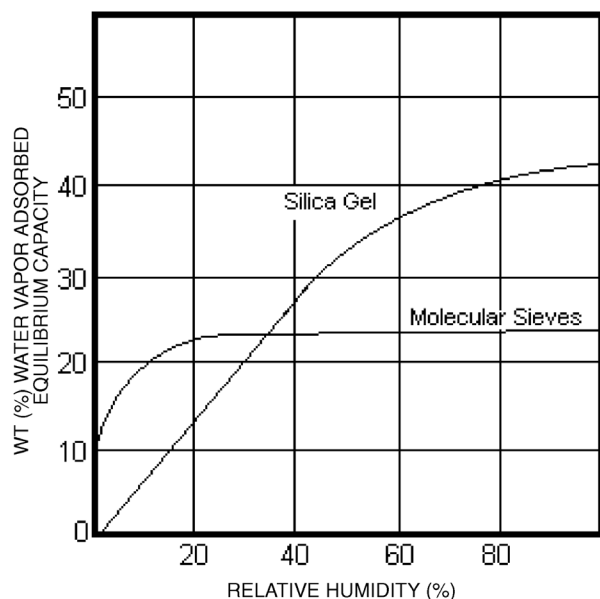


Fig. 7 — Effect of Relative Humidity on Dessicant Capacity

Fungal Growth and Moisture Transfer

WATER TRANSFER

In silica gel-based desiccant wheels, the water molecules are individually transferred by desorption or adsorption to and from the silica gel surfaces. Water is present on the wheel in a molecular layer only, and condensation does not occur. Therefore, the energy recovery wheels experience dry moisture transfer; there is no bulk liquid water present that could support fungal growth. Water transfer to and from the wheel's desiccant surfaces occurs in the vapor phase; there are no wet surfaces and liquid water does not enter the airstream. Silica gel is also highly selective for water, based on the strong preference of the gel surface for the dipolar water molecule over other compounds.

ENERGY RECOVERY APPLICATIONS

There are 2 basic seasonal scenarios for air-to-air energy recovery ventilation in comfort applications (see Fig. 8). The first is to transfer heat and moisture from the exhaust airstream to the supply airstream during the winter months. The second is the reverse

function: to transfer heat and moisture from the supply airstream to the exhaust airstream in the summer months.

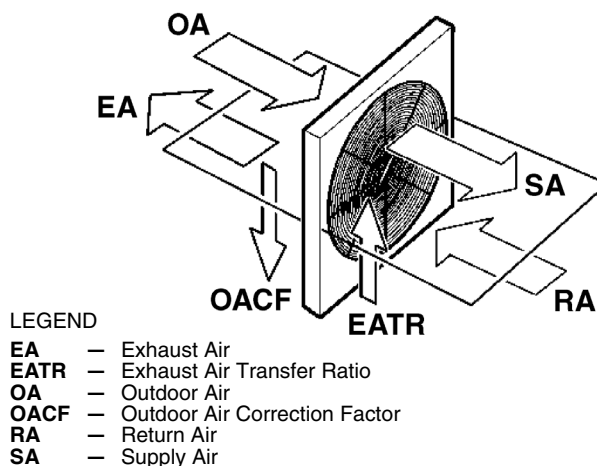


Fig. 8 — Air-to-Air Recovery Ventilation — Airflow Convention

There are many possible applications for the Aero® energy recovery section. Any building with comfort conditioning and relatively high levels of outdoor air, especially where latent cooling is a significant portion of the outdoor air requirement, is a likely candidate.

The following are typical applications for the energy recovery section:

- Schools, universities, dormitories
- Office buildings
- Gymnasiums
- Hotels, motels, department stores
- Hospitals, nursing homes
- Correctional facilities
- Retail shopping centers

APPLICATION GUIDELINES

Power Requirements

The energy recovery wheel section must have a separate single or 3-phase power. Refer to Table 1.

The energy wheel motor is thermally protected. Starter contacts must be provided and installed in the field. Refer to **AHUBuilder®** selection software for exhaust fan motor electrical requirements.

Table 1 — Electrical Data for Energy Wheel Motors

ERV WHEEL SIZE 28MV* POS 12-14	28MV* POS 15/16	MOTOR NAMEPLATE				
		VOLTAGE	PHASE	HZ	HP	AMPS
025/030	BB	115	1	50/60	80W	0.7
	BC	208-230	1	50/60	80W	0.3
036	CB	115	1	50/60	1/20	0.76
	CC	200/208-230	1	50/60	1/20	0.6
	CD	200-230/460	3	60	1/6	0.7-0.88/0.44
	CF	200/400	3	50	1/6	0.70/0.44
	CG	575	3	60	1/6	0.46
	CJ	380	3	50	1/6	0.50
041/046/052	DB	115	1	50/60	1/6	1.9
	DC	200/208-230	1	50/60	1/6	1.2
	DD	200-230/460	3	60	1/6	0.7-0.88/0.44
	DF	200/400	3	50	1/6	0.70/0.44
	DG	575	3	60	1/6	0.46
	DJ	380	3	50	1/6	0.50
058/064/068	FB	100/115	1	50/60	1/4	5.0/4.3
	FC	200-230/460	3	60	1/4	2.3-2.6/1.3
	FD	200/400	3	50	1/4	1.90/1.10
	FF	575	3	60	1/4	0.88
	FG	380-400	3	50	1/4	1.10/1.10
	FH	200-220/200-230	1	50/60	1/4	2.6-2.6/2.4-2.1
074/081	GB	100/115	1	50/60	1/3	7.6/6.4
	GC	200-230/460	3	60	1/3	2.5-2.6/1.3
	GD	200/400	3	50	1/3	2.00/1.10
	GF	575	3	60	1/3	0.9
	GG	380-400	3	50	1/3	1.20/1.10
	GH	200-220/200-230	1	50/60	1/3	3.8-4.1/3.4-3.2
086/092	HB	200-230/460	3	60	1/2	4.0-3.6/1.8
	HC	200/400	3	50	1/2	2.65/1.35
	HD	575	3	60	1/2	1.4
	HF	380	3	50	1/2	1.35
099/104	JB	200-230/460	3	60	1	5.0-5.3/2.65
	JC	200/380	3	50	1	5.20/2.70
	JD	575	3	60	1	2.5
	JF	380	3	50	1	2.70

Motor Wiring

⚠ WARNING

To avoid the possibility of electrical shock, open and tag all disconnects before installing this equipment. Failure to follow all safety instructions could result in severe personal injury or death. Install and ground per local and national codes. Consult qualified personnel with any questions.

If motor has multi-voltage capabilities, be sure to wire motor appropriately for supply voltage. See Fig. 9.

Motor leads and connectors are supplied on energy recovery sections ERC-25 to ERC-52 only. The Molex¹ connector maybe removed in the field if necessary. See Fig. 10.

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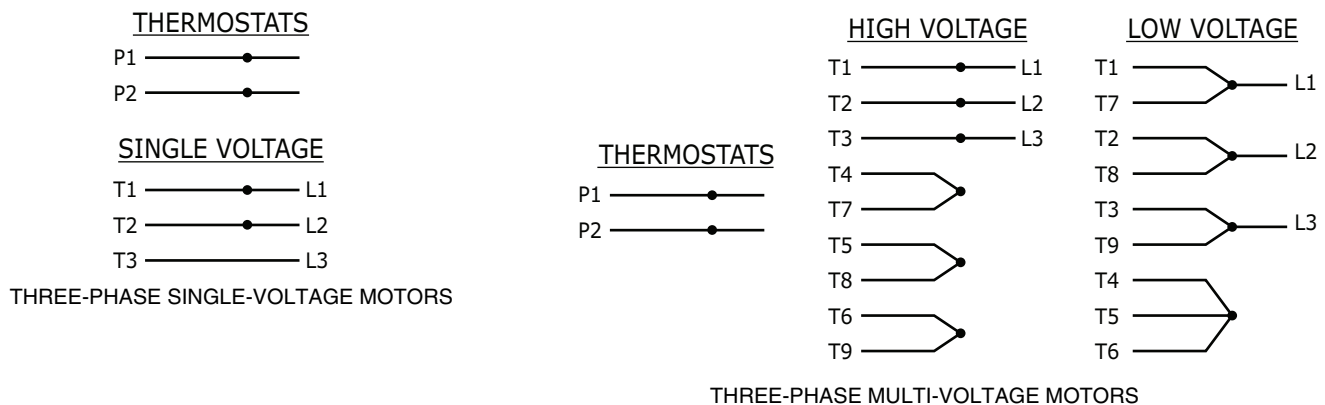
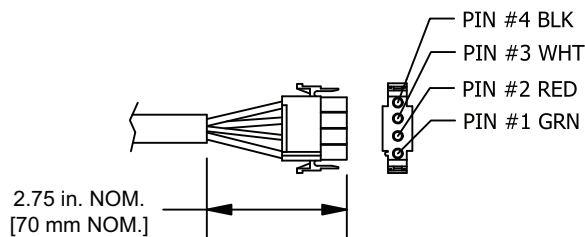
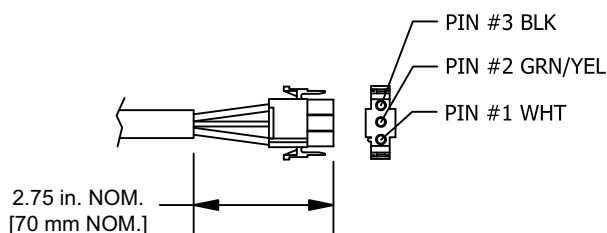


Fig. 9 — Motor Wiring



CORD TERMINATION DETAIL FOR
THREE-PHASE MOTORS



CORD TERMINATION DETAIL FOR
SINGLE-PHASE MOTORS

Fig. 10 — Motor Leads and Connectors (ERC-25 to ERC-52 Only)

MOTOR PROTECTION

All three-phase motors are inverter-duty and are therefore suitable for use with a variable frequency drive (VFD). (Single-phase motors are *not* suitable for use with a VFD.) Three-phase motors can also be utilized in “across the line” starts or “standard duty” applications.

Inverter-duty motors do not use Automatic Thermal Overloads (ATOs). Instead, thermostats are embedded in the motor and should be wired externally to the motor control device (see Fig. 9).

IMPORTANT: Failure to connect over-temperature devices will negatively impact the warranty.

Thermostat Protectors P1 and P2 (Three-Phase Inverter Duty Motors Only)

Three-phase inverter duty motors can be utilized in various applications. The protection differs based on the configuration:

- Motor connected to a contactor or relay, and the original ATO was relied upon for protection — Thermostats must be wired in series with contactor or relay to provide adequate overload/thermal protection.
- Motor connected to a starter or contactor with correctly sized thermal overload — Embedded thermostats are optional.
- Motor connected to a VFD — The VFD *should* provide overload/thermal protection. If it does not, the thermostats must be wired in series with the start/stop (or a separate stop input if there is one) of the drive to provide adequate overload/thermal protection. The wire harness lead length between the VFD and motor should not exceed 25 feet. Excessive lead length can cause voltage at the motor terminals to rise, and may cause motor winding insulation failure.

Other Recommendations

- The free flow of air around the motor should not be obstructed.
- The ambient temperature of the air inlet to the motor should not exceed 104°F (40°C) or be less than -22°F (-30°C).
- AC power to the motor terminals should not exceed $\pm 10\%$ of the rated voltage with rated frequency.

Filtration Requirements

- The energy transfer media is designed to induce laminar flow under all conditions. This results in a flow profile that allows small particles to pass through the wheel and larger particles to land on the wheel's surface and blow clear as the flow direction is reversed. Continuous airflow reversal creates a “self-cleaning” process. As a result, commercial, institutional and residential applications require minimal filtration for efficient operation.

OUTDOOR AND SUPPLY AIRSTREAMS

The outdoor air louver or intake hood should incorporate an insect screen to prohibit large items such as insects, leaves and debris from entering the enthalpy wheel. It is recommended that low efficiency 30%, cleanable or pleated filters be installed prior to installing the energy wheel.

RETURN AND EXHAUST AIRSTREAMS

In applications where the return/exhaust air is clean, filtration is not required, but still recommended. In applications where the return/exhaust air contains bacteria, lint, or oil mist, incorporate the appropriate filtration.

NOTE: Lab fume hoods and paint booths are not acceptable applications.

Fan Orientation

To limit cross-contamination, the pressure of the return airstream must be lower than that of the outdoor airstream. The energy recovery section is configured as a standard draw-thru supply/draw-thru exhaust orientation. This orientation provides good airflow distribution through the section while minimizing cross leakage and providing energy efficient fan use. See Fig. 11 and 12. There are no advantages to the arrangement shown in Fig. 13. In this draw-thru supply/blow-thru exhaust arrangement there is significant transfer of exhaust air and waste of fan energy, therefore, this configuration is not recommended. See typical fan placement diagrams (Fig. 14-19).

CAPACITY CONTROL

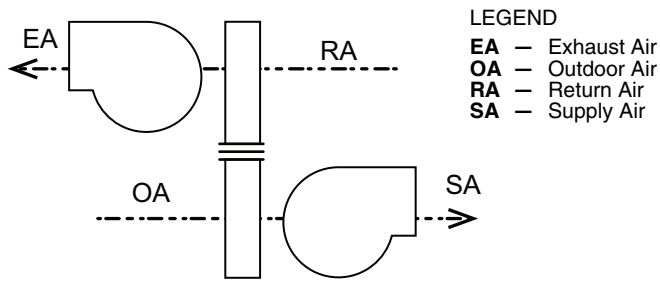
Effectiveness

Varying the energy wheel's effectiveness can be accomplished by bypassing some of the exhaust air around the energy wheel with a modulating bypass damper. The energy wheel's performance is based on worst case winter/summer conditions. Therefore, at part load conditions, lowering the effectiveness (decreasing the energy recovered from the exhaust airstream) is essential in optimizing system control and comfort.

Methods

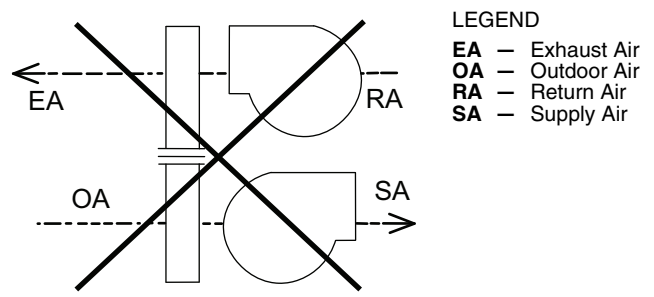
Using a simple damper and actuator to bypass the air around the wheel is the most economical way to accomplish capacity control. See Fig. 16 and 17.

IMPORTANT: Using a VFD (variable frequency drive) to slow the rotation of the wheel reduces the effectiveness of the wheel and is not recommended due to the material and installation costs, and the requirement of a 3-phase motor that is not available for all wheel sizes.



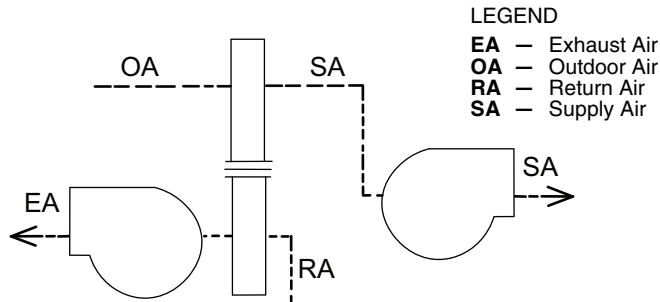
Carrier Recommended Configuration

Fig. 11 — Recommended Indoor Fan Orientation



Arrangement NOT Recommended

Fig. 13 — Improper Fan Orientation



Carrier Recommended Configuration

Fig. 12 — Recommended Outdoor Fan Orientation

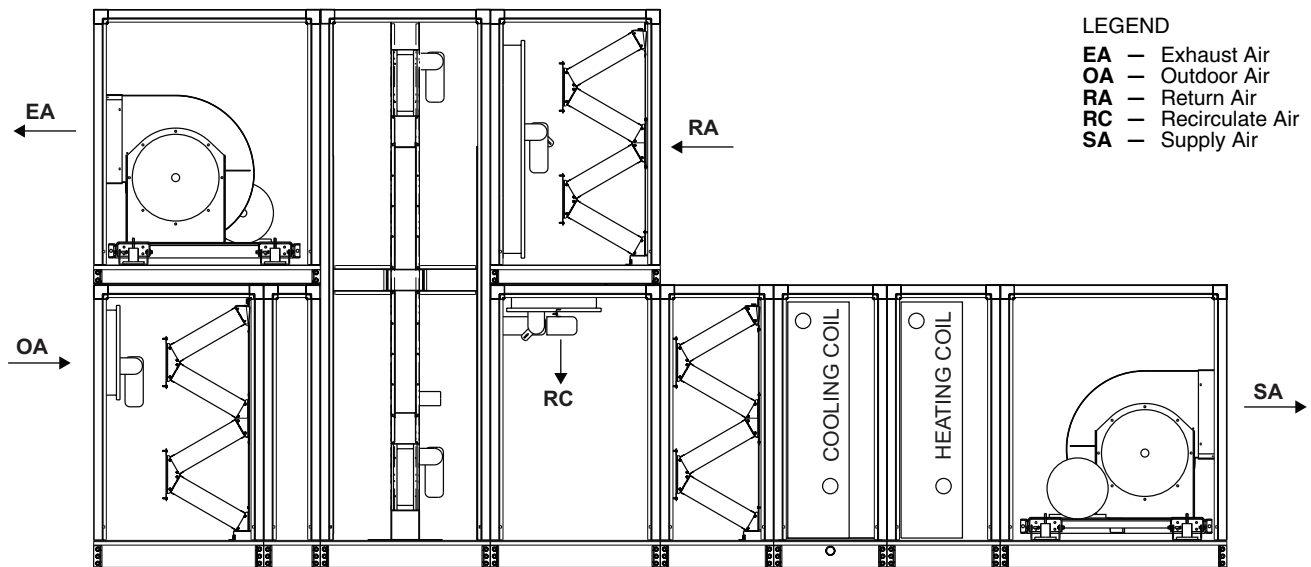


Fig. 14 — Typical 39MN Indoor Horizontal Air Handler with Energy Recovery Section

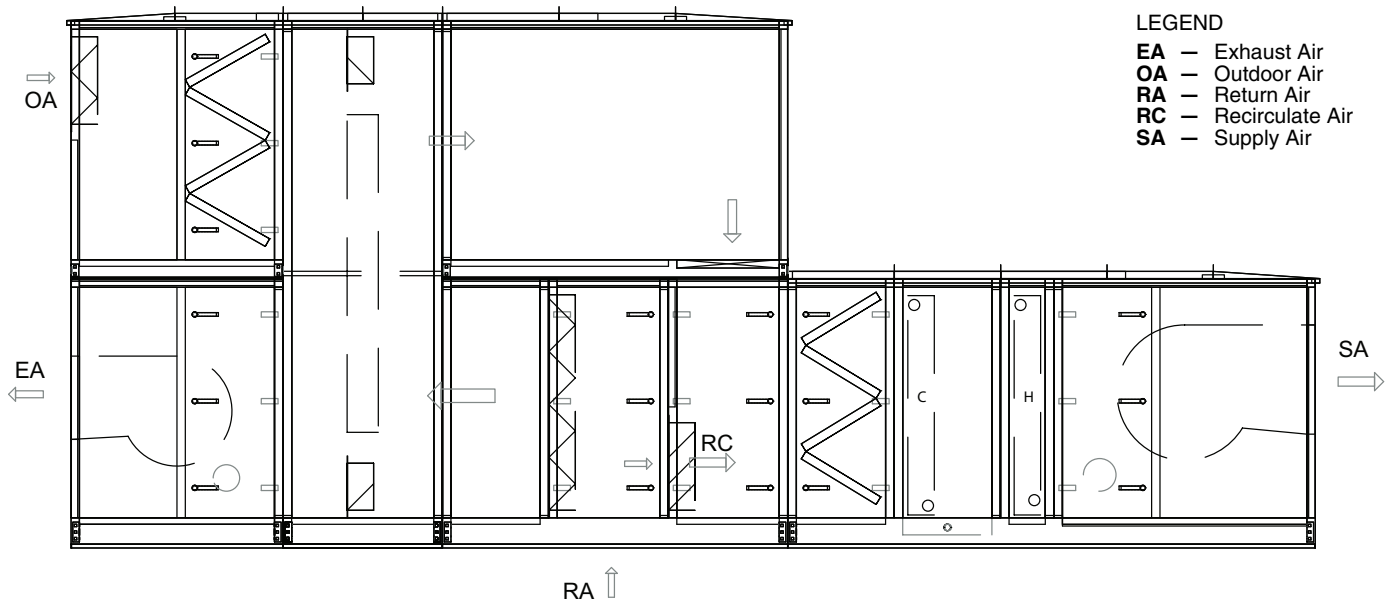


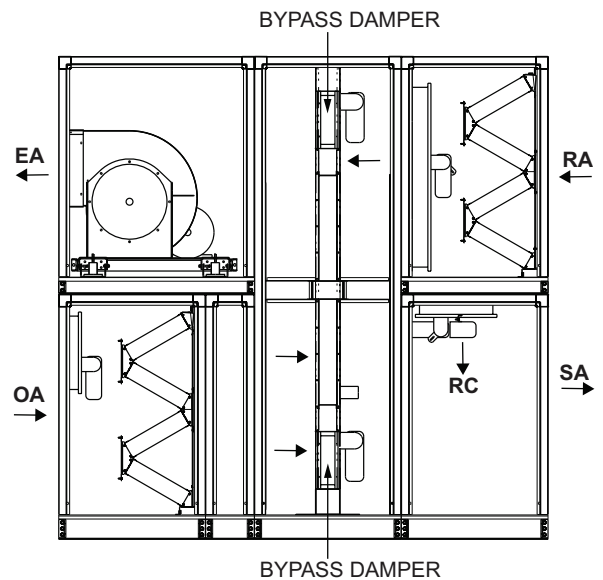
Fig. 15 — Typical 39MW Outdoor Horizontal Air Handler with Energy Recovery Section

All energy recovery sections will come equipped with bypass dampers that can be used in varying the effectiveness, bypassing for frost control and economizing when the outdoor-air temperature is at or below the economizing set point.

Modulating bypass dampers are the best choice for controlling the supply-air temperature when the outdoor-air temperature is below the economizing set point and below the return-air temperature. Not only do the dampers keep the system simple, they also provide a more stable temperature control than VFDs and are easy to install and maintain.

When To Use Bypass Dampers

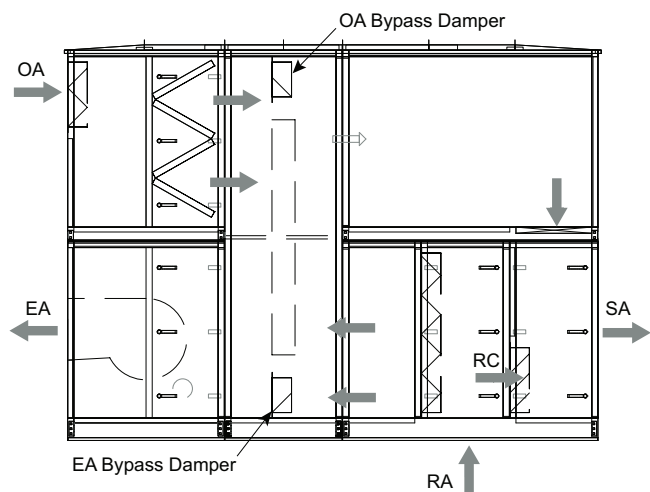
Varying the wheel's effectiveness with bypass dampers is best used when controlling to a discharge-air temperature set point (discharge air reset control) in applications where cooling is required for variable air volume (VAV) or for multiple zones. Modulating the bypass damper of the exhaust side of the system ensures that just enough energy transfer takes place without compromising the minimum ventilation requirements of the space. For example, in winter when the outdoor-air temperature is 12°F, the return-air temperature is 70°F and the required discharge-air temperature is 55°F, the energy wheel could recover just enough heat via the modulating bypass damper to maintain an acceptable discharge air set point on the supply side without using mechanical cooling. See Fig. 18 and 19.



LEGEND

- EA — Exhaust Air
- OA — Outdoor Air
- RA — Return Air
- RC — Recirculate Air
- SA — Supply Air

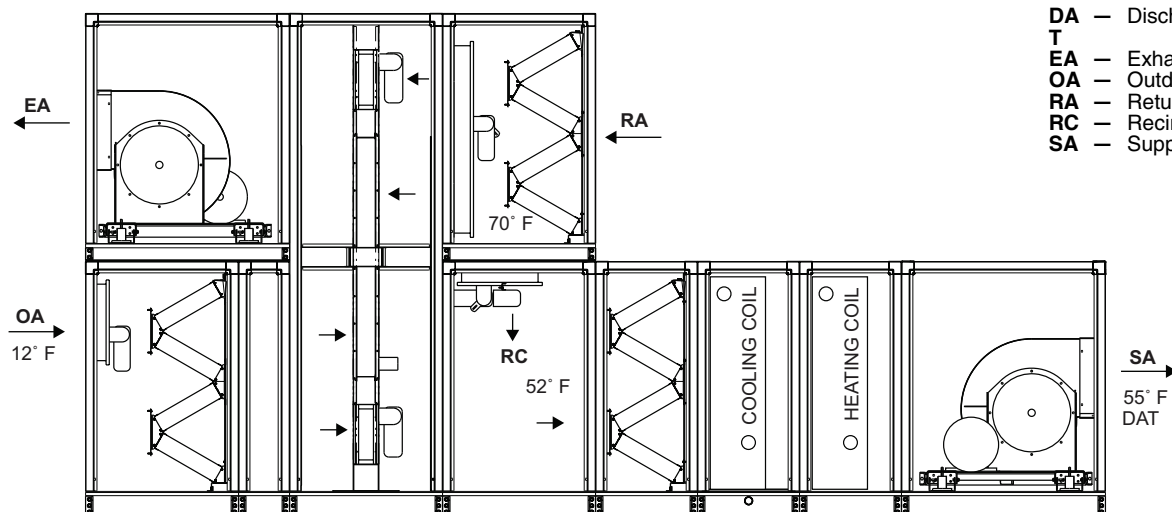
Fig. 16 — 39MN Indoor Recovery Section with Outdoor Air and Exhaust Air Bypass Dampers



LEGEND

EA — Exhaust Air
 OA — Outdoor Air
 RA — Return Air
 RC — Recirculate Air
 SA — Supply Air

Fig. 17 — 39MW Outdoor Energy Recovery Section with Outdoor Air and Exhaust Air Bypass Dampers



LEGEND

DA — Discharge Air Temperature
 T
 EA — Exhaust Air
 OA — Outdoor Air
 RA — Return Air
 RC — Recirculate Air
 SA — Supply Air

Modulating exhaust bypass dampers allow for good temperature control when economizing.
 DAT set point = 55°F.

Fig. 18 — 39MN Indoor ERV Wheel Bypass Dampers within a Complete Energy Recovery Application

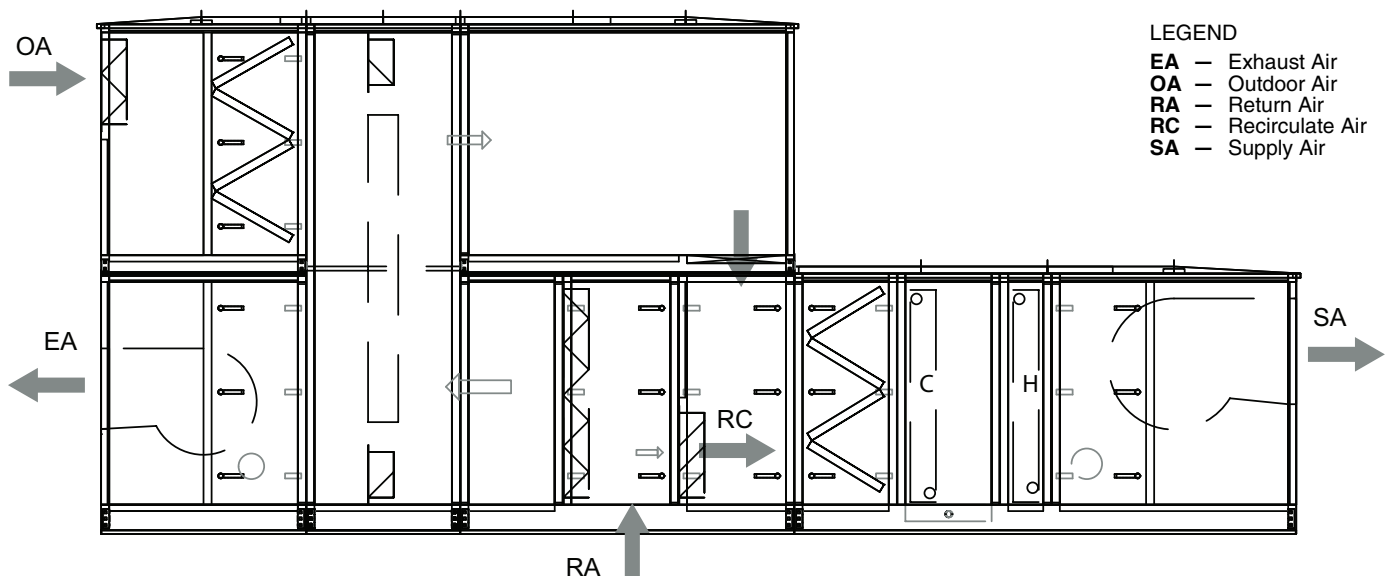
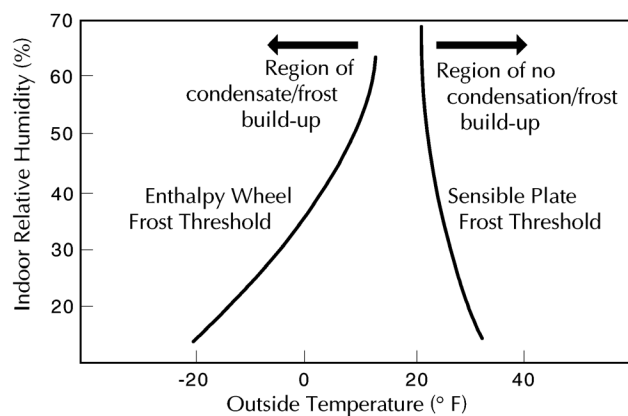


Fig. 19 — 39MW Outdoor ERV Wheel Bypass Dampers within a Complete Energy Recovery Application

FROST CONTROL REQUIREMENTS

Energy recovery systems require frost protection or a means of de-frosting in climates that experience severe winter conditions. Frost formation results in a reduction and eventual blockage of airflow through the energy wheel. The temperature below which frost formation occurs is referred to as the frost threshold temperature, and is a function of both outdoor-air temperature and indoor relative humidity.

Frost formation causes reduced airflow through the heat exchanger. Without frost control, energy recovery and airflow may be significantly reduced. The frost threshold temperature is the point at which frost begins to accumulate on heat exchanger surfaces. Figure 20 compares the frost threshold of a plate-type sensible heat exchanger with that of an enthalpy wheel.



**Frost Thresholds:
Enthalpy Wheels vs. Plate-type Heat Exchangers**

Fig. 20 — Frost Threshold Comparison

Note that frost forms at temperatures between 22°F and 30°F in a plate-type heat exchanger. Frost threshold temperatures for enthalpy wheels are generally 20 to 30 degrees lower, approximately 0°F to 20°F. This is because the enthalpy wheel removes water from the exhaust airstream, effectively lowering the exhaust's dew point. The water removed is subsequently picked up through desorption by the entering outdoor air.

Depending on the indoor relative humidity in areas where winter outside temperatures are between -5°F and 22°F, enthalpy wheel based recovery systems have a significant advantage over sensible

plate type units because there is no additional cost for frost control. Even in cold areas, in most cases, enthalpy wheel based systems for schools and office buildings can be designed without frost control because most of the frosting hours are at night when the building is unoccupied. Consult bin data, such as that provided by ASHRAE, to qualify daytime applications in cold climates for frost-free operation.

Table 2 lists typical frost threshold temperatures for the total energy recovery wheels over a wide range of indoor-air temperatures and relative humidities. Frost control is not required until outdoor-air temperatures are below the threshold.

Table 2 — Frost Thresholds Temperatures (°F)

INDOOR AIR RH (%)	INDOOR AIR DRY BULB TEMPERATURE			
	70°F	72°F	75°F	80°F
20	-14	-13	-11	-8
30	-3	-2	-1	3
40	5	7	9	11
50	12	13	15	18
60	18	19	21	26

LEGEND

RH — Relative Humidity

In regions where winter temperatures are extreme, the total energy recovery wheels can be used effectively with specific frost control strategies, such as:

- Preheat frost control, a universally applicable strategy which meets all design requirements.
- Variable effectiveness with bypass, which can be used in a limited number of applications. Wheel speed control is not recommended.
- On/Off control.
- Exhaust only.

NOTE: Refer to ASHRAE for bin data in cold climates where the threat of wheel frosting is frequent. Consult this information to ensure appropriate preheat techniques are used during occupied times.

Frost Prevention Methods

Frost control is required in extremely cold climates to preserve performance and assure the continuous supply of outdoor air. Enthalpy wheel frost control strategies take advantage of inherently low frosting thresholds. This results in minimized energy use and

maximized design load reductions. In regions that experience extreme winter conditions, total energy wheels can provide continuous frost-free operation if provided with controls to avoid reaching the frost threshold temperature. Carrier's frost control strategy includes the wheel, coil, and dampers.

PREHEAT FROST CONTROL

Preheat frost control is one of the many methods of preventing frost formation and ensuring design outdoor air ventilation rates for the most extreme winter applications. For continuous operation below the frost threshold temperature, an electric preheat coil may be configured into the energy recovery section in the outdoor airstream just before the energy wheel. Alternate method of wheel frost control is to configure the energy recovery section with a hot water or steam coil in the exhaust airstream just before the energy wheel. The frost control heating coil should be controlled to maintain a supply-air temperature approximately 5°F above the frost threshold for a given condition.

Refer to Table 3 for the required capacity (F) that is required to ensure that the preheat temperature is where it should be to prevent frost formation.

Note that the required preheat temperature at design is always below the frost threshold for a given condition. This is due to the fact that preheating lowers the relative humidity of the outside air entering the wheel, effectively lowering the frost threshold for any given set of indoor air conditions. This reduces the preheater capacity slightly and minimizes the preheater operating expense at design temperatures.

PREHEAT COIL SIZING

The Btu requirement for preheat is a function of the cfm of incoming outdoor air and the temperature difference (ΔT) between the preheat temperature at the lowest anticipated operating temperature. The Btu requirement will be calculated by the *AHUBuilder*® program with a list of available heat coils to choose from. The Btu requirements may also be calculated with the following formula:

$$\text{Required Btuh} = 1.08 \times \text{cfm} \times \text{desired } \Delta T \text{ (°F)}$$

OR

$$\text{Required Btuh} = 4.121 \text{ l/s} \times \text{desired } \Delta T \text{ (°C)}$$

System outdoor air required: 3200 cfm

For example:

Return air temperature: 70°F

Return air relative humidity: 30%

Outdoor winter design temperature: -5°F

From Table 4, temperature $\Delta T = 6^\circ\text{F}$

$$\text{Btuh} = 1.08 \times \text{cfm} \times \Delta T \text{ (°F)}$$

$$\text{Btuh} = 1.08 \times 3200 \times 6$$

$$\text{Btuh} = 20,736$$

For Electric Heat Coils:

$$\text{Required kW} = 1.08 \times \text{cfm} \times \text{desired } \Delta T \text{ (°F)} / 3414$$

From the example above, kW calculations can be made as follows:

$$\text{Required kW} = 20,736 / 3414 = 6.1 \text{ kW}$$

To effectively control an outdoor air preheat coil to set point, an averaging temperature sensor should be installed at the energy recovery wheel's inlet. The reading from the averaging sensor will be used to control the staging output to the electric heat coil to maintain the design minimum air temperature to the wheel. The averaging sensor must be mounted in a serpentine fashion such that it adequately senses the air temperature leaving the preheat coil. A bullet type or single-point sensor will not suffice in this control scheme.

The preheat set point should correspond to the frost thresholds listed in Table 2.

ON/OFF CONTROL

Use on/off control for intermittent ventilation below the frost threshold temperature. A control scheme would disable the energy wheel system when the outdoor-air temperature drops down to the frost threshold temperature. The system would be controlled on when the outside air conditions permit. On/off control should only be used if the following considerations make intermittent ventilation acceptable:

- Temperatures below the frost threshold (temperature when the natural ventilation rate is highest because of maximum indoor/outdoor temperature differential) occur for a limited amount of time.
- Temperatures below the winter design temperature usually occur during early morning hours. Depending on the application, these low temperatures may only occur during unoccupied periods when ventilation is not required.

EXHAUST ONLY FROST CONTROL

This method allows the exhaust fan to operate below the frost threshold temperature; however, a temperature sensor would disable the supply fan when the outdoor-air temperatures reach the frost control set point. The outdoor-air temperature sensor should be located in the outdoor air intake as close as possible to the intake opening on the ERV section. To avoid depressurization of the space, fresh air dampers may be required as part of the building's ventilation system.

Frost control is required in cold climates to protect energy recovery ventilation components and assure a continuous supply of outdoor air. Frost control strategies for enthalpy wheels should take advantage of their inherent low frosting thresholds and minimize energy use while maximizing design load reductions in airflow. Preheat frost control is a universally applicable strategy, which meets all design requirements. Variable speed control can only be used in a limited number of applications.

Table 3 — Preheat Frost Control Temperatures and Capacity (ΔT) Requirements at Selected Indoor and Outdoor Conditions (°F)

OUTDOOR WINTER DESIGN TEMP (°F)	INDOOR AIR (RETURN) CONDITIONS					
	70 °F and 20% RH		70 °F and 30% RH		70 °F and 40% RH	
	Preheat Temperature Design (°F)	Required Capacity (°F)	Preheat Temperature Design (°F)	Required Capacity (°F)	Preheat Temperature Design (°F)	Required Capacity (°F)
5	—	—	—	—	—	—
0	—	—	—	—	8	8
-5	—	—	1	6	6	11
-10	—	—	-1	9	4	14
-15	-9	6	-3	12	3	18
-20	-11	9	-4	16	2	23
-25	-13	12	-5	20	2	27
-30	-14	16	-6	24	1	31
-35	-15	20	-6	28	1	36
-40	-16	24	-7	33	1	41

LEGEND

RH — Relative Humidity

PERFORMANCE CALCULATIONS

Manual Wheel Selections

The objective of energy recovery ventilation is to pre-treat the incoming outdoor air.

For example:

OA cfm = 4000, Total system design cfm = 10,500

Approximately 38% OA is required for the system design.

Based on the system design cfm, the required unit size will be the 39MN size 21 with a 52-in. standard or high-efficiency energy recovery wheel. The effectiveness for this selection is 70%, the pressure drop is 0.62 in. wg.

The **AHUBuilder®** selection software is the easiest and most accurate way to select energy recovery sections. See Table 4 for wheel models. See Fig. 21 for wheel dimensions.

After the energy wheel size has been determined, the performance data may be used to determine various conditions. The balanced flow equations to use are shown below.

Dry Bulb Temperature:

Cooling: $T_{sa} = T_{oa} - E_s \times (T_{oa} - T_{ra})$

Heating: $T_{sa} = T_{oa} + E_s \times (T_{ra} - T_{oa})$

Humidity Ratio:

Cooling: $W_{sa} = W_{oa} - E_L \times (W_{oa} - W_{ra})$

Heating: $W_{sa} = W_{oa} + E_L \times (W_{ra} - W_{oa})$

Enthalpy:

Cooling: $H_{sa} = H_{oa} - E_T \times (H_{oa} - H_{ra})$

Heating: $H_{sa} = H_{oa} + E_T \times (H_{ra} - H_{oa})$

Where:

T = dry bulb temperature (°F)

W = humidity ratio

H = enthalpy in Btu/lb

oa = outdoor air

ra = return air

sa = supply air

E_s = sensible effectiveness

E_L = latent effectiveness

E_T = total effectiveness

Table 4 — 39MN/MW Unit Wheel Models (Standard and High Efficiency)

ALLOWABLE ERV WHEEL SIZES PER UNIT SIZE						
UNIT SIZE	NOMINAL AIRFLOW (cfm)	SINGLE WHEEL			DUAL WHEEL	
		DIA.	DIA.	DIA.	DIA.	DIA.
03W	1,500	N/A	N/A	25	N/A	N/A
06W	3,000	25	30	36	N/A	30
08W	4,000	30	36	41	N/A	36
10W	5,000	30	36	41	N/A	36
12W	6,000	41	46	52	N/A	41
14W	7,000	41	46	52	N/A	46
17W	8,500	46	52	58	N/A	52
21W	10,500	52	64	68	N/A	52
25W	12,500	58	64	68	N/A	58
30W	15,000	58	68	74	58	68
36W	18,000	68	74	81	N/A	74
40W	20,000	74	81	86	N/A	74
50W	25,000	86	92	99	N/A	81
61W	30,500	92	99	104	N/A	81

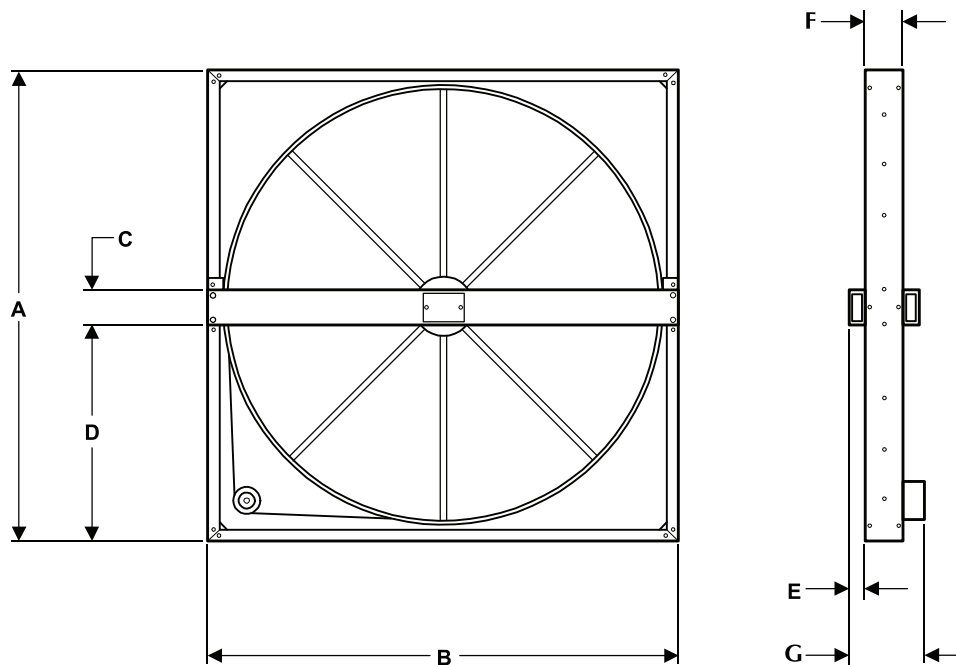
ERV WHEEL OFFERING				
DIA.	STANDARD EFFICIENCY		HIGH EFFICIENCY	
	OA Cfm Range ^a	Wheel Model	OA Cfm Range ^a	Wheel Model
25	600-1,400	ERC-2513C	400-1,150	ERC-2510C
30	900-2,000	ERC-3019C	600-1,600	ERC-3014C
36	1,400-3,900	ERC-3628C	1,000-2,700	ERC-3622C
41	1,800-4,800	ERC-4136C	1,400-3,400	ERC-4128C
46	2,200-6,000	ERC-4646C	1,600-4,200	ERC-4634C
52	3,000-8,250	ERC-5262C	2,250-5,750	ERC-5248C
58	3,500-10,000	ERC-5874C	2,750-7,000	ERC-5856C
64	4,000-12,000	ERC-6488C	3,000-8,000	ERC-6475C
68	5,000-13,500	ERC-68100C	3,500-9,500	ERC-6876C
74	6,000-16,000	ERC-74122C	4,500-11,000	ERC-7490C
81	7,000-19,500	ERC-81146C	5,500-13,500	ERC-81110C
86	8,000-22,000	ERC-86170C	6,000-15,000	ERC-86125C
92	9,000-24,000	ERC-92180C	7,000-17,000	ERC-92135C
99	11,000-29,000	ERC-99215C	8,000-20,000	ERC-99160C
104	12,000-31,000	ERC-104250C	9,000-22,000	ERC-104195C

NOTE(S):

a. OA cfm range is for reference only. Cfm maximum occurs when flow results in 1.25 in. wg pressure drop across the wheel.

LEGEND

OA cfm — Outdoor Air cfm



WHEEL MODEL SERIES	WHEEL DEPTH (in.)	DIMENSIONS (in.)							MAX. WGT. (lb)	WHEEL TYPE
		A	B	C	D	E	F	G		
ERC-25	3	29.00	29.00	2.08	13.50	2.24	2.49	5.91	36	Segmented
ERC-30	3	34.00	34.00	2.08	15.98	2.24	2.49	5.91	61	Segmented
ERC-36	3	39.82	39.82	2.82	18.50	1.31	4.36	10.82	118	Segmented
ERC-41	3	44.00	44.00	4.27	19.87	1.58	4.36	11.08	170	Segmented
ERC-46	3	50.00	50.00	4.27	22.87	1.58	4.36	11.08	185	Segmented
ERC-52	3	56.19	56.19	4.27	26.00	1.58	4.36	11.08	220	Segmented
ERC-58	3	62.42	62.42	5.00	28.71	2.05	6.07	14.84	320	Segmented
ERC-64C	3	68.00	68.00	5.00	31.50	2.05	6.07	14.06	344	Segmented
ERC-68C	3	72.00	72.00	6.00	33.00	2.05	7.07	15.34	408	Segmented
ERC-74C	3	78.00	78.00	7.00	36.00	2.05	7.07	14.56	454	Segmented
ERC-81C	3	85.00	85.00	7.00	39.00	2.05	7.07	15.56	580	Segmented
ERC-86C	3	91.00	91.00	7.00	42.00	3.05	10.00	17.24	656	Segmented
ERC-92C	3	96.00	96.00	7.00	44.50	3.05	10.00	17.24	858	Segmented
ERC-99C	3	104.00	104.00	7.00	48.50	3.05	10.00	17.24	921	Segmented
ERC-104C	3	108.00	108.00	8.00	50.00	3.30	14.00	19.31	984	Segmented

Fig. 21 — Wheel Dimensions

HVAC System Capacity Reduction

A significant benefit of enthalpy energy recovery is the ability to use it to reduce the size and cost of the chiller and boiler plant.

The following examples show the power of enthalpy recovery in reducing the size of the central plant and its components.

Example 1 (see Fig. 22):

$$\begin{aligned}
 \text{Btuh} &= 4.5 \times \text{Actual cfm} \times (H_{\text{oa}} - H_{\text{sa}}) \\
 &= 4.5 \times 8,000 \times (35 - 29) \\
 &= 216,000 \text{ Btuh} \\
 \text{Tons} &= 216,000 / 12,000 \\
 &= 18 \text{ Tons}
 \end{aligned}$$

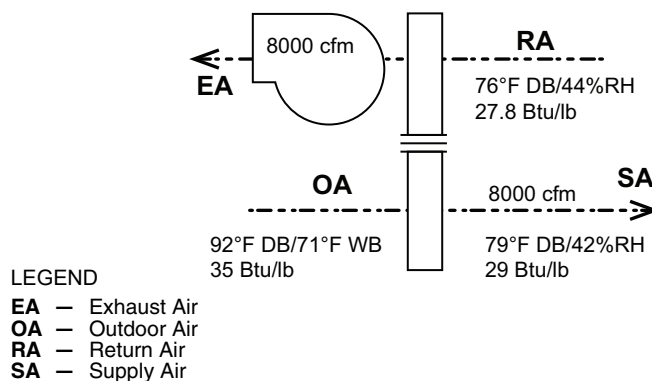
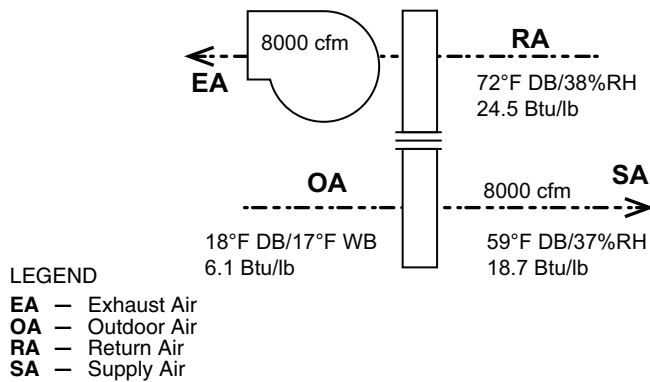


Fig. 22 — Summer Energy Wheel Analysis

Example 2 (see Fig. 23):

$$\begin{aligned}
 \text{Btuh} &= 4.5 \times \text{Actual cfm} \times (H_{\text{oa}} - H_{\text{sa}}) \\
 &= 4.5 \times 8,000 \times (6.1 - 18.7) \\
 &= 453,600 \text{ Btuh} \\
 \text{Boiler HP} &= \text{Btuh} / 33,470 \\
 &= 453,600 / 33,470 \text{ Btuh/hp} \\
 &= 13.6 \text{ hp}
 \end{aligned}$$

**Fig. 23 — Winter Energy Wheel Analysis****SELECTION GUIDELINES FOR ENERGY RECOVERY SYSTEMS**

1. Determine the maximum ventilation air requirements and OA/RA (outdoor air/return air) design conditions for both winter and summer modes.
2. Determine the percentage of total system cfm in the form of ventilation air.
3. Determine the overall 39MN/MW unit size. Effectiveness and pressure drop are based on balanced airflows. If the airflows are unequal, the effectiveness of the higher airflow decreases while that of the lower airflow increases. This system imbalance is made up by infiltration or exfiltration having an energy recovery effectiveness of 0%. Thus, unbalanced flow reduces the benefit of energy recovery for the building system. **AHUBuilder®** selection software will automatically calculate the performance for unbalanced airflow conditions.
4. Determine ERV system configuration. A number of possible ERV configurations are available through the **AHUBuilder** selection software to meet specific requirements.
 - a. Select electric preheat coils or bypass dampers for frost control. Choose from various damper types (standard or premium) including an airflow measuring device.
 - b. Select split return/exhaust section to eliminate the possibility of cross contamination through the recirculation damper.
 - c. Flat or angle filter sections (2-in. or 4-in.) are available to protect the wheel on the exhaust side and standard angle filters are available on the outdoor air intake side of the energy wheel.
 - d. Forward-curved airfoil fans are available to meet design conditions. Select the fan type that best suits those conditions. Variable frequency drives are also available as a standard option on fans only.
5. Run the selection software to obtain the proper wheel model and performance.

Once the design conditions and ventilation requirements are known, the **AHUBuilder** program will calculate the wheel effectiveness, pressure drops, supply air conditions from the

wheel, and total energy recovered in Btuh for both heating and cooling seasons. The supply air conditions from the wheel will be sent to the **AHUBuilder** mixed air calculator. The mixed air conditions are forwarded to the coil performance screens and used in coil selections. The conditions that the mixed air calculator generates should never be altered, as system performance will be invalidated.

Total Energy Wheel Selection Software

The energy wheel selection software has been integrated into **AHUBuilder** selection software to help the sales engineer and designer in selecting the proper energy wheel size and type. The selection software allows the designer to specify an energy wheel based on system airflow and its resulting effectiveness.

A simple calculation performed by **AHUBuilder** selection software will provide the supply air conditions from the energy recovery wheel and use that data in calculating the total energy recovered in Btuh for both summer and winter conditions. The calculated total energy recovered is based on ASHRAE bin data analysis of the ventilation loads. The supply air conditions off the wheel are also used in determining the mixed condition of the air before entering the air handler. These calculated mixed air conditions are forwarded to all coil performance screens and may result in a noticeable reduction in coil capacity.

TOTAL ENERGY RECOVERY SYSTEM CONTROL**Introduction**

This section provides some sample control operating sequences for the energy recovery sections. There are many configurations available with the Aero® 39MN/MW energy recovery section and, depending upon the application, additional options may be required to get the desired performance.

Section Features

The following energy recovery section (see Fig. 16 or 17) combines a total energy recovery wheel, bypass dampers, and a return-air damper to favorably condition the incoming ventilation air. The energy recovery section recovers both sensible (temperature) and latent (moisture) energy from the return airstream before it is exhausted to the outdoors.

As air enters the section through the outdoor-air damper, it is filtered and enters the wheel section. The bypass dampers located above and below the wheel control the amount of outside air and exhaust air passing through the wheel media. The modulating bypass damper feature enables the air-handling unit to fully economize when the outdoor-air temperature is less than the economizing set point. Using the bypass dampers allows the unit to pull 100% airflow through the wheel section without exceeding the wheel airflow limits. Varying the amount of energy recovered through the wheel can significantly reduce the load on the downstream heating and cooling coils. Wheel effectiveness is controlled by the exhaust bypass damper by transferring just enough heat from the exhaust air chamber to the outside air chamber to maintain a good mixed-air temperature.

As the wheel rotates between the return and outdoor air chambers, the higher temperature airstream gives up its sensible energy to the wheel, which in turn releases the sensible energy to the cooler airstream on the second 180 degrees of rotation.

Within the wheel, moisture is transferred by means of adsorption. The silica gel desiccant imbedded into the wheel media has superior moisture handling capabilities in the working range above 30% relative humidity. Silica gel energy wheels transfer water by rotating between 2 airstreams of different vapor pressures. The vapor pressure differential drives water molecules into or out of the desiccant material to transfer moisture from the more humid airstream to the drier airstream.

Total Energy Recovery Methods

HEAT RECOVERY

During heat recovery operation, the wheel rotates continuously, the outdoor-air damper modulates to the predetermined minimum position, and the OA (outdoor air) bypass damper modulates to its closed position. The exhaust bypass damper modulates to control the energy transfer, which varies the supply temperature of the wheel to maintain the mixed-air temperature at the mixed air set point.

HEAT RECOVERY WITH ELECTRIC PREHEAT COIL (FOR FROST PREVENTION)

The outdoor-air temperature is below the frost control set point. The wheel will rotate continuously and the electric heat coil will be staged to maintain the preheat temperature at set point. The outdoor-air damper will be closed and the exhaust bypass damper will close or modulate as necessary to maintain the mixed-air temperature at set point. See Fig. 24 or 25.

HEAT RECOVERY WITH BYPASS (FOR FROST PREVENTION)

The outdoor-air temperature is below the frost control set point. The wheel will rotate continuously and the exhaust bypass damper will modulate to vary the effectiveness of the wheel to prevent the exhaust air from being cooled down below the saturation point. The OA bypass damper will modulate open to bypass the cold air

and prevent the wheel from frosting. The recirculation damper will modulate with the OA damper to maintain the mixed-air temperature at set point. See Fig. 18 and 19.

COOLING WITH ENERGY RECOVERY

The outdoor air enthalpy is high, or the outdoor-air temperature is above the outdoor air economizing set point and the return-air temperature. The wheel rotates continuously in the occupied mode. The cooler return air will be picked up by the wheel media and transferred to cool the warmer ventilation air.

COOLING WITHOUT ENERGY RECOVERY

The outdoor air enthalpy is low, or the outdoor-air temperature is below the return-air temperature, but above the economizing set point. The energy wheel will be disabled during this mode of operation and bypass dampers will be opened. The mixing dampers will modulate to 100% OA.

COOLING ECONOMIZER WITH OUTDOOR AIR

The outdoor air enthalpy is low and the outdoor-air temperature is below the return-air temperature and below the economizing set point. The wheel will be disabled during this mode of operation. The OA damper and recirculation ("recirc") damper will modulate to maintain the mixed-air temperature to set point. See DCV Control Methods section for additional information on controlling the outdoor-air damper.

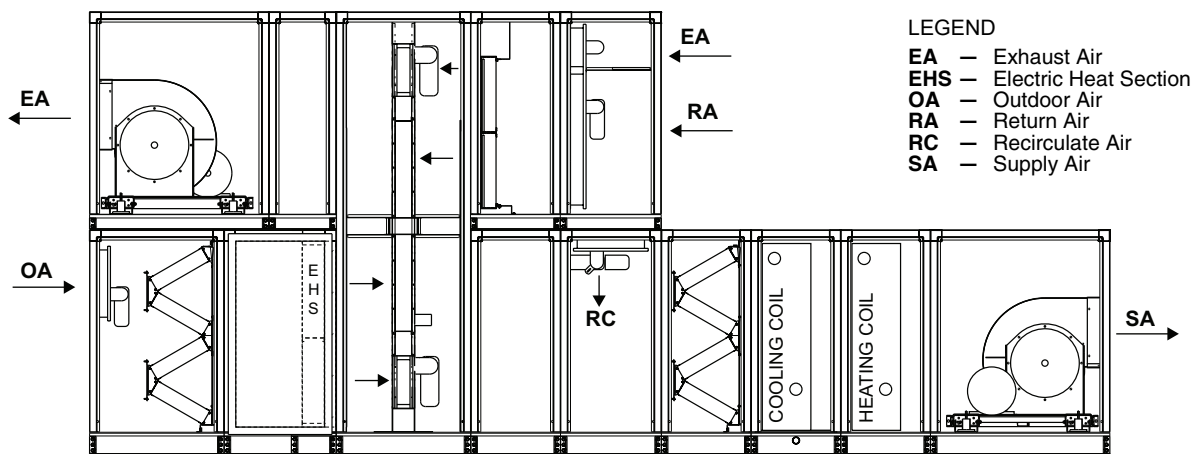


Fig. 24 — 39MN Indoor Frost Prevention Using an Electric Heat Coil in the Outside Air Stream

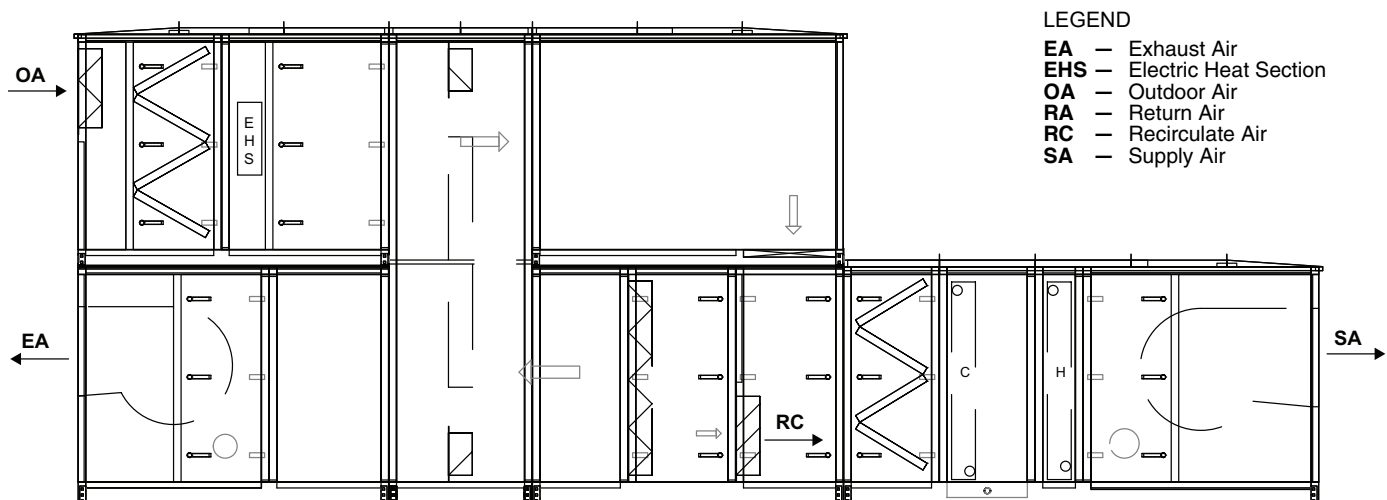


Fig. 25 — 39MW Outdoor Frost Prevention Using an Electric Heat Coil in the Outside Air Stream

TOTAL ENERGY RECOVERY WHEEL

The energy wheel will run continuously whenever the air-handling unit is in the occupied heating or occupied cooling mode. The wheel will be disabled and the OA dampers will close when the building is in the unoccupied mode. In the event the outside-air temperature sensor fails, the energy wheel will continue to operate, the bypass dampers will modulate to their closed position, and an alarm signal will be sent by the system control panel.

WHEEL BYPASS DAMPER CONTROL:

Outdoor Air (OA) Chamber

- During *Cooling with Energy Recovery* mode of operation, the bypass damper will be fully closed. This ensures that all incoming outdoor air is completely conditioned by the energy wheel.
- During *Cooling without Energy Recovery* or *Cooling Economizer with Outdoor Air* modes of operation, the bypass damper will be fully open.
- During *Heat Recovery* (all modes), the bypass damper will modulate to its closed position.

Exhaust Air (EA) Chamber

- During *Cooling with Energy Recovery* mode of operation, the bypass damper will be fully closed. This ensures maximum possible energy recovery by directing all cooler exhaust air through the wheel.
- During *Cooling without Energy Recovery* or *Cooling Economizer with Outdoor Air* modes of operation, the bypass damper will be fully open.
- During *Heat Recovery* (all modes), the bypass damper will modulate to its closed position.

SYSTEM LAYOUTS

The total energy wheel may require frost control in climates experiencing severe winter conditions. Frost build-up on the energy wheel results in an eventual blockage of airflow through the energy wheel media.

One method of preventing frost control in severe winter conditions is shown in Fig. 26 and 27, where the system layout includes an electric heat coil in the outside airstream to provide just enough sensible heat to prevent the wheel from frosting.

For example: Winter outdoor air and return air design conditions in Chicago, IL, are -4°F dry bulb (db)/ -5°F wet bulb (wb) and 72°F (db)/ 54°F (wb), respectively. The relative humidity at these conditions is approximately 28%. Based on the data from Table 3, the frost threshold temperature is approximately -3°F . The

required preheater capacity is around 1°F . The preheat coil in the outdoor airstream lowers the relative humidity of the outdoor air entering the wheel, which lowers the frost threshold of the indoor air conditions. This configuration is ideal for applications that do not have hot water available.

This configuration also incorporates a split return section that allows the polluted exhaust airflow to be separated from the cleaner return air via a separating baffle plate. The baffle plate prevents the contaminated exhaust air from mixing with the return air and dropping down into the recirculation damper, ultimately reaching the occupied space. **Exhaust air should not be biologically or chemically contaminated.**

The energy recovery system layout shown in Fig. 18 and 19 uses bypass dampers to prevent frosting. The exhaust bypass damper modulates to vary the effectiveness of the wheel and prevents the exhaust air from being cooled below the saturation point. The outdoor air bypass damper will modulate open to bypass the cold air and prevent the wheel from frosting. The recirculation damper modulates with the outdoor-air damper to maintain mixed-air temperature at set point.

This configuration also incorporates a full open return air intake angle filter section, which is ideal for systems where there is no threat of contaminated exhaust air.

As in Fig. 24 and 25, the example shown in Fig. 26 and 27 shows an energy recovery system layout with an electric heat coil in the outside airstream. The same conditions (Chicago, IL, example) apply to this configuration.

In addition to the electric heat coil, this configuration incorporates a full open return air intake angle filter section, which is ideal for systems where there is no threat of contaminated exhaust air. However, for applications with contaminated exhaust air, and to eliminate cross transfer, the standard exhaust fan section with optional top inlet opening will direct the contaminated exhaust out of the building, steering it clear of the energy wheel.

The energy recovery system configuration shown in Fig. 28 and 29 also uses bypass dampers to prevent frosting. This configuration is ideal for a tight mechanical room where a smaller air handler footprint is accomplished by stacking the fan section.

As in the previous example, this configuration also incorporates a full open return air intake, angle filter section, which is ideal for systems where there is no threat of contaminated exhaust air.

Alternate method of frost control when application has hot water or steam available is shown in Fig. 30 and 31, where system layout includes a hot water or steam coil to provide heat to the wheel in the exhaust airstream.

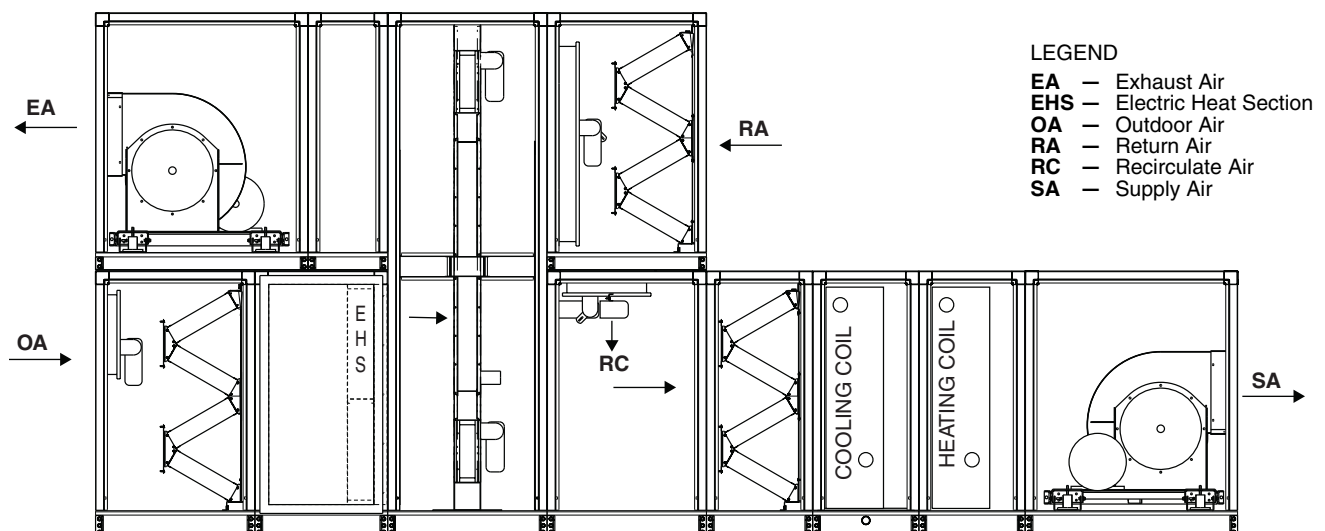


Fig. 26 — 39MN Indoor Frost Prevention Using an Electric Heat Coil and Full Open Return Air Intake

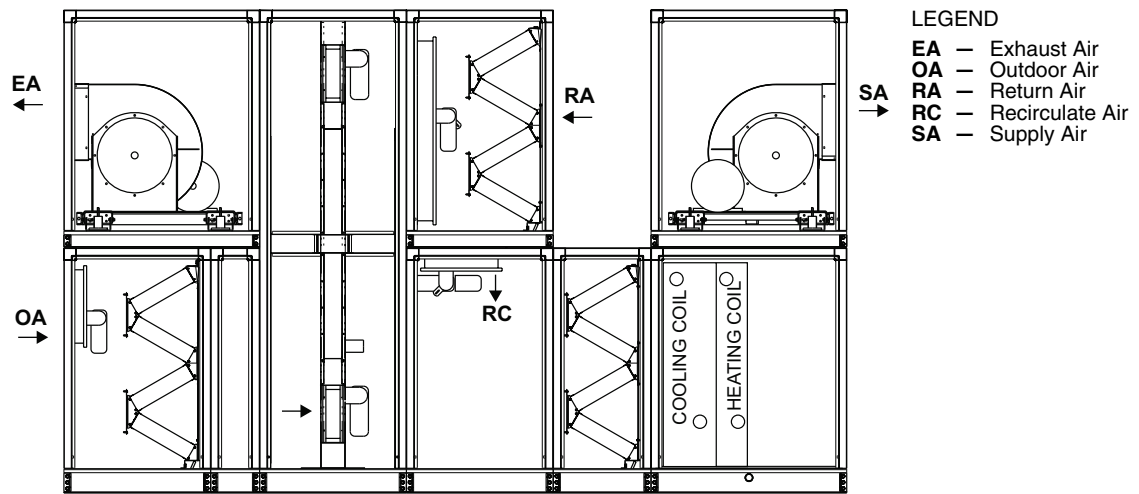


Fig. 27 — 39MN Indoor Frost Prevention Using Bypass Dampers — Smaller Air Handler Footprint

DEMAND CONTROLLED VENTILATION

Carbon dioxide ventilation control or demand controlled ventilation (DCV) allows for the measurement and control of outside air ventilation levels to a target cfm/person ventilation rate (15 cfm/person) in the space based on the number of people in the space. It is a direct measure of ventilation effectiveness and is a method whereby buildings can regain active and automatic zone level ventilation control and avoid the cost often related to over ventilating a building.

Carbon dioxide (CO₂) based ventilation control is a dynamic system that responds to how the building is used and occupied. It is a real time control approach that offers a vast improvement over ventilating a building at a fixed rate based on an assumption that the space is always occupied. The fixed ventilation approach depends on a set-it-and-forget-it methodology that is completely unresponsive to changes in the way spaces are used or how equipment is maintained.

Carrier Corporation believes that ventilation control with CO₂ (CO₂ DCV) is an important building control technique that can be applied to most buildings and types of building occupancies.

DCV on Variable Air Volume (VAV) Systems

Using VAV systems with active ventilation control with CO₂ provides a high degree of comfort to multi-zone spaces. By integrating zone control of both temperature and ventilation, it is possible to measure and control ventilation to ensure that adequate fresh air is actually delivered to all spaces. Zone ventilation control with DCV removes the traditional dependence that ventilation has had on space conditioning load. It is now possible to control fresh air and space conditioning to a zone independently using the same VAV box. The result is that the design engineer does not have to oversize outside air intake capacity to handle low load conditions. Significant energy can be saved over traditional VAV approaches.

Carbon dioxide (CO₂) based DCV is an economical means of providing outdoor air to occupied spaces at the rates required by local building codes and ASHRAE Standard 62, "Ventilation for Acceptable Indoor Air Quality." Engineers and building owners both grieve the high cost of conditioning outdoor air, and the inexact control methodologies that often result in significant over ventilation of spaces. Demand controlled ventilation offers designers and building owners an ability to monitor both occupancy and ventilation rates in a space to ensure there is adequate ventilation at all times.

DCV CONTROL METHODS

The energy recovery system sequence of operations is unchanged by the incorporation of DCV. The CO₂ sensors may override the normal thermal controls and airflow measuring system (if used) in some situations. The sequences included below discuss the ventilation functions only and must be added to the designer's description of thermal controls to create complete operating sequences.

Constant Volume — Purge Cycle

At air handler start-up, the outdoor-air damper shall open, initiating a timed purge cycle. The outdoor-air damper shall modulate to maintain a predetermined percentage of outdoor air. The purge cycle shall be adjustable and set for a predetermined period of time.

The air handler controller shall modulate its preheat coil to maintain the discharge-air temperature set point if the mixed-air temperature falls below the discharge-air temperature set point. At the conclusion of the timed purge cycle, the outdoor-air damper shall modulate closed to maintain a predetermined base ventilation rate and the DCV control algorithm shall be enabled.

Constant Volume — Single and Multi-Zone Applications

All zones served by the air-handling unit shall be polled and the highest CO₂ sensor reading will be taken by the air handler controller and used to control the outdoor-air damper. The worse case CO₂ reading shall be compared to the CO₂ set point at the unit controller. If the reading is below set point, the air handler shall maintain the predetermined minimum outdoor-air damper position. If the reading is above set point, the air handler controller shall modulate the outdoor-air damper open to increase the amount of ventilation to the space and reduce the CO₂ concentration. Once the CO₂ levels drop below set point, the outside-air dampers shall modulate to maintain the base ventilation rate.

The economizer function is enabled when the air handler controller determines that it is beneficial to use outside air for cooling the space. Once the economizer function is enabled, as commanded by the air handler controller, the outdoor-air damper will modulate between minimum position and fully open to maintain the discharge-air temperature at the economizing set point.

Variable Air Volume Systems

Each zone controller shall include the inherent ability to override the temperature control loop and modulate the VAV box's damper based on a CO₂ sensor and its associated set point schedule. The zone controller shall be capable of maintaining a ventilation set point through a DCV algorithm in conjunction with the air-handling unit to fulfill the requirements of ASHRAE standard, 62-2010 "Ventilation for Acceptable Indoor Air Quality."

The DCV control function shall determine the zone ventilation airflow based on the CO₂ zone sensor input value. When the DCV function is enabled, the zone controller shall override (increase) the primary airflow in order to provide additional ventilation as required to maintain the CO₂ set point if the base ventilation airflow is insufficient to meet the zone ventilation requirements. A control algorithm shall be used to determine the required airflow in order to maintain the required ventilation rate in the space (maintain the CO₂ sensor reading at the desired zone set point).

Whenever the air-handling system is in the occupied mode, the air handler controller shall maintain the base ventilation rate (minimum outdoor air damper position) until overridden by the system DCV function.

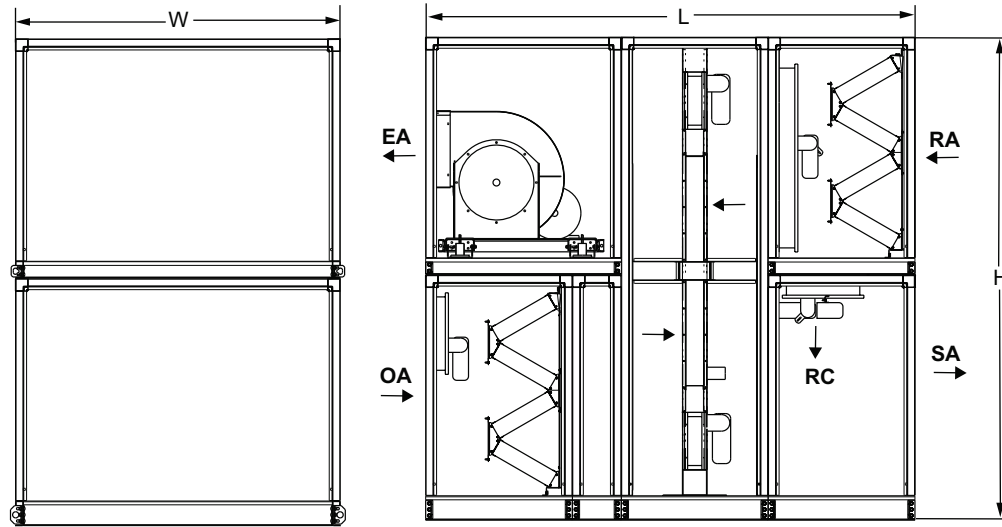
All zone controllers working with a given air-handling unit shall be polled and the highest CO₂ sensor reading will be taken by the air handler controller and used to control the outdoor air damper. The worse case CO₂ reading shall be compared to the CO₂ set point at the unit controller. If the reading is below set point, the air handler shall continue to maintain the base ventilation. If the reading is above set point, the air handler controller shall modulate the outdoor-air damper open to increase the amount of outdoor air ventilation. Once the CO₂ levels drop below set point, the outside-air dampers shall modulate to maintain the base ventilation rate.

The economizer function is enabled when the air handler controller determines that it is beneficial to use outside air for cooling the space. Once the economizer function is enabled, as commanded by the air handler controller, the outdoor-air damper will modulate between minimum position and fully open to maintain the discharge-air temperature at the economizing set point.

Component specific control sequences help to maximize the amount of energy recovered by the total energy recovery wheel section. Additional information on applying and configuring DDC (Direct Digital Control) hardware and software will be available in the Comfort Controller application guide. The Comfort Controller will provide control and monitoring capability in a stand-alone or network environment.

STANDARD CONFIGURATIONS AND PHYSICAL DATA

The following illustrations (Fig. 28-36) show the various Aero® energy recovery system configuration options available.



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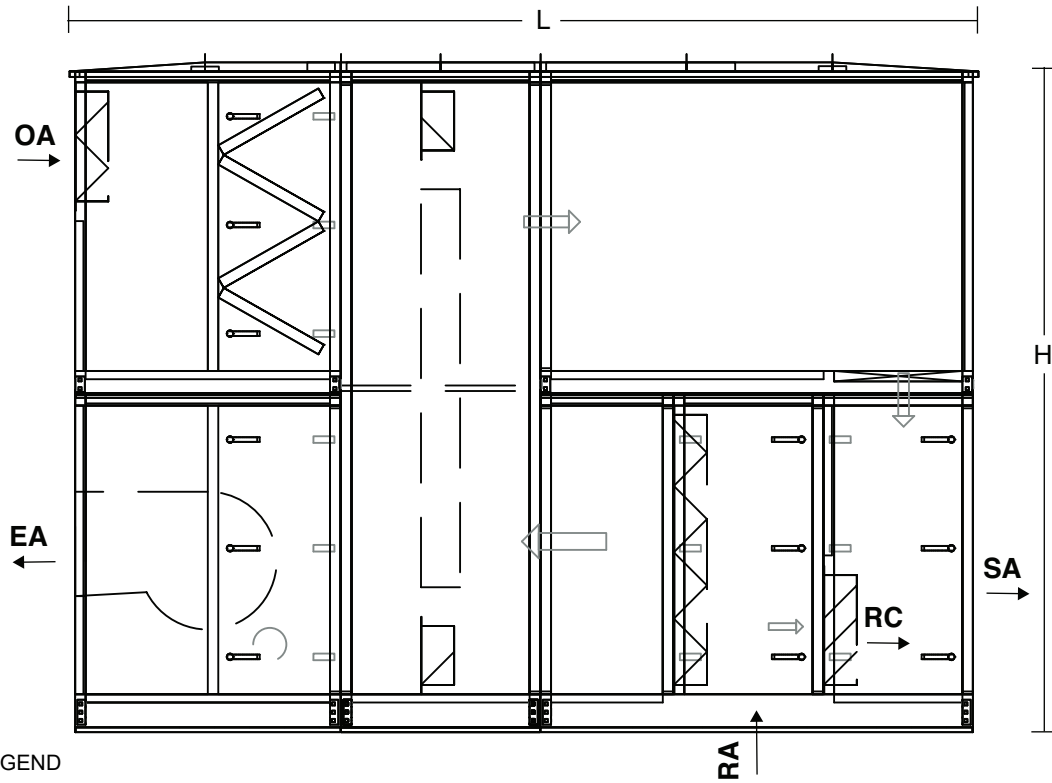
EA — Exhaust Air
 OA — Outdoor Air
 RA — Return Air
 RC — Recirculate Air
 SA — Supply Air

39MN UNIT SIZE	L (in.)	W (in.)	H (in.)
03	102.2	33	72.5
06	102.2	46	72.5
08	108.2	54	78.5
10	108.2	67	78.5
12	108.2	67	92.5
14	114.2	72	92.5
17	120.2	79	98.5
21	120.2	79	118.5
25	138.2	86	118.5
30	138.2	104	118.5

NOTE(S):

1. H = section height including a 6-in. base rail.
2. L = the total airway length of the energy recovery section.
3. Length may vary with section and electrical options. Typical dimensions shown.
4. Energy recovery sections include the largest fan and motor available for each size with a single wheel.
5. Dimensions are subject to change without notice. Refer to the **AHUBuilder®** selection software for current weights, dimensions and configurations.
6. Because of shipping limitations, energy recovery sections in unit sizes 17 and larger will be shipped unstacked.

Fig. 28 — 39MN Indoor ERV Section Assembly without Electric Heat



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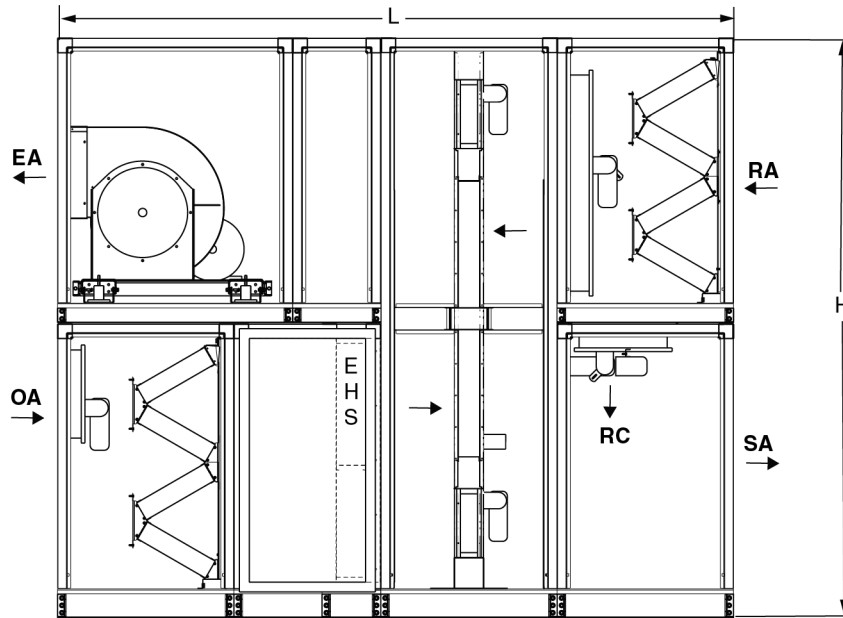
EA — Exhaust Air
OA — Outdoor Air
RA — Return Air
RC — Recirculate Air
SA — Supply Air

39M UNIT SIZE	L, NOMINAL (in.)		W, NOMINAL (in.) (Not Shown)		H, NOMINAL (in.)	
	39MN	39MW	39MN	39MW	39MN	39MW
	INDOOR	OUTDOOR	INDOOR	OUTDOOR	INDOOR	OUTDOOR
03	102.2	N/A	33	35	72.5	75.0
06	102.2	N/A	46	48	72.5	75.2
08	108.2	N/A	54	56	78.5	81.3
10	108.2	N/A	67	69	78.5	81.5
12	108.2	N/A	67	69	92.5	95.5
14	114.2	N/A	72	74	92.6	95.6
17	120.2	N/A	79	81	98.5	101.7
21	120.2	N/A	79	81	98.5	121.7
25	138.2	N/A	86	88	118.5	121.8
30	138.2	N/A	104	106	120.5	124.1
36	N/A	N/A	109	111	142.5	146.2
40	N/A	N/A	109	111	154.5	158.2
50	N/A	N/A	117	119	174.5	178.3
61	N/A	N/A	117	119	204.5	208.3

NOTE(S):

1. H = section height including a 6-in. base rail.
2. L = the total airway length of the energy recovery section.
3. Length may vary with section and electrical options. Typical dimensions shown.
4. Energy recovery sections include the largest fan and motor available for each size with a single wheel.
5. Dimensions are subject to change without notice. Refer to the **AHUBuilder®** selection software for current weights, dimensions and configurations.
6. Because of shipping limitations, energy recovery sections in unit sizes 17 and larger will be shipped unstacked.

Fig. 29 — 39MW Outdoor ERV Section Assembly without Electric Heat



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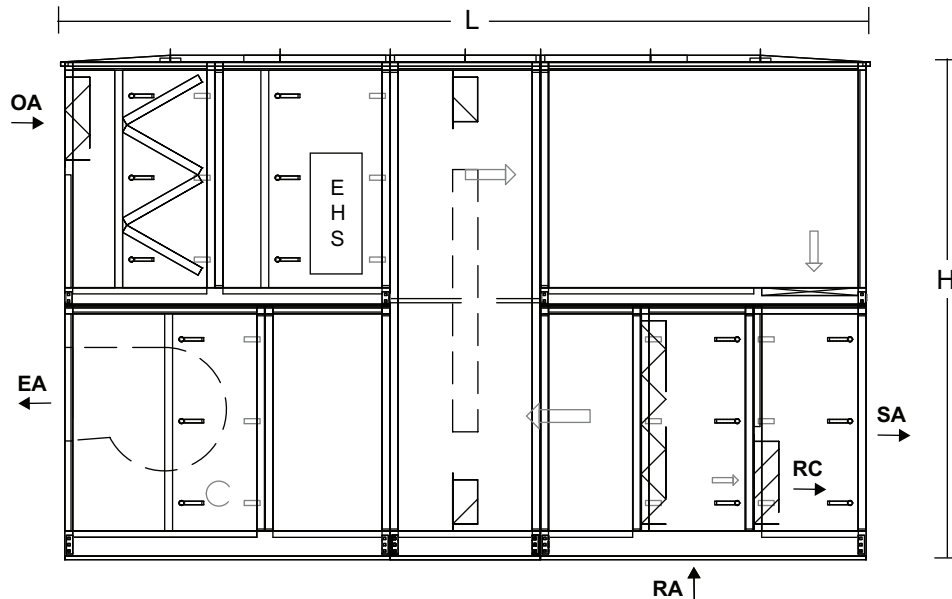
EA — Exhaust Air
EHS — Electric Heat Section
OA — Outdoor Air
RA — Return Air
RC — Recirculate Air
SA — Supply Air

39MN UNIT SIZE	L (in.)	W (in.) (Not Shown)	H (in.)
03	126.3	33	72.5
06	132.3	46	72.5
08	138.3	54	78.5
10	138.3	67	78.5
12	138.3	67	92.5
14	132.3	72	92.5
17	138.3	79	98.5
21	138.3	79	118.5
25	138.3	86	118.5
30	138.3	104	118.5

NOTE(S):

1. H = section height including a 6-in. base rail.
2. L = the total airway length of the energy recovery section.
3. Length may vary with section and electrical options. Typical dimensions shown.
4. Energy recovery sections include the largest fan and motor available for each size with a single wheel.
5. Dimensions are subject to change without notice. Refer to the **AHUBuilder®** selection software for current weights, dimensions and configurations.
6. Because of shipping limitations, energy recovery sections in unit sizes 17 and larger will be shipped unstacked.

Fig. 30 — 39MN Indoor ERV Section Assembly with Electric Heat Option



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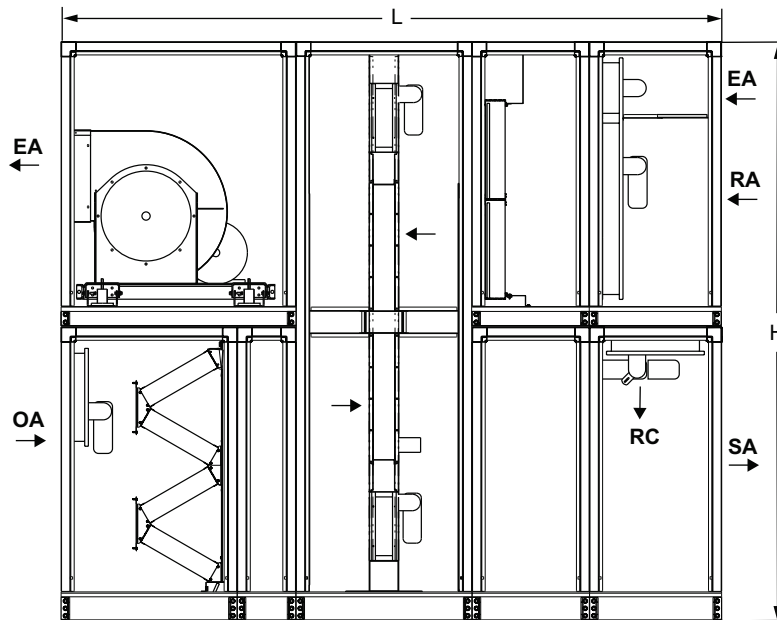
- EA — Exhaust Air
- EHS — Electric Heat Section
- OA — Outdoor Air
- RA — Return Air
- RC — Recirculate Air
- SA — Supply Air

39M UNIT SIZE	L, NOMINAL (in.)		W, NOMINAL (in.) (Not Shown)		H, NOMINAL (in.)	
	39MN	39MW	39MN	39MW	39MN	39MW
	INDOOR	OUTDOOR	INDOOR	OUTDOOR	INDOOR	OUTDOOR
03	126.3	N/A	33	35	72.5	75.0
06	132.3	N/A	46	48	72.5	75.2
08	138.3	N/A	54	56	78.5	81.3
10	138.3	N/A	67	69	78.5	81.5
12	138.3	N/A	67	69	92.5	95.5
14	132.3	N/A	72	74	92.5	95.6
17	138.3	N/A	79	81	98.5	101.7
21	138.3	N/A	79	81	98.5	121.7
25	138.3	N/A	86	88	118.5	121.8
30	138.3	N/A	104	106	120.5	124.1
36	N/A	N/A	109	111	142.5	146.2
40	N/A	N/A	109	111	154.5	158.2
50	N/A	N/A	117	119	174.5	178.3
61	N/A	N/A	117	119	204.5	208.3

NOTE(S):

1. H = section height including a 6-in. base rail.
2. L = the total airway length of the energy recovery section.
3. Length may vary with section and electrical options. Typical dimensions shown.
4. Energy recovery sections include the largest fan and motor available for each size with a single wheel.
5. Dimensions are subject to change without notice. Refer to the **AHUBuilder®** selection software for current weights, dimensions and configurations.
6. Because of shipping limitations, energy recovery sections in unit sizes 17 and larger will be shipped unstacked.

Fig. 31 — 39MW Outdoor ERV Section Assembly with Electric Heat Option



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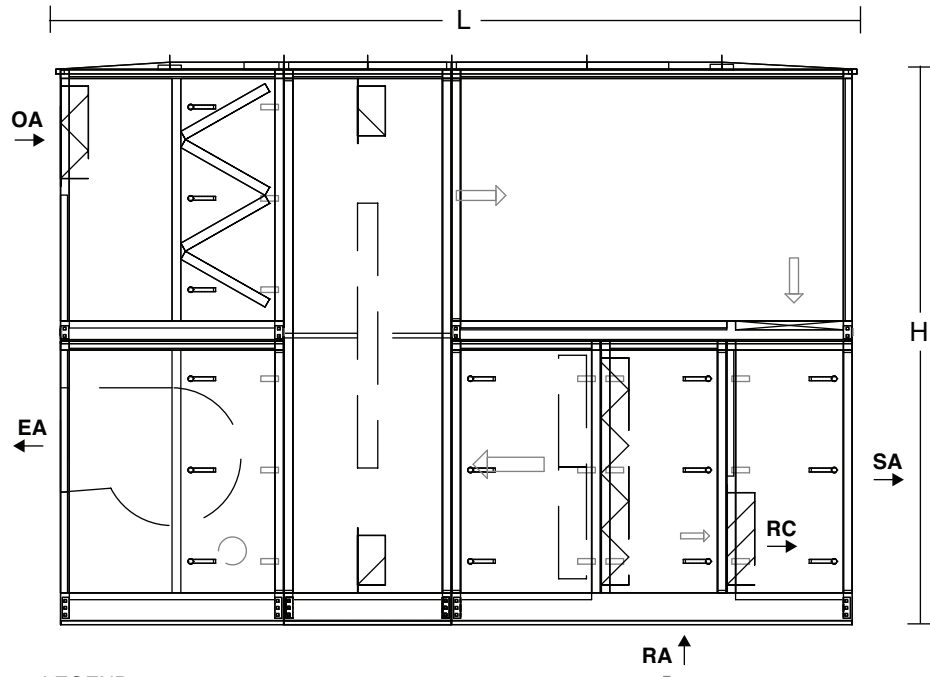
EA — Exhaust Air
 OA — Outdoor Air
 RA — Return Air
 RC — Recirculate Air
 SA — Supply Air

39MN UNIT SIZE	L (in.)	W (in.) (Not Shown)	H (in.)
03	108.3	33	72.5
06	111.3	46	72.5
08	117.3	54	78.5
10	117.3	67	78.5
12	117.3	67	92.5
14	126.3	72	92.5
17	132.3	79	98.5
21	135.3	79	118.5
25	153.3	86	118.5
30	153.3	104	118.5

NOTE(S):

1. H = section height including a 6-in. base rail.
2. L = the total airway length of the energy recovery section.
3. Length may vary with section and electrical options. Typical dimensions shown.
4. Energy recovery sections include the largest fan and motor available for each size with a single wheel.
5. Dimensions are subject to change without notice. Refer to the **AHUBuilder®** selection software for current weights, dimensions and configurations.
6. Because of shipping limitations, energy recovery sections in unit sizes 17 and larger will be shipped unstacked.

Fig. 32 — 39MN Indoor ERV Section Assembly without Electric Heat, with Separate Return and Exhaust Airflow



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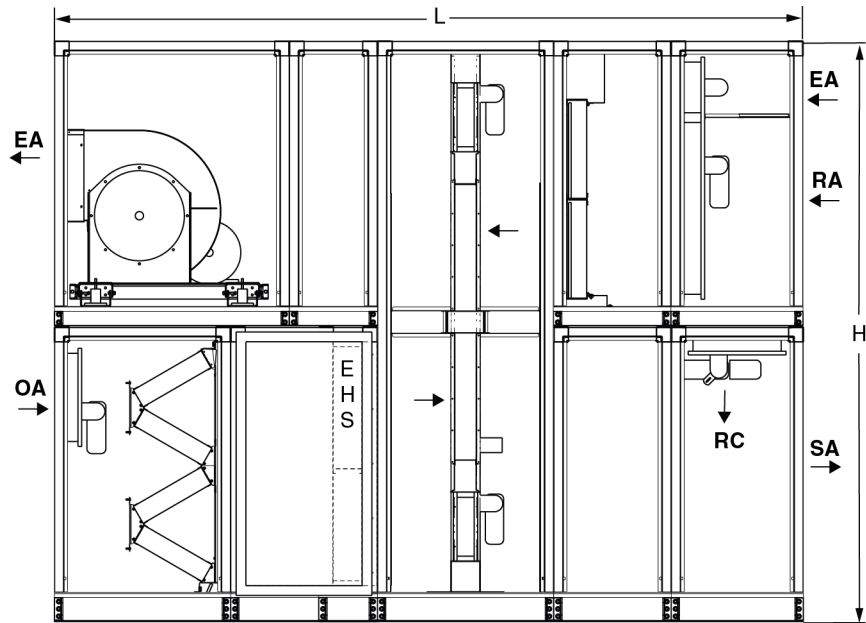
EA — Exhaust Air
 OA — Outdoor Air
 RA — Return Air
 RC — Recirculate Air
 SA — Supply Air

39M UNIT SIZE	L, NOMINAL (in.)		W, NOMINAL (in.) (Not Shown)		H, NOMINAL (in.)	
	39MN	39MW	39MN	39MW	39MN	39MW
	INDOOR	OUTDOOR	INDOOR	OUTDOOR	INDOOR	OUTDOOR
03	108.3	N/A	33	35	72.5	75.0
06	111.3	N/A	46	48	72.5	75.2
08	117.3	N/A	54	56	78.5	81.3
10	117.3	N/A	67	69	78.5	81.5
12	117.3	N/A	67	69	92.5	95.5
14	126.3	N/A	72	74	92.5	95.6
17	132.3	N/A	79	81	98.5	101.7
21	135.3	N/A	79	81	98.5	121.7
25	153.3	N/A	86	88	118.5	121.8
30	153.3	N/A	104	106	120.5	124.1
36	N/A	N/A	109	111	142.5	146.2
40	N/A	N/A	109	111	154.5	158.2
50	N/A	N/A	117	119	174.5	178.3
61	N/A	N/A	117	119	204.5	208.3

NOTE(S):

1. H = section height including a 6-in. base rail.
2. L = the total airway length of the energy recovery section.
3. Length may vary with section and electrical options. Typical dimensions shown.
4. Energy recovery sections include the largest fan and motor available for each size with a single wheel.
5. Dimensions are subject to change without notice. Refer to the **AHUBuilder®** selection software for current weights, dimensions and configurations.
6. Because of shipping limitations, energy recovery sections in unit sizes 17 and larger will be shipped unstacked.

Fig. 33 — 39MW Outdoor ERV Section Assembly without Electric Heat, with Separate Return and Exhaust Airflow



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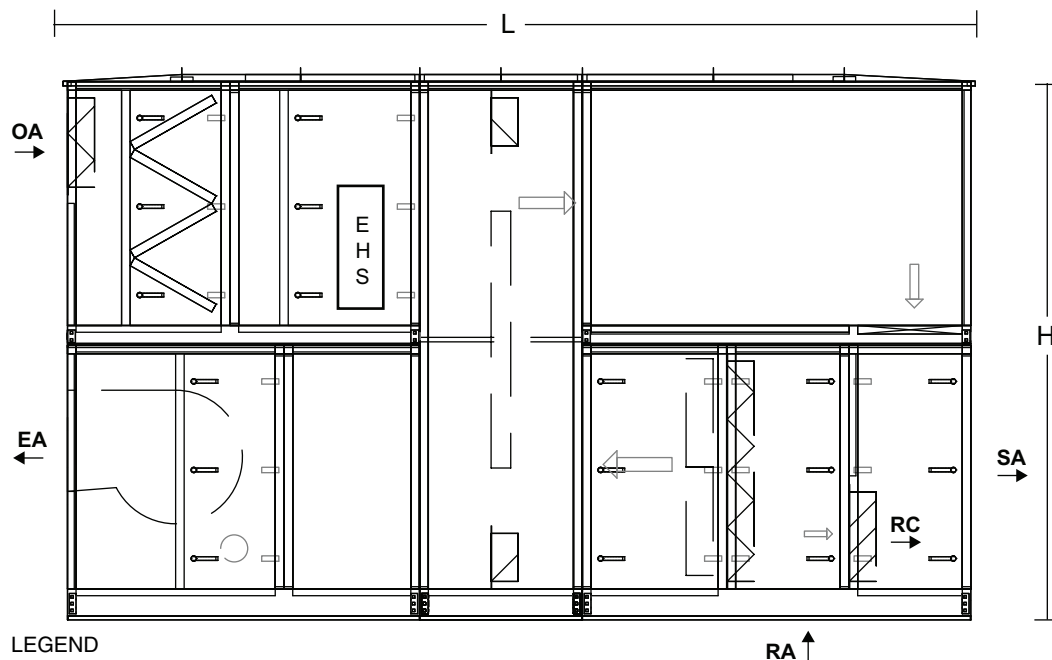
EA — Exhaust Air
 EHS — Electric Heat Section
 OA — Outdoor Air
 RA — Return Air
 RC — Recirculate Air
 SA — Supply Air

39MN UNIT SIZE	L (in.)	W (in.) (Not Shown)	H (in.)
03	132.4	33	72.5
06	141.4	46	72.5
08	147.4	54	78.5
10	147.4	67	78.5
12	147.4	67	92.5
14	144.4	72	92.5
17	150.4	79	98.5
21	153.4	79	118.5
25	153.4	86	118.5
30	153.4	104	118.5

NOTE(S):

1. H = section height including a 6-in. base rail.
2. L = the total airway length of the energy recovery section.
3. Length may vary with section and electrical options. Typical dimensions shown.
4. Energy recovery sections include the largest fan and motor available for each size with a single wheel.
5. Dimensions are subject to change without notice. Refer to the **AHUBuilder®** selection software for current weights, dimensions and configurations.
6. Because of shipping limitations, energy recovery sections in unit sizes 17 and larger will be shipped unstacked.

Fig. 34 — 39MN Indoor ERV Section Assembly with Electric Heat and Separate Return and Exhaust Airflow



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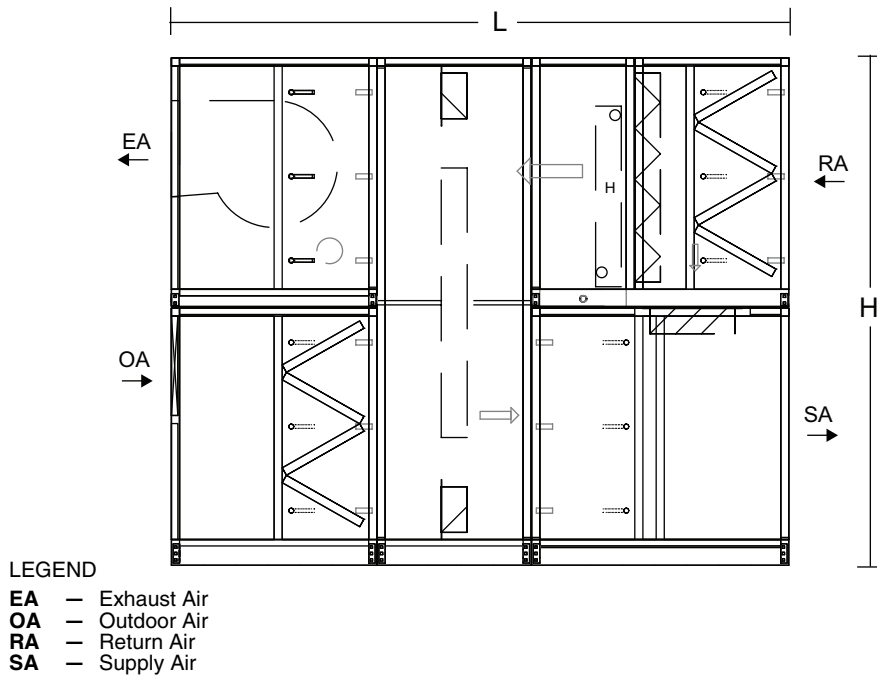
EA — Exhaust Air
 OA — Outdoor Air
 RA — Return Air
 RC — Recirculate Air
 SA — Supply Air

39M UNIT SIZE	L, NOMINAL (in.)		W, NOMINAL (in.) (Not Shown)		H, NOMINAL (in.)	
	39MN	39MW	39MN	39MW	39MN	39MW
	INDOOR	OUTDOOR	INDOOR	OUTDOOR	INDOOR	OUTDOOR
03	126.3	N/A	33	35	72.5	75.0
06	132.3	N/A	46	48	72.5	75.2
08	138.3	N/A	54	56	78.5	81.3
10	138.3	N/A	67	69	78.5	81.5
12	138.3	N/A	67	69	92.5	95.5
14	132.3	N/A	72	74	92.5	95.6
17	138.3	N/A	79	81	98.5	101.7
21	138.3	N/A	79	81	98.5	121.7
25	138.3	N/A	86	88	118.5	121.8
30	138.3	N/A	104	106	120.5	124.1
36	N/A	N/A	109	111	142.5	146.2
40	N/A	N/A	109	111	154.5	158.2
50	N/A	N/A	117	119	174.5	178.3
61	N/A	N/A	117	119	204.5	208.3

NOTE(S):

1. H = section height including a 6-in. base rail.
2. L = the total airway length of the energy recovery section.
3. Length may vary with section and electrical options. Typical dimensions shown.
4. Energy recovery sections include the largest fan and motor available for each size with a single wheel.
5. Dimensions are subject to change without notice. Refer to the **AHUBuilder®** selection software for current weights, dimensions and configurations.
6. Because of shipping limitations, energy recovery sections in unit sizes 17 and larger will be shipped unstacked.

Fig. 35 — 39MW Outdoor ERV Section Assembly with Electric Heat and Separate Return and Exhaust Airflow



39MN UNIT SIZE	L, NOMINAL (in.)	W, NOMINAL (in.) (Not Shown)	H, NOMINAL (in.)
	39MN	39MN	39MN
	INDOOR	INDOOR	INDOOR
03	114.3	33	72.5
06	114.3	46	72.5
08	120.3	54	78.5
10	120.3	67	78.5
12	120.3	67	92.5
14	126.3	72	92.5
17	132.3	79	98.5
21	132.3	79	98.5
25	132.3	86	118.5
30	144.3	104	120.5
36	175.4	109	142.5
40	185.4	109	154.5
50	197.4	117	174.5
61	225.4	117	204.5

NOTE(S):

1. H = section height including a 6-in. base rail.
2. L = the total airway length of the energy recovery section.
3. Length may vary with section and electrical options. Typical dimensions shown.
4. Energy recovery sections include the largest fan and motor available for each size with a single wheel.
5. Dimensions are subject to change without notice. Refer to the **AHUBuilder®** selection software for current weights, dimensions and configurations.
6. Because of shipping limitations, energy recovery sections in unit sizes 17 and larger will be shipped unstacked.

Fig. 36 — 39MN Indoor ERV Section Assembly with Hot Water Wheel Defrost with RA Filter before Wheel

HVAC GUIDE SPECIFICATIONS

39MN/MW Total Energy Recovery Wheel Section

Size Range: **1,500 to 30,500 Nominal cfm**

Carrier Model Number: **39MN/MW — Total Energy Recovery Wheel Section**

Part 1 — General

1.01 QUALITY ASSURANCE

A. Manufacturer Qualifications:

Company specializing in manufacturing the products specified in this section with minimum of five years documented experience.

B. Units shall be manufactured in a facility registered to ISO 9001 manufacturing quality standard.

C. Energy recovery unit assembly shall have UL 60335-2-40 certification for safety, including use with electric heat.

D. Products requiring electric connection shall be listed and classified by ETL and CSA as suitable for the purpose specified and indicated.

E. Coil performance shall be certified in accordance with AHRI Standard 410. Air-handling unit fan performance shall be certified in accordance with AHRI Standard 430. Air-Handling unit shall meet NFPA 90A requirements.

F. Energy recovery wheel shall be AHRI Standard 1060 certified and bear the AHRI Certified Product Seal.

1.02 DELIVERY, STORAGE AND PROTECTION

Inspect for transportation damage and store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish. Stacking of unit sections must be avoided as damage may result.

1.03 START-UP REQUIREMENTS

Do not operate units until ductwork is clean, filters are in place, bearings lubricated, condensate properly trapped, piping connections verified and leak tested, belts aligned and tensioned, all shipping braces have been removed, and fan has been test run under observation per service and installation instructions.

Part 2 — Products

2.01 GENERAL DESCRIPTION

A. Units shall ship in the number of sections necessary to meet project and transportation requirements and shall ship in as many splits as specified in **AHUBuilder®** software.

B. ERV section shall have same construction as main unit.

2.02 ENERGY RECOVERY WHEEL SECTION

A. Construction:

1. Wheel sections shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor and drive belt.

2. The wheel shall be coated with silica gel desiccant, permanently bonded without the use of binders or adhesives.
3. The substrate shall be made of a light weight polymer and shall not degrade nor require additional coatings for application in coastal environments.
4. Coated wheel segments shall be washable with detergent or alkaline coil cleaner and water.
5. The silica gel desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.
6. The wheel polymer layers shall be wound continuously with one flat and one structured layer in an ideal parallel plate geometry providing laminar flow and minimum pressure drop.
7. The wheel shall incorporate the channel matrix design.
8. The polymer layers shall be captured in a stainless steel wheel frame or aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix.
9. Energy recovery wheels greater than 30 inches in diameter shall be provided with removable wheel segments.
10. Wheel frame shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without the wheel segments in place.
11. Wheel segments shall be removable without the use of tools to facilitate maintenance and cleaning.
12. Wheel bearings shall provide an L-10 life in excess of 400,000 hours.
13. Wheel rim shall be continuous rolled stainless steel and the wheel shall be connected to the shaft by means of taper locks.
14. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set.
15. Drive belts of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.
16. The energy recovery section shall be a UL recognized component.
17. Energy wheel performance shall be AHRI Standard 1060 certified and bear the AHRI Certified Product Seal.

B. Warranty:

Energy Recovery Section parts and components shall be warranted to be free from defects in material and workmanship under normal use and service for a period of five (5) years from the date of manufacture, with the exception of the motor, which is warranted for a period of eighteen (18) months.

