# HLR Technology Design Guide

enVerid
Energy savings. Air quality.

## Contents

# Introduction

HLR technology represents a vital addition to conventional HVAC systems to reduce outside air heating and cooling loads. enVerid's molecular air cleaning technology removes previously hard-to-capture contaminants from the indoor air, thereby decreasing the required volume of outside air ventilation and providing more control over air quality.

enVerid HLR technology is used in two models:

- HLR 14M is designed for indoor installation, typically in a mechanical room.
- HLR 15R is designed for outdoor installation, typically on a rooftop.

Each model is an all-inclusive solution containing a cabinet, replaceable sorbent cartridges, embedded controller, MSTP BACnet Card, 3G/4G modem connectivity for over-the-air programming (enVerid approved service provider only), along with embedded web-accessible controls and sensors. The system is designed to be scalable to building size. Individual or multiple HLR Modules can be installed to account for varying building types and HVAC system sizes.


HLR 14M Indoor Module


HLR 15R Outdoor Module

### Section 1: External Connections to HLR Module

This section provides an overview of HVAC, power, and communications components integral to the HLR Module that interface with external devices / systems. Note that components integral to the HLR module that do not interface externally, are not included in this guide – please refer to the *HLR 14M Technical Guide* and the *HLR 15R Technical Guide* for an overview of all components.

### Section 2: HLR Technology Modes of Operation

This section explains the two (2) modes of operation associated with HLR technology: Adsorption Mode and Regeneration Mode. The section explains how the components defined in *Section 1* react during the different modes.

### Section 3: Product Data

This section provides equipment technical data, dimensional drawings, and clearance information for all HLR modules currently available.

### Section 4: HLR Technology Integration Overview

This section includes one-line schematics of conventional HVAC airside system designs with and without HLR modules.

### Section 5: Detailed Integration Drawings

This section includes drawings and notes on how HLR modules should be specified in mechanical design drawings.

### Section 6: Installation Configurations

This section provides a guide for manufacturer approved installation configurations when floor mounting HLR module(s).

### Section 7: HLR Clusters

This section includes an in-depth description into designing HLR modules in common groupings called "Clusters"

### Section 8: Regeneration Integration

This section includes detailed discussion regarding Regeneration exhaust, and integration of (optional) auxiliary exhaust fans.

### Section 9: HLR Module Ductwork Connections

This section includes methods to improve side stream flow through the HLR module(s).

### Appendix A: Additional Resources

This section includes downloads to HLR modules CAD blocks, Revit content, and equipment details.

### Appendix B: ASHRAE 90.1 Compliance Pathway Flow Chart

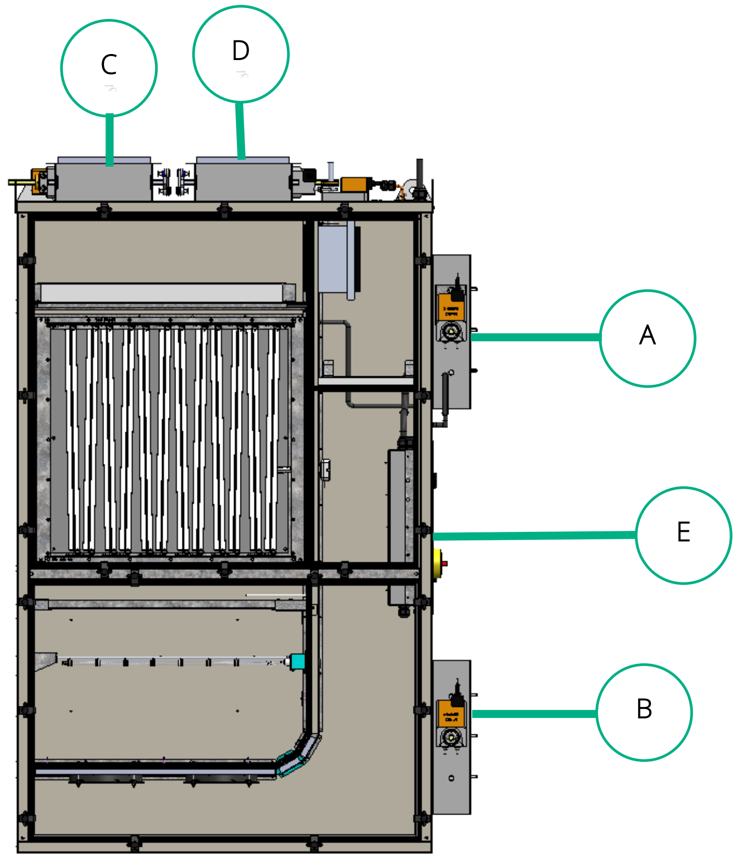
This section provides guide to energy code compliance pathways when using HLR technology to eliminate energy recovery.

# Section 1 – External Connections to HLR Module

Each HLR module has mechanical and electrical components. The naming convention of these components is provided in this section and will be referenced in subsequent sections.

Components integral to the HLR module, that do not interface externally, are not discussed in this guide – please refer to the *HLR 14M Technical Guide* and *HLR 15R Technical Guide* for an overview of all components.

## HLR 14M



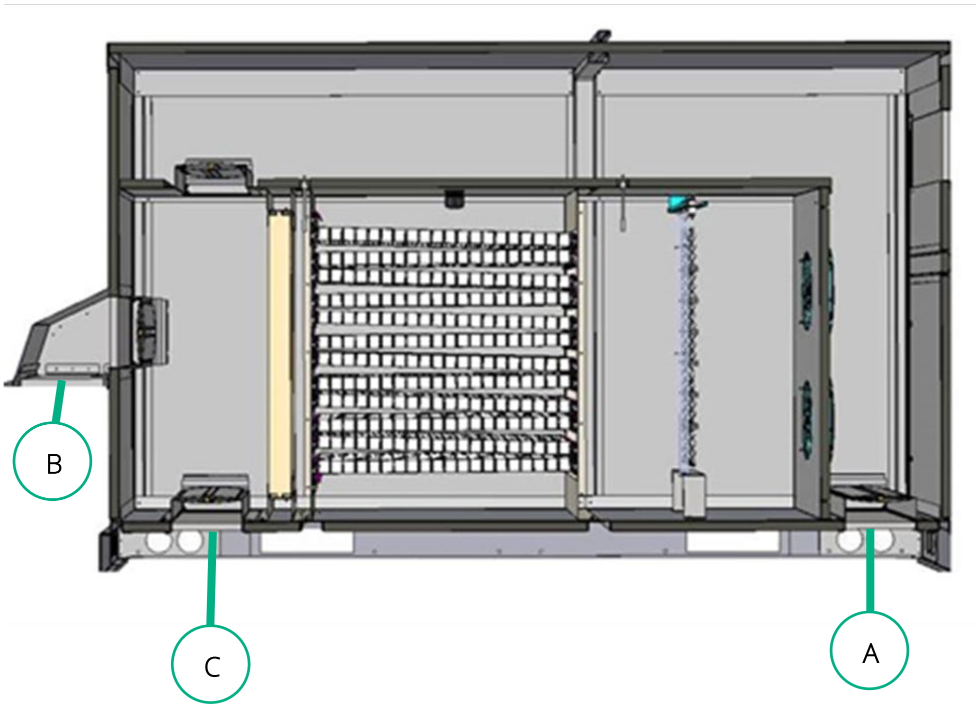

| | Connection / Component |
|---|---|
| A | Indoor Air Inlet (Adsorption Mode) [1] |
| B | Indoor Air Inlet (Regeneration Mode) [1] |
| C | Clean Air Outlet[1] |
| D | Exhaust Outlet[1] |
| E | Electrical Enclosure[2] |

<u>*Notes*</u>

*[1] Inlet / outlet are equipped with an integral, two position (open / close) motorized damper-actuator assembly. The assembly is controlled locally by the on-board HLR controller housed in the electrical enclosure (5).*

*[2] Houses the controller board, power supply, and communications Module.*

## HLR 15R




| | Connection / Component |
|---|---|
| A | Indoor (Adsorption and Regeneration Mode) Air Inlet[1] |
| B | Exhaust Outlet[1] |
| C | Clean Air Outlet[1] |
| D | Electrical Enclosure[2] (not pictured) |

<u>*Notes*</u>

*[1]Each inlet / outlet are equipped with an integral, two position (open / close) motorized damper-actuator assembly. The assembly is controlled locally by the on-board HLR controller housed in the electrical enclosure (4).*

*[2]Houses the controller board, power supply, and communications Module. Located on unit panel facing reader.*

# Section 2 – HLR Technology Modes of Operation

HLR Module(s) have two (2) modes of operation: Adsorption Mode and Regeneration Mode. These two modes of operation are discussed in this section.

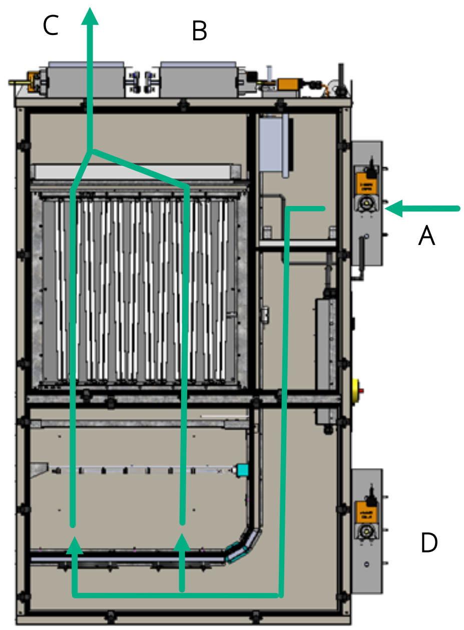
## HLR 14M

### Adsorption Mode

During adsorption mode, the HLR Module is actively cleaning the indoor air in the following steps:

1. Return air enters the unit,
2. Return air passes through the cartridges,
3. Return air exits the unit as clean air.

The HLR 14M fans nominally operate at 900 CFM and 0.2" ESP during adsorption mode (Electric heater is OFF).




| | | |
|---|---|---|
| A | Adsorption Mode Air Inlet | Air entering this inlet is the air that is being cleaned. Inlet damper is in open position (controlled locally). |
| B | Exhaust Outlet | Outlet damper is in closed position (controlled locally). |
| C | Clean Air Outlet | Outlet damper is in open position (controlled locally). |
| D | Regeneration Mode Air Inlet | Inlet damper is in closed position (controlled locally). |

## Regeneration Mode

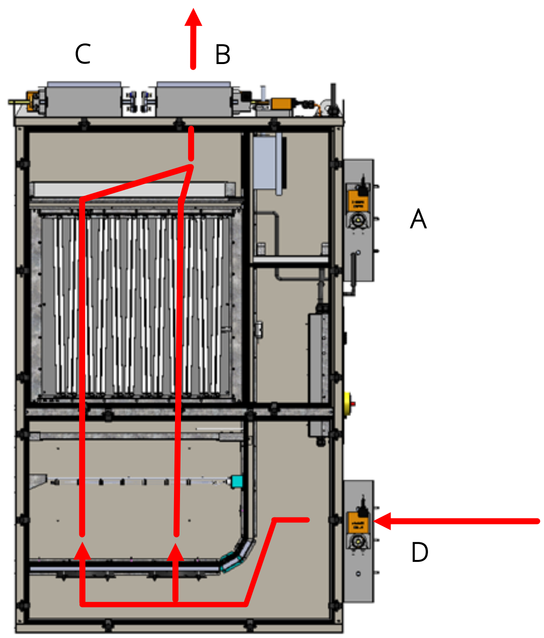
Over time, the sorbent media becomes saturated and needs to be self-cleaned or "regenerated".

A typical regeneration cycle occurs daily and is scheduled, as needed.

During regeneration mode, the HLR Module "self-cleans" the sorbent media in the following steps:

1. Indoor air enters the unit and is heated (by internal electrical resistance heater) to 130-150°F,
2. The heated air passes through the saturated sorbent media to release contaminants,
3. Released contaminants are exhausted out of the unit*.

* The HLR 14M fans operate at 300 CFM and 0.2" ESP during regeneration mode (Electric heater is ON).




| | | |
|---|---|---|
| A | Adsorption Mode Air Inlet | Inlet damper is in closed position (controlled locally). |
| B | Exhaust Outlet | Outlet damper is in open position (controlled locally). |
| C | Clean Air Outlet | Outlet damper is in closed position (controlled locally). |
| D | Regeneration Mode Air Inlet | Air entering this inlet is the air that is being heated and regenerated. Inlet damper is in open position (controlled locally). |

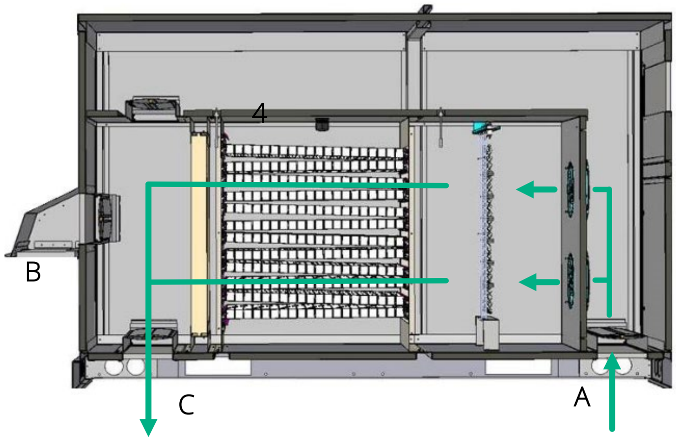
## HLR 15R

### Adsorption Mode

During adsorption mode, the HLR Module is actively cleaning the indoor air in the following steps:

1. Indoor air enters the unit,
2. Indoor air passes through the cartridges,
3. Indoor air exits the unit as clean air.

The HLR 15R fans nominally operate at 900 CFM and 0.2" ESP during adsorption mode (Electric heater is OFF).




| | | |
|---|---|---|
| A | Indoor Air Inlet | Inlet damper is in open position (controlled locally). |
| B | Exhaust Outlet | Outlet damper is in closed position (controlled locally). |
| C | Clean Air Outlet | Outlet damper is in open position (controlled locally). |

## Regeneration Mode

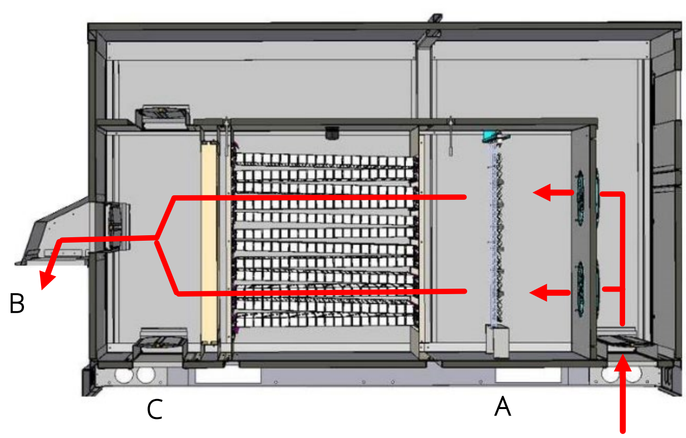
Over time, the sorbent media becomes saturated and needs to be self-cleaned or "regenerated".

A typical regeneration cycle occurs daily and is automatically scheduled, as needed.

During regeneration mode, the HLR Module "self-cleans" the sorbent media in the following steps:

1. Indoor air enters the unit and is heated (by internal electrical resistance heater) to 130-150°F,
2. The heated air passes through the saturated sorbent media to release contaminants,
3. Released contaminants are exhausted out of the unit*.

* The HLR 15R fans operate at 300 CFM and 0.2" ESP during regeneration mode (Electric heater is ON).




| | | |
|---|---|---|
| A | Indoor Air Inlet | Inlet damper is in open position (controlled locally). |
| B | Exhaust Outlet | Outlet damper is in open position (controlled locally). |
| C | Clean Air Outlet | Outlet damper is in closed position (controlled locally). |

## HLR 14M Indoor Module Specifications

### GENERAL SPECS

| | | |
|---|---|---|
| Installation | Mechanical Room or Air Plenum | |
| Construction | Single wall, Insulated, Powder-coated Galvanized Steel | |
| Sorbent Cartridges per Set | 12 | |
| Typical Airflow (Adsorption) | 700 - 800 SCFM | 1,190 - 1,360 CMH |
| Typical Airflow (Regeneration) | 250 - 300 SCFM | 425 - 510 CMH |
| Static pressure added to AHU fan | None | |
| Sound Power Level | 68 dB | |
| Maximum Allowed External Static Pressure | 0.2" WG / 50 Pa | |
| Maintenance | Annual | |
| Operating Life | 20+ years with scheduled maintenance | |

### COMMUNICATIONS

| | |
|---|---|
| Cellular Link | 3G / 4G |
| BMS Integration | BACnet over MSTP or Hardwire |

### POWER

| Voltage (VAC) | Frequency (Hz) | MCA | MOCP |
|---|---|---|---|
| 208 V | 60 Hz | 34.3 Amp | 35 Amp |
| 277 V | 60 Hz | 30.6 Amp | 35 Amp |
| 240 V | 50 Hz | 28.4 Amp | 30 Amp |

### SYSTEM POWER CONSUMPTION

| | 208 V | 277 V | 240 V |
|---|---|---|---|
| Adsorption Mode | 300 W | 300 W | 300 W |
| Regeneration Mode | 5,800 W | 6,800 W | 5,540 W |

### REQUIRED CONTROL CONNECTIONS

| | |
|---|---|
| Start/Stop | Binary Input to HLR Module |

### OPTIONAL CONNECTIONS

| | |
|---|---|
| Fire Signal | Binary Input to HLR Module |
| HLR Status | Analog Output from HLR Module |
| Regeneration Booster Fan Start/Stop | **Binary Output from HLR Module** |
| Indoor Air $CO_2$ Sensor | Analog Output from HLR Module |
| Indoor Air TVOC Sensor | Analog Output from HLR Module |

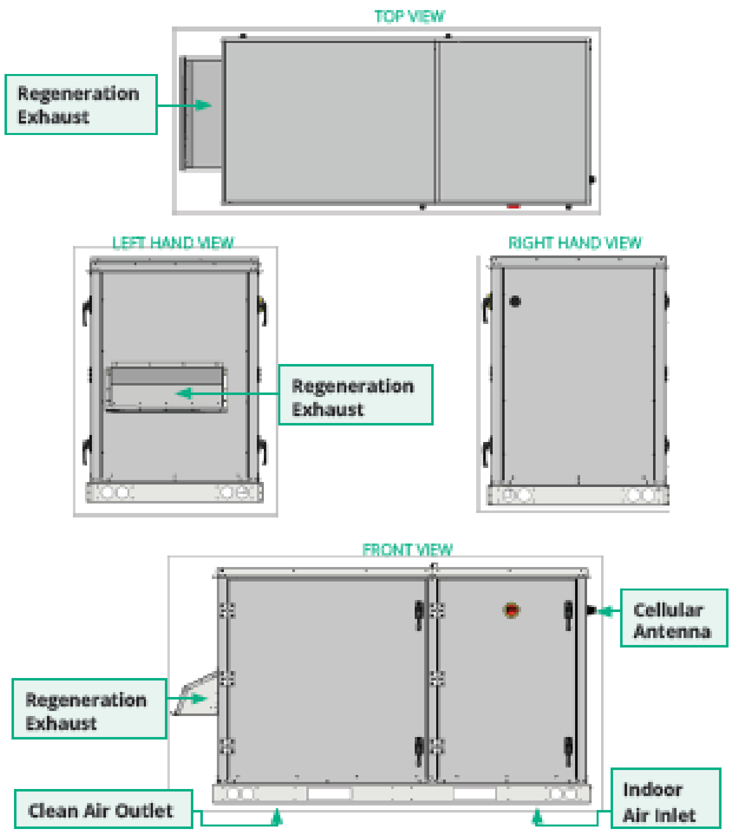
### HLR 14M MODULE WEIGHTS

| | | |
|---|---|---|
| Module Shipping Weight | 650 lbs | 295 kg |
| Cartridge Shipping Weight | 200 lbs | 91 kg |
| Installation/Operating Weight | 630 lbs | 286 kg |

### HLR 14M MODULE DIMENSIONS (Front View)

| | |
|---|---|
| Height (Allow Additional 21" Clearance for Elbow) | 72" / 1,829 mm |
| Width (Allow Additional 36" Clearance for Control Panel Service) | 48" / 1,219 mm |
| Depth (Allow Additional 36" Clearance for Cartridge Service) | 27" / 686 mm |
| Ducts (Indoor Air Inlet and Regeneration Air Inlet) | 10" x 14" w/ 1.0" flange<br>254 mm x 356 mm w/ 25 mm flange |
| Ducts (Clean Air Outlet and Regeneration Exhaust) | 10" x 14" w/ 1.0" flange<br>254 mm x 356 mm w/ 25 mm flange |

## HLR 15R Outdoor Module Drawings




### WEIGHTS

| | | |
|---|---|---|
| Module Shipping/Lifting Weight | 930 lbs | 422 kg |
| Cartridge Shipping Weight | 200 lbs | 91 kg |
| Installation/Operating Weight | 960 lbs | 435 kg |

### DIMENSIONS (Front View)

| | |
|---|---|
| Height<br>(Including Rail) | 49" / 1,245 mm |
| Width (Includes Exhaust Hood) | 87" / 2,210 mm |
| Depth<br>(Allow Additional 48" / 1,219 mm Clearance on Front and Back for Service) | 36" / 914 mm |
| Ducts<br>(Indoor Air Inlet and Clean Air Oulet) | 6.5" x 22.75" / 165 mm x 578 mm |

## HLR 15R Outdoor Module Specifications

### GENERAL SPECS

| | | |
|---|---|---|
| Outdoor Installation | Insulated curb or above roof on equipment support | |
| Construction | Double-wall, insulated, powder-coated galvanized steel | |
| Sorbent Cartridges per Set | 12 | |
| Typical Airflow (Adsorption) | 700 - 800 SCFM | 1,190 - 1,360 CMH |
| Typical Airflow (Regeneration) | 250 - 300 SCFM | 425 - 510 CMH |
| Static Pressure added to AHU fan | None | |
| Sound Power Level | 68 dB | |
| Maximum Allowed External Static Pressure | 0.2" WG / 50 Pa | |
| Maintenance | Annual | |
| Operating Life | 20+ years with scheduled maintenance | |

### COMMUNICATIONS

| | |
|---|---|
| Cellular Link | 3G / 4G |
| BMS Integration | BACnet over MSTP or Hardwire |

### POWER

| Voltage (VAC) | Frequency (Hz) | MCA | MOCP |
|---|---|---|---|
| 208 V | 60 Hz | 34.3 Amp | 35 Amp |
| 277 V | 60 Hz | 30.6 Amp | 35 Amp |
| 240 V | 50 Hz | 28.4 Amp | 30 Amp |

### SYSTEM POWER CONSUMPTION

| | 208 V | 277 V | 240 V |
|---|---|---|---|
| Adsorption Mode | 300 W | 300 W | 300 W |
| Regeneration Mode | 5,800 W | 6,800 W | 5,540 W |

### REQUIRED CONTROL CONNECTIONS

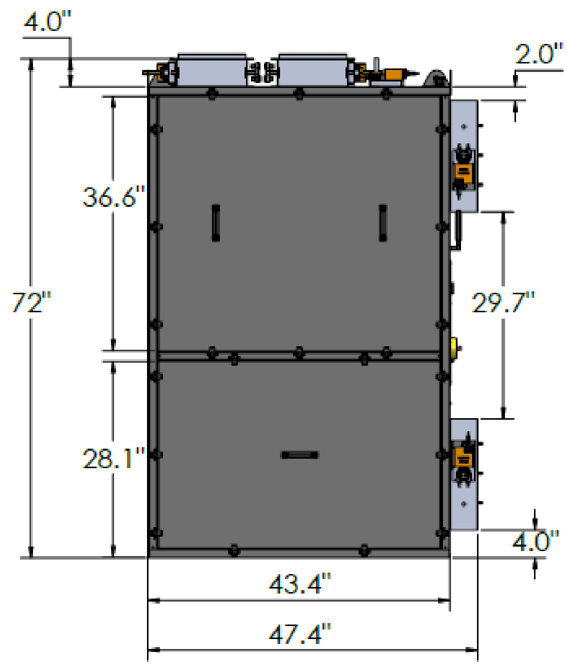
| | |
|---|---|
| Start/Stop | Binary Input to HLR Module |

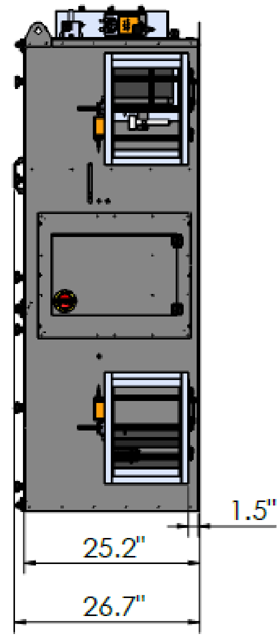
### OPTIONAL CONNECTIONS

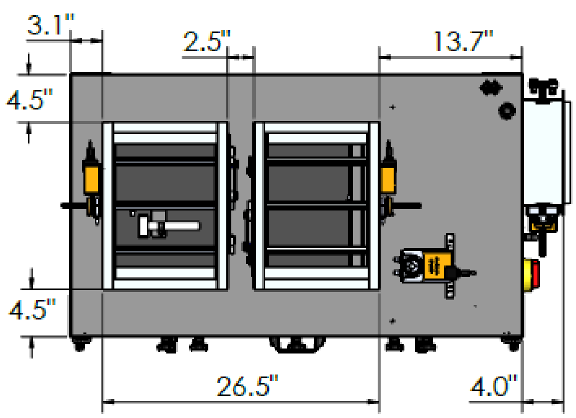
| | |
|---|---|
| Fire Signal | Binary Input to HLR Module |
| HLR Status | Analog Output from HLR Module |
| Indoor Air $CO_2$ Sensor | Analog Output from HLR Module |
| Indoor Air TVOC Sensor | Analog Output from HLR Module |

HLR 14M

## Dimensional Drawings

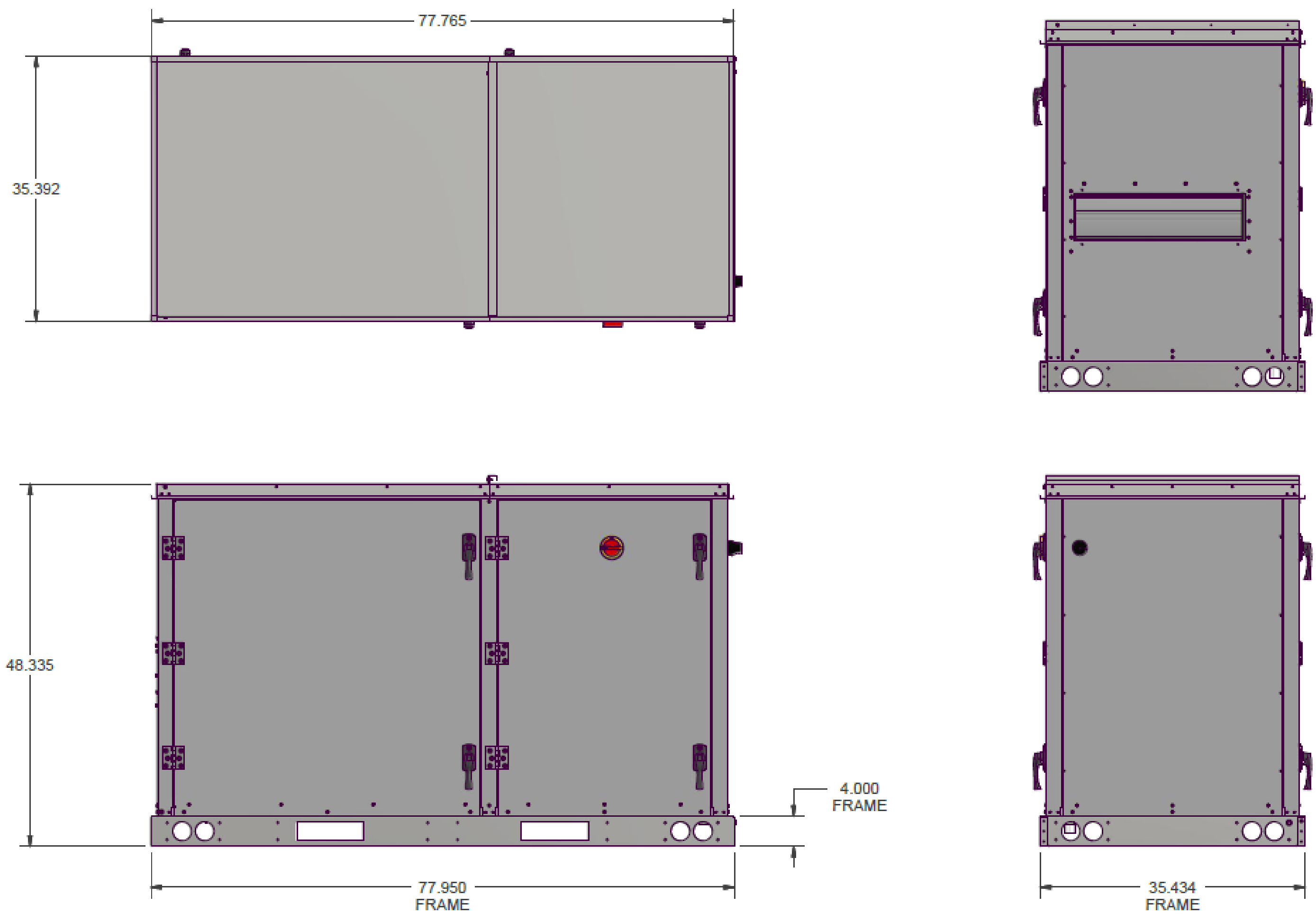


# HLR 15R

## Dimensional Drawings



# Section 4 – HLR Technology Integration Overview

This section provides high level diagrammatic examples of how HLR modules can be integrated into different baseline HVAC design cases.

For each baseline case, the minimum outside air (OA) flow is representative of a prescriptive-based requirement per ASHRAE 62.1 Ventilation Rate Procedure (VRP). For each proposed case, minimum OA and clean air (CA) flow rates are representative of a performance-based requirement per ASHRAE 62.1 Indoor Air Quality Procedure (IAQP).

Note: The proposed cases diagrammatically show one (1) HLR Module for simplicity. However, when integrating with larger systems, multiple modules can be installed in parallel and function as an "HLR cluster (Section 7)". Airflows during the 2 modes of the HLR module are shown in different colors- Green for Adsorption Mode and Red for Regeneration Mode.

The baseline cases and proposed cases discussed in this section are outlined below:

| Baseline Case | Applicable Proposed Cases: |
|---|---|
| Baseline Case 1: Mixed Air System | Proposed Case 1: Downsized Mixed Air System + HLR Module(s) |
| Baseline Case 2: Dedicated Outside Air System (100% OA) | Proposed Case 2A: Dedicated Clean Air System w/ Downsized Energy Recovery |
| | Proposed Case 2B: Dedicated Clean Air System, no Energy Recovery |

Referenced acronyms in schematics:

*OA = Outside Air*

*SA = Supply Air*

*RA = Return Air*

*IA = Indoor Air*

*EA = Exhaust Air*

*TX = Toilet Exhaust*

*GX = General Exhaust*

*CA = Clean Air (from HLR modules)*

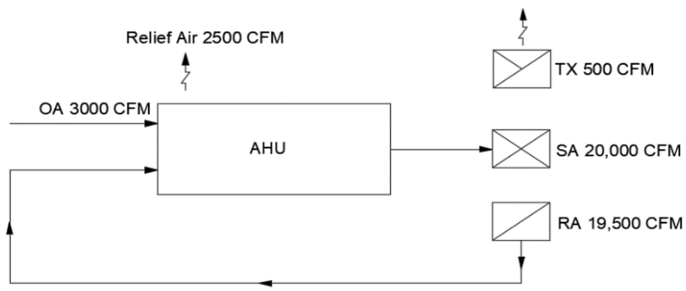
*DCAS = Dedicated Clean Air System*

*DOAS = Dedicated Outside Air System*

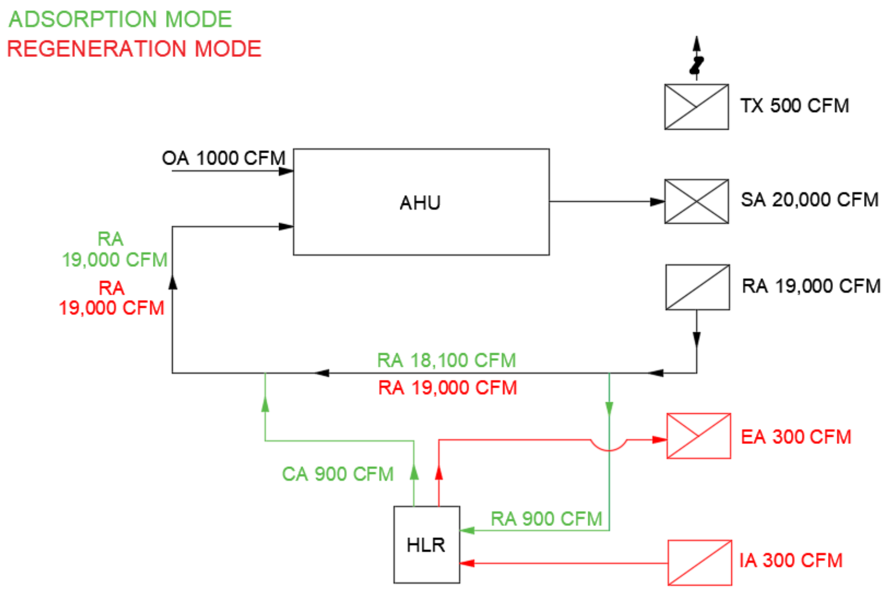
*AHU = Air Handling Unit*

*RTU = Rooftop Unit*

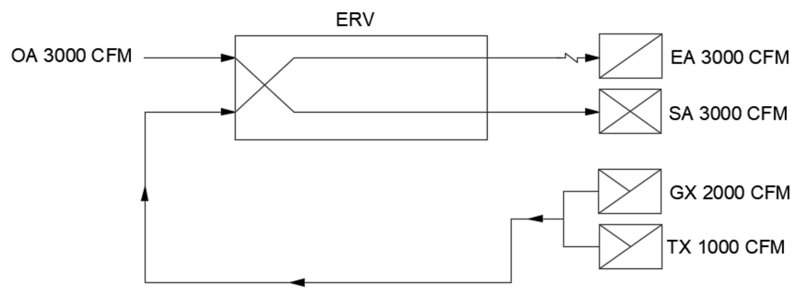
## Baseline Case 1: Mixed Air System

| Baseline Case 1 | |
|---|---|
| Conditions | 1. AHU or RTU is supplying 20,000 CFM of mixed air (OA + RA).<br>2. Can be Constant Volume (CV) or Variable Air Volume (VAV).<br>3. Outside air to AHU / RTU is provided locally or is decoupled. |
| Schematic | <br> |

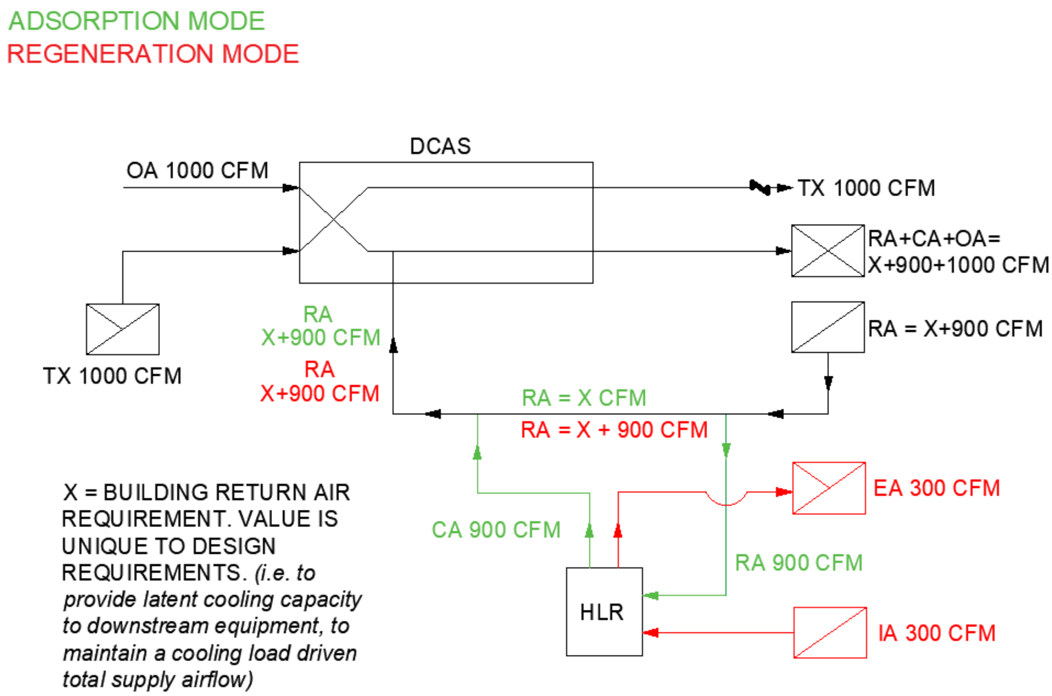
## Proposed Case 1: Downsized Mixed Air System + HLR Module(s)

| Proposed Case 1 | |
|---|---|
| Conditions | 1. Same as Baseline Case 1, and:<br>2. HLR module(s) installed in return air ductwork or return air plenum. |
| Schematic | <br> |
| Load Reduction Impact | 1. Downsized heating and cooling coils and respective central plant equipment (if applicable).<br>2. Downsized OA intake and DOAS or ERV (if applicable).<br>3. Downsized or eliminated Relief Section / General Exhaust Fan. |
| Detailed Drawing ref. | Integration Drawing 1 (plenum indoor); Integration Drawing 2 (ducted indoor); Integration Drawing 3 (plenum rooftop). |

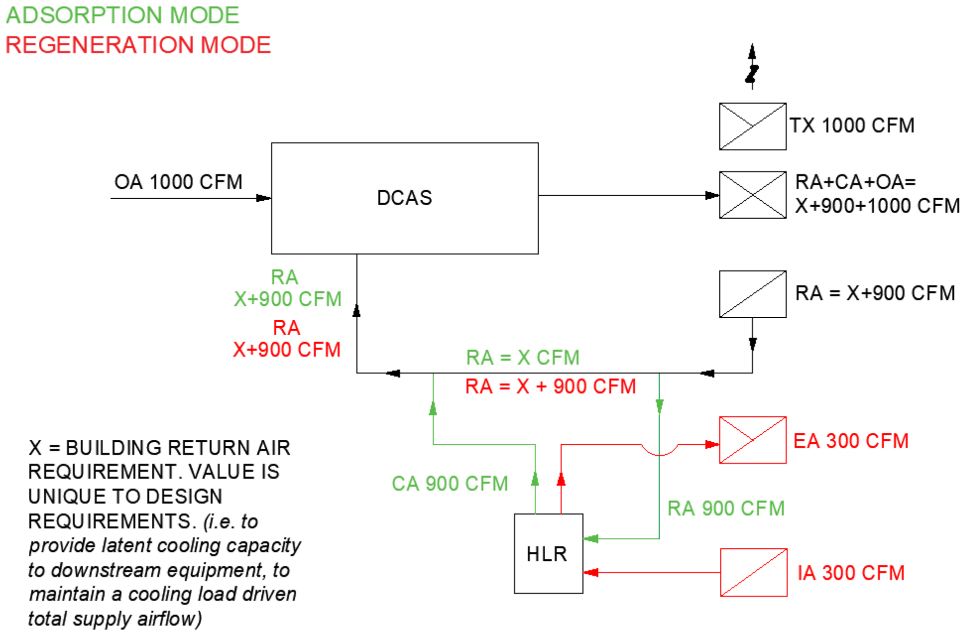
## Baseline Case 2: Dedicated Outside Air System (100% OA)

<table>
<tr><th colspan="2">Baseline Case 2</th></tr>
<tr><td>Conditions</td><td>1. 100% OA System supplying 3000 CFM of tempered air.<br>2. OA is supplied directly to space or indirectly via:<br>    a. Fan Coil Units, Variable Refrigerant Flow Units, Heat Pumps, chilled beams, Mixed Air AHU / RTU, etc.<br>3. Energy may be recovered from TX and GX.</td></tr>
<tr><td>Schematic</td><td>
</td></tr>
</table>

## Proposed Case 2A: Dedicated Clean Air System with Downsized Energy Recovery

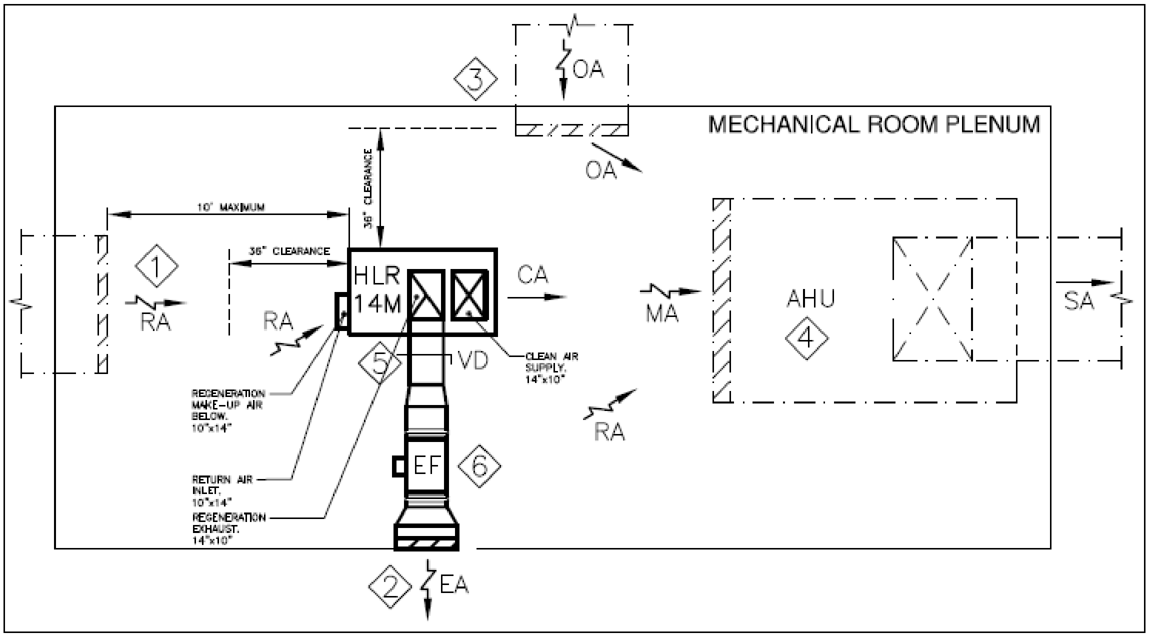
<table>
<tr><th colspan="2">Proposed Case 2A</th></tr>
<tr><td>Conditions</td><td>1. Dedicated Clean Air System (DCAS) supplying (X+800+1000) CFM of mixed air (OA + RA + CA).<br>a. Total system supply airflow is downsized per the minimum OA and minimum CA flow rate calculated per ASHRAE 62.1 – Indoor Air Quality Procedure.<br>2. HLR Module(s) installed in return air ductwork or return air plenum.<br>3. Energy is recovered from TX.</td></tr>
<tr><td>Schematic</td><td><br></td></tr>
<tr><td>Load Reduction Impact</td><td>1. Downsized heating, cooling, re-heat coils and respective central plant equipment (if applicable).<br>2. Downsized supply fan and respective ductwork.<br>3. Downsized or eliminated General Exhaust fan and respective ductwork.<br>4. Downsized energy recovery section.</td></tr>
<tr><td>Detailed Drawing ref.</td><td>Integration Drawing 4 (X = 0 CFM); Integration Drawing 5 (X <= 2700 CFM or CA flow >= 30% RA flow).</td></tr>
</table>

## Proposed Case 2B: Dedicated Clean Air System, no Energy Recovery

| Proposed Case 2B | |
|---|---|
| Conditions | 1. Same as Proposed Case 2A, but energy is <u>not</u> recovered from TX. |
| Schematic |  |
| Load Reduction Impact | 1. Downsized heating, cooling, re-heating coils and respective central plant equipment (if applicable).<br>2. Downsized supply fan and respective ductwork.<br>3. Downsized or eliminated General Exhaust fan and respective ductwork.<br>4. Eliminated energy recovery, in compliance with ASHRAE 90.1 and/or International Energy Conservation Code (IECC):<br>a. <u>Prescriptive Compliance Path</u>: energy recovery is no longer required if outside air is less than a certain % of total supply air. See *Table 6.5.6.1* of *ASHRAE 90.1 – 2013* or *Table C403.2.7* of IECC.<br>b. <u>Performance-based Compliance Path</u>: energy recovery is no longer required if the annual energy use of the proposed case energy model (i.e. building with HLR modules and ventilation rate calculated per IAQP) is less than the annual energy use of the ASHRAE 90.1 baseline case energy model (i.e. building with ventilation calculated per VRP and 50% energy recovery effectiveness.). See *Appendix B – ASHRAE 90.1 – 2013 Compliance Pathways Flow Chart* for more information. |
| Detailed Drawing ref. | Integration Drawing 4 (X = 0 CFM); Integration Drawing 5 (X <= 2700 CFM or CA flow >= 30% RA flow). |

# Section 5 – Detailed Integration Drawings

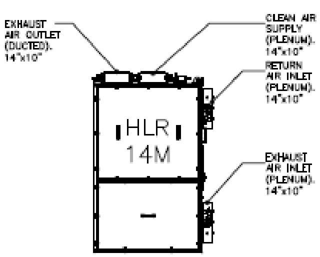
| Integration Drawing 1 – Indoor Installation – Plenum Return | |
|---|---|
| Conditions | 1. HLR Module(s) are integrated with an air handling unit (AHU) located in a plenum room.<br>2. Outside air and return air are ducted to plenum room.<br>3. The AHU supplies mixed air. |




NTS

**LEGEND:**

| | |
|---|---|
| VD | VOLUME DAMPER |
| SA | SUPPLY AIR |
| RA | RETURN AIR |
| MA | MIXED AIR |
| OA | OUTSIDE AIR |
| RA | RETURN AIR |
| CA | CLEAN AIR |
| EF | EXHAUST FAN |




HLR–14M ELEVATION

**KEYED NOTES:**

**1 RETURN AIR**

1. HLR MODULE DRAWS AIR FROM THE RETURN AIR INLET. LOCATE HLR MODULE NEAR ROOM RETURN AIR INLET AND AWAY FROM OA SOURCE. IF HLR IS NOT LOCATED NEAR THE RETURN INLET (>10'), A DUCT OR 'SNORKEL' SHALL BE REQUIRED.

**2 HLR REGENERATION EXHAUST:**

1. HLR MODULE EXHAUST DUCTWORK AND CONNECTION TO BUILDING EXHAUST LOUVER OR DUCT SHALL BE ENGINEERED TO HAVE AN EXTERNAL STATIC PRESSURE (ESP) LESS THAN 0.2" w.c AT 300 CFM.
2. EXHAUST DUCTWORK SHALL BE INSULATED. HLR EXHAUST IS HOT & HUMID.

**3 OUTSIDE AIR:**

1. CONTROLLED BY BUILDING MANAGEMENT SYSTEM TO MAINTAIN IAQP MINIMUM OUTSIDE AIR FLOW RATE.

**4 AIR HANDLING UNIT:**

1. AHU INTAKE DRAWS MIXED AIR (RETURN AIR, CLEANED AIR FROM HLR MODULE, AND OUTSIDE AIR)

**5 HLR MODULE(HLR–14M):**

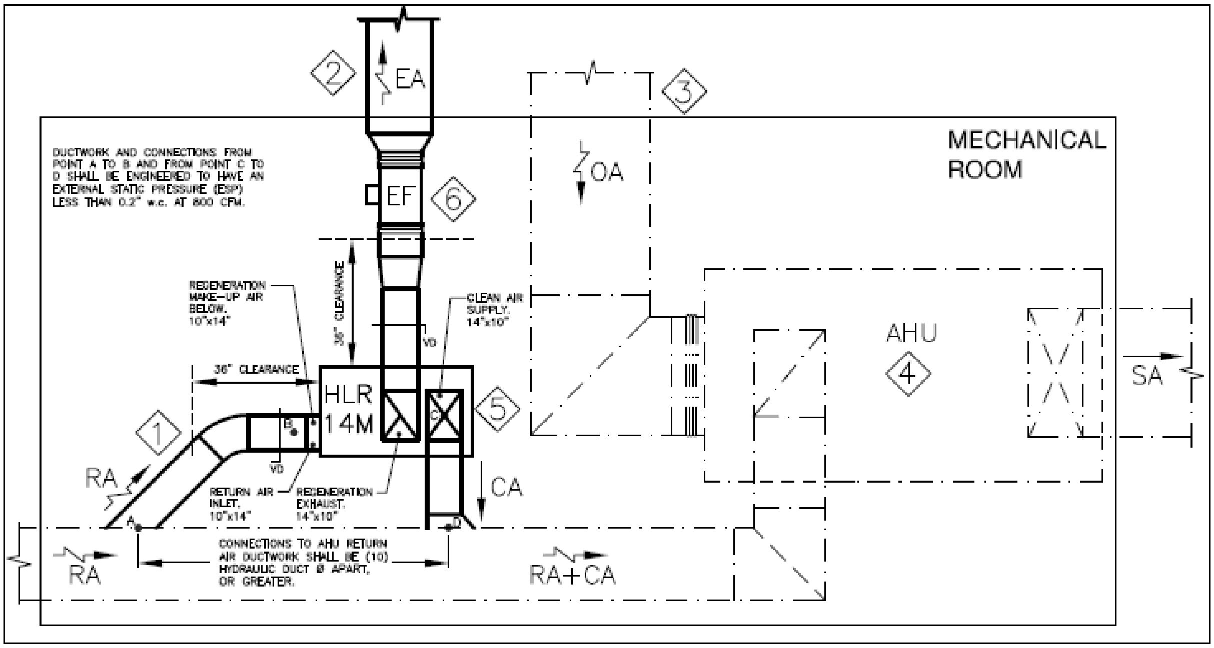
1. HLR MODULE IS EQUIPPED WITH A 14" X 10" EXHAUST OUTLET.
2. HLR MODULE IS EQUIPPED WITH A 14" X 10" CLEAN AIR OUTLET.
3. HLR MODULE IS EQUIPPED WITH A 14" X 10" RETURN AIR INLET.
4. HLR MODULE IS EQUIPPED WITH A 14" X 10" REGENERATION MAKE–UP AIR INLET.
5. SEE HLR TECHNICAL GUIDE FOR DETAILED CLEARANCE REQUIREMENTS DRAWINGS.

**6 (OPTIONAL) AUXILIARY EXHAUST FAN:**

1. SPECIFY VARIABLE SPEED FAN WITH AN OPERATING AIRFLOW OF 300 CFM AND EXTERNAL STATIC PRESSURE ENGINEERED TO OVERCOME DUCT PRESSURE DROP.
2. FAN SHALL INCLUDE PRESSURE SENSOR.
3. FAN SHALL BE CONTROLLED BY HLR MODULE VIA HARDWIRE OR BACnet
4. INCLUDE VIBRATION ISOLATION (I.E. FLEX DUCT CONNECTORS)

## Integration Drawing 2 – Indoor Installation – Ducted Return

| | |
|---|---|
| Conditions | 1. HLR module(s) are integrated with an AHU located in a mechanical room.<br>2. Outside air and return air are ducted directly to AHU.<br>3. The AHU supplies mixed air. |




NTS

**LEGEND:**

| | |
|---|---|
| VD | VOLUME DAMPER |
| SA | SUPPLY AIR |
| RA | RETURN AIR |
| MA | MIXED AIR |
| OA | OUTSIDE AIR |
| RA | RETURN AIR |
| CA | CLEAN AIR |
| EF | EXHAUST FAN |

### KEYED NOTES:

**1 RETURN AIR**

1. DUCTED CONNECTION FROM AHU RETURN AIR DUCT TO HLR MODULE RETURN AIR INLET.

**2 HLR REGENERATION EXHAUST:**

1. HLR MODULE EXHAUST DUCTWORK AND CONNECTION TO BUILDING EXHAUST LOUVER OR DUCT SHALL BE ENGINEERED TO HAVE AN EXTERNAL STATIC PRESSURE (ESP) LESS THAN 0.2" w.c AT 300 CFM.
2. EXHAUST DUCTWORK SHALL BE INSULATED. HLR EXHAUST IS HOT & HUMID.

**3 OUTSIDE AIR:**

1. CONTROLLED BY BUILDING MANAGEMENT SYSTEM TO MAINTAIN IAQP MINIMUM OUTSIDE AIR FLOW RATE.

**4 AIR HANDLING UNIT:**

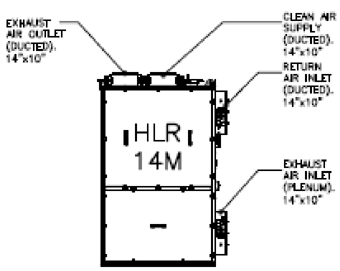
1. AHU INTAKE DRAWS MIXED AIR (RETURN AIR, CLEANED AIR FROM HLR MODULE, AND OUTSIDE AIR)

**5 HLR MODULE(HLR–14M):**

1. HLR MODULE IS EQUIPPED WITH A 14" X 10" EXHAUST OUTLET.
2. HLR MODULE IS EQUIPPED WITH A 14" X 10" CLEAN AIR OUTLET.
3. HLR MODULE IS EQUIPPED WITH A 14" X 10" RETURN AIR INLET.
4. HLR MODULE IS EQUIPPED WITH A 14" X 10" REGENERATION MAKE–UP AIR INLET.
5. SEE HLR TECHNICAL GUIDE FOR DETAILED CLEARANCE REQUIREMENTS DRAWINGS.

**6 (OPTIONAL) AUXILIARY EXHAUST FAN:**

1. SPECIFY VARIABLE SPEED FAN WITH AN OPERATING AIRFLOW OF 300 CFM AND EXTERNAL STATIC PRESSURE ENGINEERED TO OVERCOME DUCT PRESSURE DROP.
2. FAN SHALL INCLUDE PRESSURE SENSOR.
3. FAN SHALL BE CONTROLLED BY HLR MODULE VIA HARDWIRE OR BACnet
4. INCLUDE VIBRATION ISOLATION (I.E. FLEX DUCT CONNECTORS)

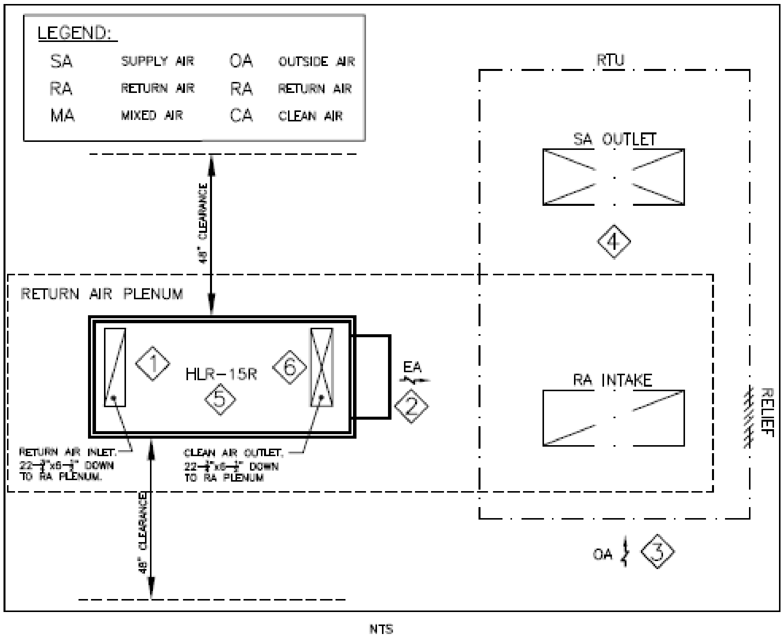



HLR–14M ELEVATION

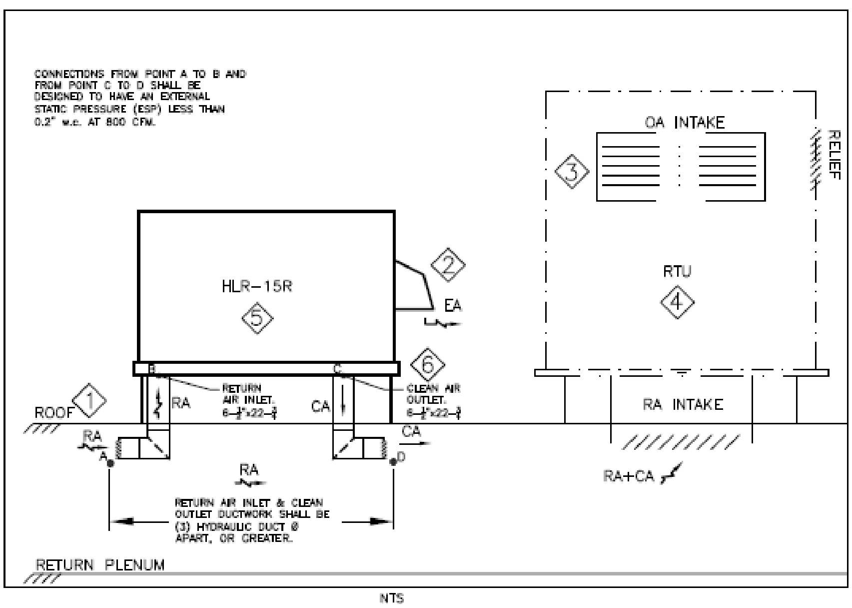
## Integration Drawing 3 – Rooftop Penetration Installation

| | |
|---|---|
| Conditions | 1. HLR module(s) are integrated with a roof top unit (RTU)<br>2. Return air to the RTU is from the plenum below. |

PLAN VIEW:




ELEVATION VIEW:




**1 RETURN AIR CONNECTION:**

1. SPECIFYING THE EXACT LOCATION FOR THE RETURN AIR INLET CONNECTION REQUIRES BEING COGNIZANT OF THE DIRECTION OF AIRFLOW AND PRESSURE WITHIN THE PLENUM.
2. THE RETURN AIR CONNECTION MUST BE POSITIONED UPSTREAM OF THE CLEAN AIR OUTLET CONNECTION TO PREVENT BACKFLOW OF CLEAN AIR TO THE RETURN AIR INLET (SHORTCIRCUITING).

**2 HLR EXHAUST:**

1. DIRECT EXHAUST FROM HLR MODULE TO ATMOSPHERE.
2. DESIGN AIRFLOW 300 CFM @ 0.2" w.c. ESP.

**3 OUTSIDE AIR:**

1. CONTROLLED BY BUILDING MANAGEMENT SYSTEM TO MAINTAIN IAQP MINIMUM OUTSIDE AIR FLOW RATE.

**4 ROOF TOP UNIT:**

1. RTU DRAWS MIXED AIR (RETURN AIR, CLEAN AIR FROM HLR MODULE, AND OUTSIDE AIR).

**5 HLR MODULE(HLR-15R):**

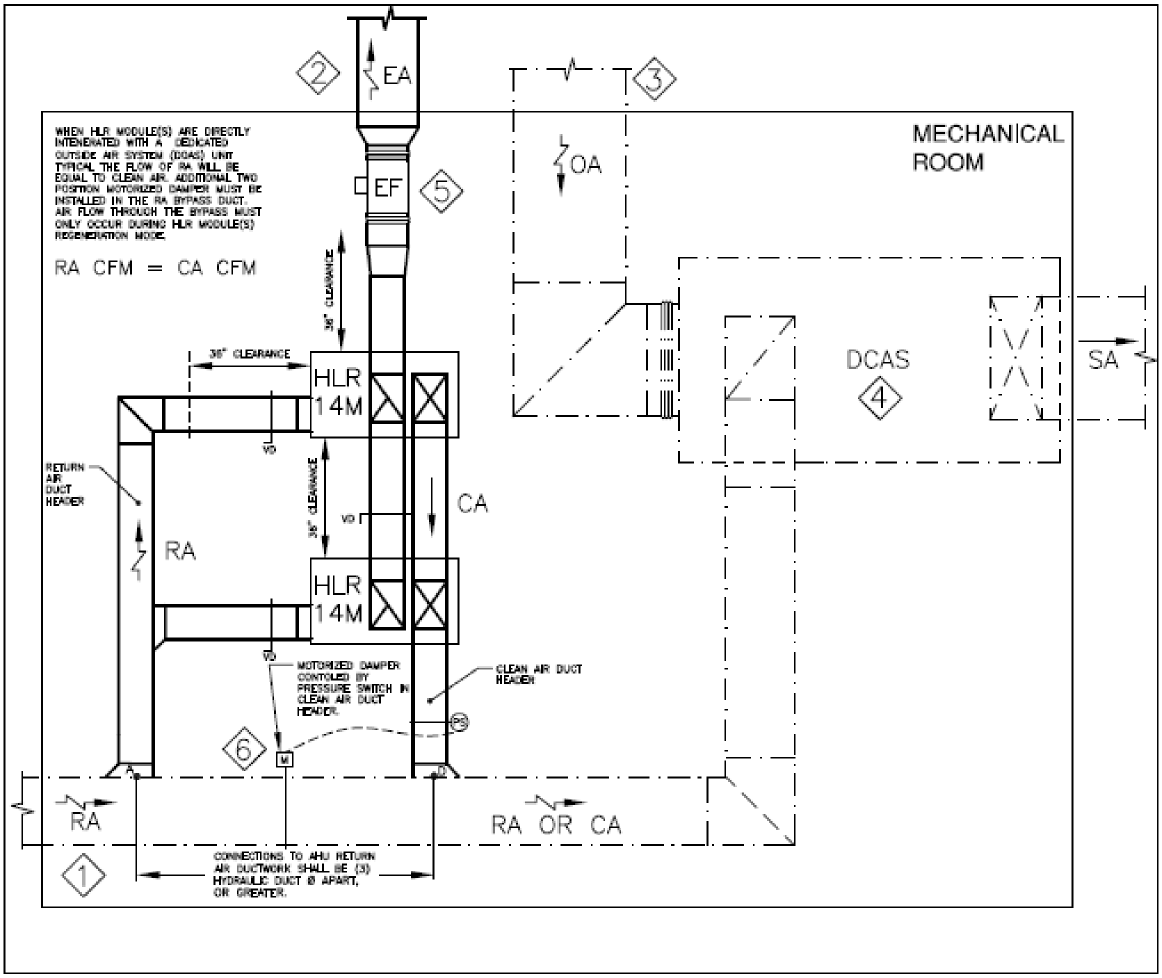
1. HLR MODULE IS EQUIPPED WITH A 6.5"x 22.75" CLEAN AIR OUTLET.
2. HLR MODULE IS EQUIPPED WITH A 6.5"x 22.75" RETURN AIR INLET.
3. HLR IS EQUIPPED WITH AN EXHAUST AIR OUTLET WITH HOOD.
4. SEE CLEARANCE ALLOWANCES IN TECHNICAL GUIDE.

**6 CLEAN AIR CONNECTION:**

1. SPECIFYING THE EXACT LOCATION FOR THE CLEAN AIR CONNECTION REQUIRES BEING COGNIZANT OF THE DIRECTION OF AIRFLOW AND PRESSURE WITHIN THE PLENUM.
2. THE CLEAN AIR OUTLET CONNECTION MUST BE POSITIONED DOWNSTREAM OF THE RETURN AIR INLET CONNECTION TO PREVENT BACKFLOW OF CLEAN AIR TO THE RETURN AIR INLET (SHORTCIRCUITING).

## Integration Drawing 4 – Dedicated Outside Air Unit

| Conditions | 1. HLR module(s) are integrated with a dedicated clean air system (DCAS)<br>2. Scheduled return air flow to the AHU is equal to the scheduled clean air flow from the HLR Module(s) |
|---|---|




NTS

**LEGEND:**

| | |
|---|---|
| VD | VOLUME DAMPER |
| SA | SUPPLY AIR |
| RA | RETURN AIR |
| MA | MIXED AIR |
| OA | OUTSIDE AIR |
| RA | RETURN AIR |
| CA | CLEAN AIR |
| EF | EXHAUST FAN |

**KEYED NOTES:**

**1 RETURN AIR**

1. DUCTED CONNECTION FROM AHU RETURN AIR DUCT TO HLR MODULE RETURN AIR INLET.

**2 HLR REGENERATION EXHAUST:**

1. HLR MODULE EXHAUST DUCTWORK AND CONNECTION TO BUILDING EXHAUST LOUVER OR DUCT SHALL BE ENGINEERED TO HAVE AN EXTERNAL STATIC PRESSURE (ESP) LESS THAN 0.2" w.c AT 300 CFM.
2. EXHAUST DUCTWORK SHALL BE INSULATED.

**3 OUTSIDE AIR:**

1. CONTROLLED BY BUILDING MANAGEMENT SYSTEM TO MAINTAIN IAQP MINIMUM OUTSIDE AIR FLOW RATE.

**4 DEDICATED CLEAN AIR SYSTEM (DCAS):**

1. DOAS UNIT CONVERTED TO DCAS UNIT WHERE HLR MODULE(S) CLEAN AIR FLOW EQUALS RETURN AIR FLOW.

**5 (OPTIONAL) AUXILIARY EXHAUST FAN:**

1. SPECIFY VARIABLE SPEED FAN WITH AN OPERATING RANGE OF COMBINED HLR MODULE(S) EXHAUST FLOW. FAN SHALL INCLUDE PRESSURE SENSOR OR AFMS.
2. FAN SHALL BE CONTROLLED BY HLR MODULE VIA HARDWIRE.
3. INCLUDE VIBRATION ISOLATION (I.E. FLEX DUCT CONNECTORS)

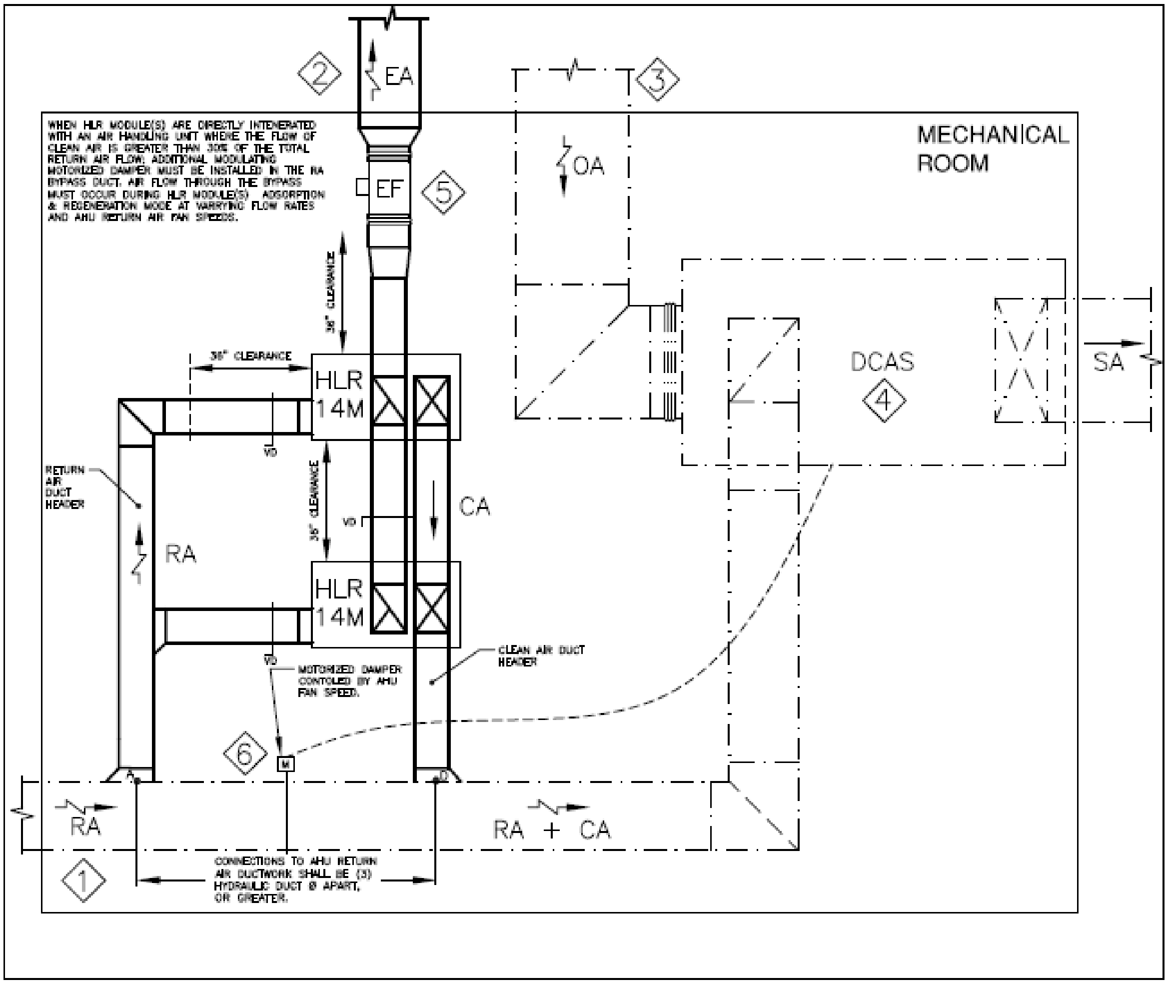
**6 RETURN AIR BY-PASS DAMPER:**

1. SPECIFY TWO-POISTION MOTORIZED DAMPER LOCATED IN THE RETURN AIR BY-PASS DUCT SECTION.
2. DAMPER CONTROLLED BY DIFFERENTIAL PRESSURE SWITCH LOCATED IN CLEAN AIR DUCT HEADER.

## Integration Drawing 5 – AHU or RTU w/ CA flow >= 30% RA flow

Conditions

1. HLR module(s) are integrated with a AHU where scheduled clean air flow rate > 30% schduled return air flow rate
2. Scheduled clean air flow is < 100% scheduled return air flow.




NTS

**LEGEND:**

| | |
|---|---|
| VD | VOLUME DAMPER |
| SA | SUPPLY AIR |
| RA | RETURN AIR |
| MA | MIXED AIR |
| OA | OUTSIDE AIR |
| RA | RETURN AIR |
| CA | CLEAN AIR |
| EF | EXHAUST FAN |

### KEYED NOTES:

**⟨1⟩ RETURN AIR**

1. DUCTED CONNECTION FROM AHU RETURN AIR DUCT TO HLR MODULE RETURN AIR INLET.

**⟨2⟩ HLR REGENERATION EXHAUST:**

1. HLR MODULE EXHAUST DUCTWORK AND CONNECTION TO BUILDING EXHAUST LOUVER OR DUCT SHALL BE ENGINEERED TO HAVE AN EXTERNAL STATIC PRESSURE (ESP) LESS THAN 0.2" w.c AT 300 CFM.
2. EXHAUST DUCTWORK SHALL BE INSULATED.

**⟨3⟩ OUTSIDE AIR:**

1. CONTROLLED BY BUILDING MANAGEMENT SYSTEM TO MAINTAIN IAQP MINIMUM OUTSIDE AIR FLOW RATE.

**⟨4⟩ DEDICATED CLEAN AIR SYSTEM (DCAS):**

1. DCAS UNIT CONVERTED TO DCAS UNIT WHERE HLR MODULE(S) CLEAN AIR FLOW EQUALS RETURN AIR FLOW.

**⟨5⟩ (OPTIONAL) AUXILIARY EXHAUST FAN:**

1. SPECIFY VARIABLE SPEED FAN WITH AN OPERATING RANGE OF COMBINED HLR MODULE(S) EXHAUST FLOW. FAN SHALL INCLUDE PRESSURE SENSOR OR AFMS.
2. FAN SHALL BE CONTROLLED BY HLR MODULE VIA HARDWIRE.
3. INCLUDE VIBRATION ISOLATION (I.E. FLEX DUCT CONNECTORS)

**⟨6⟩ RETURN AIR BY–PASS DAMPER:**

1. SPECIFY MODULATING MOTORIZED DAMPER LOCATED IN THE RETURN AIR BY–PASS DUCT SECTION.
2. DAMPER CONTROLLED BY AHU FAN SPEED.

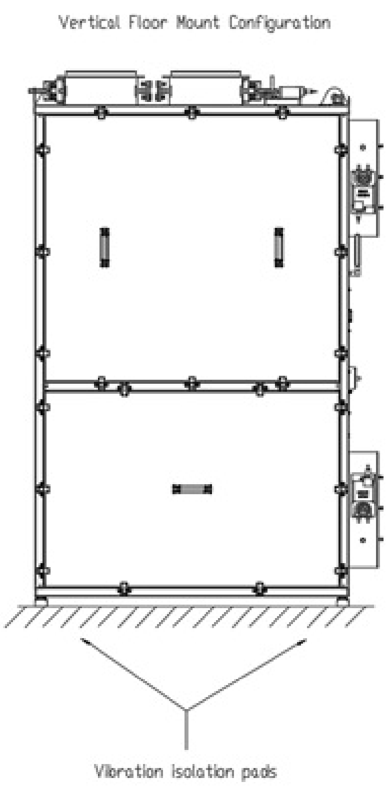
# Section 6 – Installation Configurations

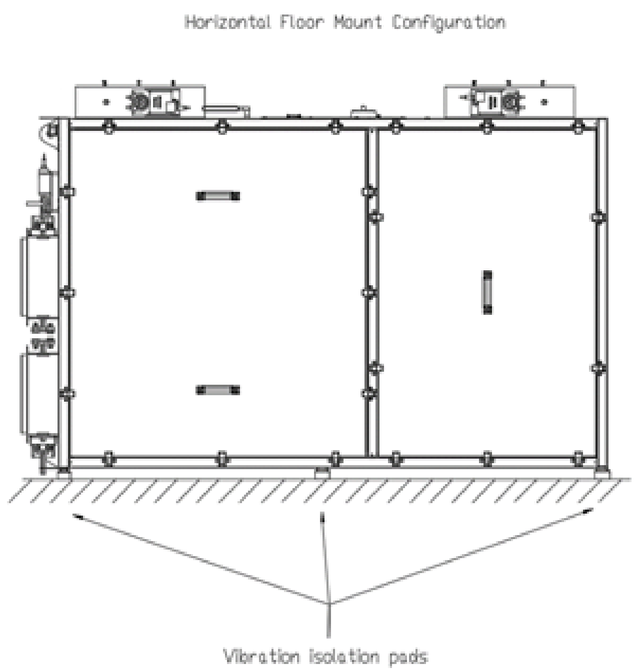
## Introduction

This section provides an overview of the different configurations the HLR module can be installed in. The indoor model - HLR 14M, can be either mounted on the floor (vertically/horizontally). The outdoor model - HLR 15R, can be mounted on a roof curb or structural dunnage for outdoor rooftop applications. Please refer to the “Installation Section” in the installation manual for detailed installation instructions and clearance requirements. *Note: The cartridge door should not face downwards in any installation. The HLR Module should not be placed in egress spaces and should be easily accessible for service and maintenance.*

## Floor Mounted (14M)

In this configuration the indoor modules can be placed either on its base vertically or on its side horizontally as shown in the schematic below. The unit will be placed on four vibration isolation pads in vertical orientation and six vibration isolation pads in the horizontal orientation.



# Section 7 – HLR Clusters

## Introduction

Multiple HLR modules serving common ventilation system and/or ventilation zone are considered an "HLR Cluster". Clusters can serve plenum or ducted return systems.

In design scenarios where multiple HLR modules are recommended for a common ventilation system and/or ventilation zone implementation of an HLR Cluster design will make the overall integration of HLR modules into a project more efficient, more effective, and reduce overall installation costs.

The project specific IAQP report submitted by enVerid or the calculation the designer has completed using the enVerid IAQP Calculator® tool will help the designer understand the quantity of HLR modules recommended for each ventilation system and/or ventilation zone.

## HLR Cluster Serving a Plenum

A cluster of HLR Modules integrated into a plenum may follow the integration concept outlined in Integration Drawing #1 & Figure 7.1.

*HLR Modules should never be installed in series—clean air from one HLR Module flowing, or shortcutting through another HLR Module.*

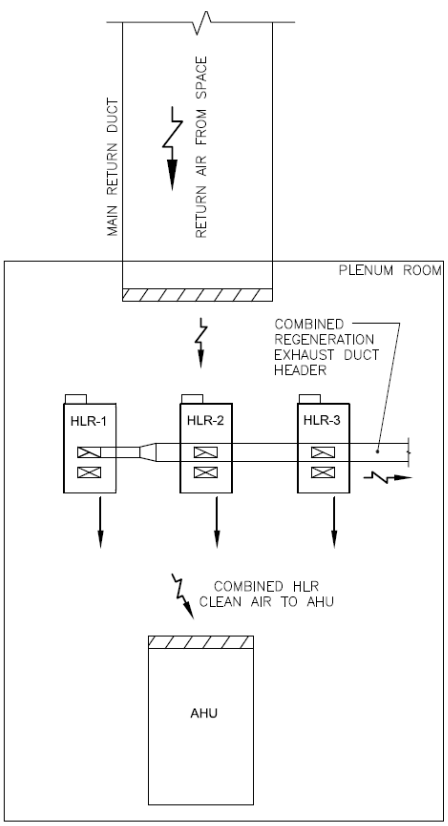



Figure 7.1: HLR Cluster in Mechanical Room Plenum Cluster – (3) HLR-14M units providing clean air to a common return plenum

## HLR Cluster Ducted Application

In a ducted application the major advantage of an HLR Cluster is the ability for the designer to combine the adsorption air inlet & outlet ductwork, as well as combine regeneration exhaust ductwork and optional auxiliary exhaust fan, see Section 8—"Regeneration Integration”.

Combined duct headers in adsorption mode should be sized for full combined adsorption airflow (HLR Modules operating in adsorption mode concurrently). See Figure 7.2 showing (3) HLR Modules serving a common ventilation system via return air and clean air duct headers.

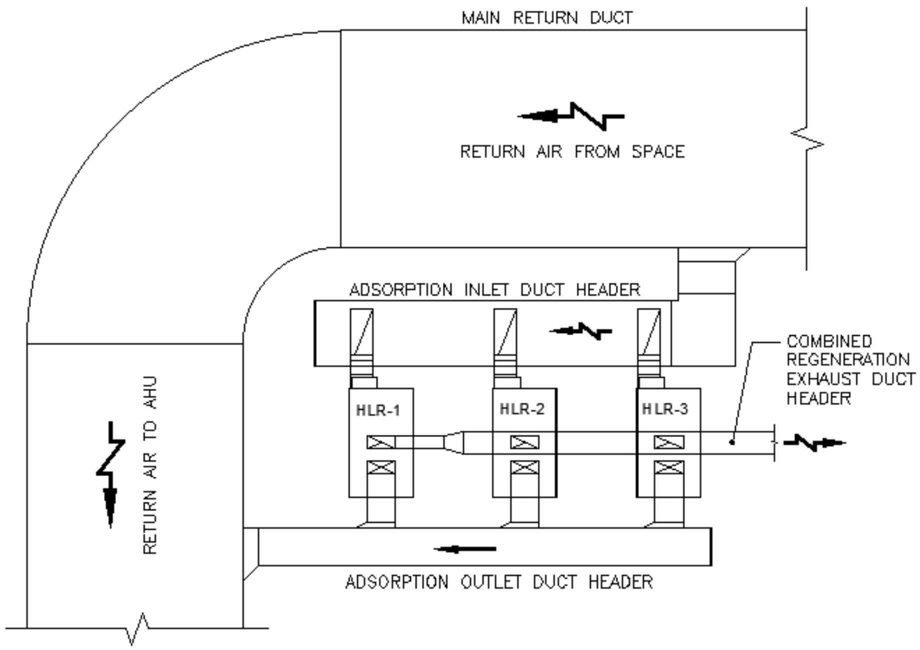



Figure 7.2: HLR Cluster – (3) HLR-14M units in cluster configuration providing clean air to a common return air duct system.

## Cluster Controls Considerations

Using an HLR Cluster can allow for the designer to reduce the control wiring and landing points at the local BAS panel. A cluster of modules will operate in tandem during adsorption mode, as a single module, and will share controls points and equipment as required. When specifying controls for a cluster application, the size of the cluster may require further consideration, i.e. regeneration groups, power consumption, and exhaust airflow, this is addressed in Section 8—“Regeneration” and the enVerid “Control Guidelines”.

# Section 8 – Regeneration Integration

## Introduction

### What is Regeneration?

Regeneration is a process that occurs within an HLR module when the sorbent cartridge has become saturated and can no longer effectively adsorb containments from the air. During this process the HLR module is closed off from the ventilation system it typically serves. To "Regenerate" the sorbent cartridges they must be heated to a temperature between 130°F-150°F. Once the sorbent is heated the internal HLR fans draw 300 CFM through the unit, across the heating coil, over the sorbent cartridge, and then the air (now containing the released contaminants) is exhausted to the atmosphere. This process happens intermittently.

### When does Regeneration Occur?

Regeneration occurs as needed based on a schedule created for each building occupancy profile. Regeneration can occur both during the nighttime unoccupied hours, and the daytime occupied hours. (Frequency of regeneration is driven by $CO_2$).

<u>HLR modules must be integrated with a mechanical ventilation system such that they have the capability of regenerating during both unoccupied and occupied modes of building operation.</u>

### Integration

Regeneration exhaust air is not to be sent through energy recovery devices. HLR exhaust is intermittent and requires its own dedicated exhaust (utilizing the internal HLR module exhaust fan, and in some applications, with the assistance of a dedicated auxiliary exhaust fan).

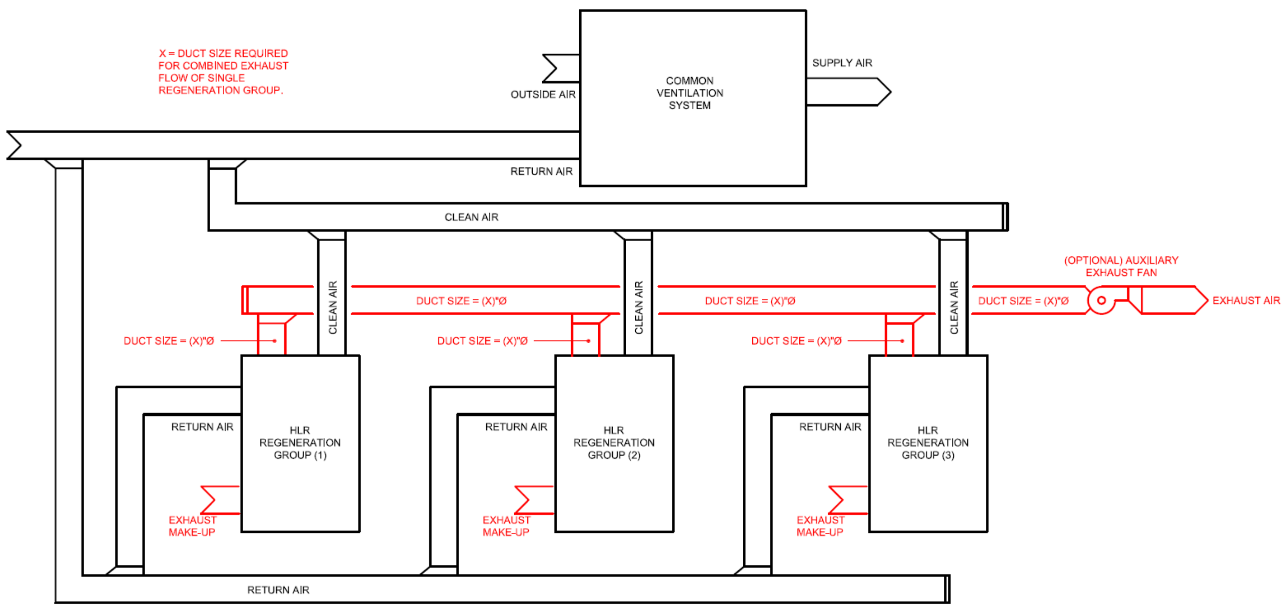
Due to temperature of regeneration air from the HLR module(s); exhaust ductwork must be insulated in accordance with local codes and standards.

| Regeneration Scenarios | Applicable Regeneration Schemes: |
|---|---|
| Scenario 1: Single HLR Module | See Integration Drawing #1 for regeneration design requirements including (optional) auxiliary exhaust fan |
| Scenario 2: HLR Cluster regeneration | See below table Regeneration Scenarios—HLR Clusters for further discussion and design requirements including controls considerations for (optional) auxiliary exhaust fan requirements. |
| Scenario 3: Multiple HLR Modules, each serving independent ventilation systems with shared dedicated regeneration exhaust | See below table Regeneration Scenarios—HLR Exhaust Riser for further discussion and design requirements including controls considerations for (optional) auxiliary exhaust fan requirements. |

## Regeneration Scenarios—HLR Clusters

Ductwork Design Considerations:

Due to the power load of the heating coils during regeneration, modules within a cluster are generally staged in **regeneration groups** to stagger the regeneration over a longer period. This also allows the associated ductwork to be sized at the reduced airflow of each regeneration group rather than the full volume of the cluster (see in red below). Regeneration groups should be made up of an equal number of HLR modules when possible. The number of recommended regeneration groups is determined by building operating hours, occupant profile, and occupant density—a typical office building unoccupied mode runs ~12 hours, resulting in a maximum of three regeneration groups (each regeneration group takes ~4 hours to complete a full regeneration). The heating coil in each module operates on a single phase; by regenerating one regeneration group at a time, the electrical load can be balanced across the three phases of the electrical service entering the building.




Controls Considerations:

Regeneration mode occurs for a **regeneration group** based on schedules uploaded to each HLR module in a regeneration group. All units communicate with the BMS. Refer to the enVerid "Control Guidelines" for detailed information.

Auxiliary Exhaust Fan Considerations:

- In the scenario that the regeneration group within a cluster are not made up of an even quantity of HLR Modules, the auxiliary exhaust fan must be capable of the full flow of the largest regeneration group with the ability to modulate flow down to that required of the smallest regeneration group.
- The fan should be selected with multi-speed capability based on local differential pressure sensor.

## Regeneration Scenarios—HLR Exhaust Riser

Ductwork Design Considerations:

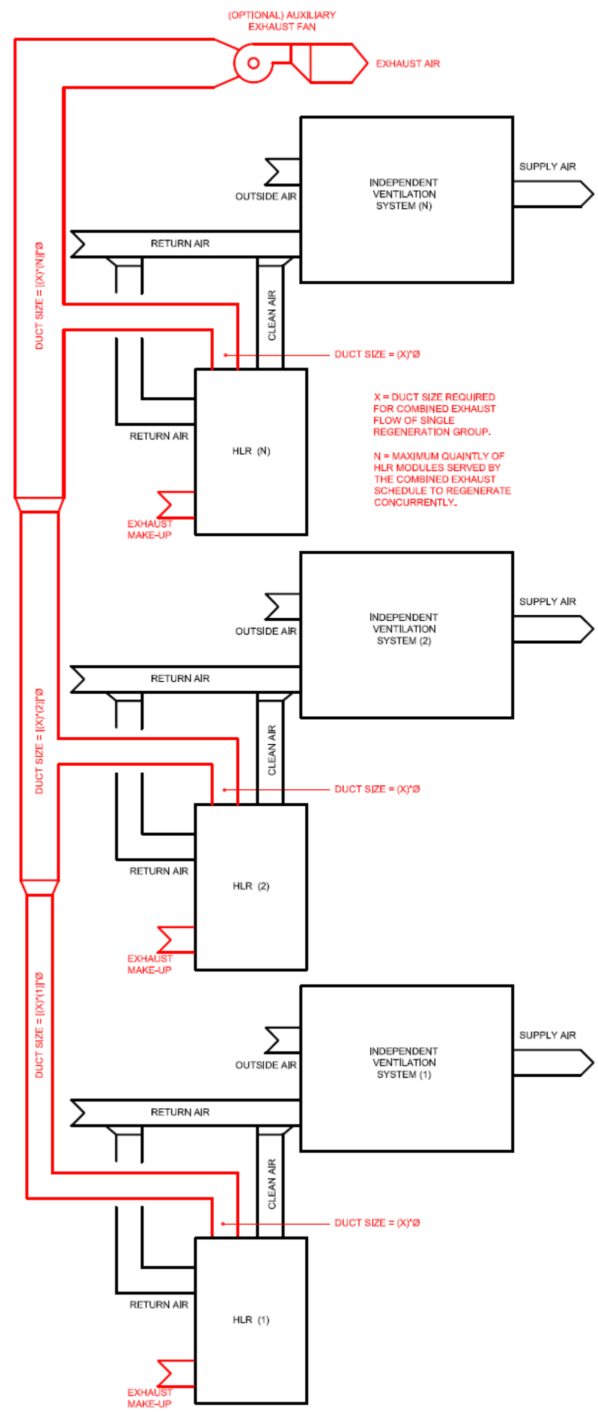
Multiple HLR modules located on different floors each serving independent ventilation systems; connected to a common HLR exhaust riser (see in red to the right). Using regeneration schedules the exhaust riser must be sized for a maximum exhaust CFM load and a minimum exhaust CFM load (regeneration scheduling is determined by each independent ventilation system).

Controls Considerations:

Regeneration mode occurs at each independent HLR module whenever the schedule calls for it. Each HLR module in the riser will be controlled independently of the others and may have separate regeneration schedules. Refer to the enVerid "Control Guidelines" for detailed information.

Auxiliary Exhaust Fan Requirements:

- Fan should be sized to accommodate the minimum and maximum airflow for the maximum quantity of HLR modules in regeneration mode concurrently, with ability to turn down to minimum airflow requirement.
- Fan should be selected with multi-speed capability based on duct static pressure sensor within the HLR exhaust ductwork.



# Section 9 – HLR Module Ductwork Connections

## Introduction

### Inducing flow through HLR Module

Inducing a side stream airflow in a heavily negative pressure return duct main presents unique duct design challenges. enVerid has identified two solutions commonly used by designers and which have been deployed in the field.

*These methods are not required, and HLR Modules ducted conventionally with return are systems will function as intended, below measures are suggestions for improved operation.*

### Subduct Solution

Installing a subduct into the return duct air stream can help direct flow into the HLR return air intake. The branch connection to the HLR protrudes through the main return duct wall and into the airstream to direct the flow into the branch. Please see Figure 9.1 below describing the solution.

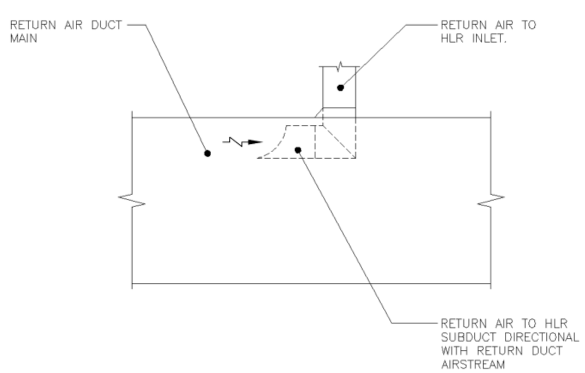



Figure 9.1: Subduct Branch Inlet

### Venturi Effect—duct upsizing Solution

An increase in the cross-sectional area of the main return duct in the localized section where the HLR return air inlet branch connection occurs will cause the velocity of the air flow in that section to decrease, resulting in an increase in static pressure in that duct section—the venturi effect. As the duct returns to its original design size; the static pressure decreases as the velocity increases. This will cause a pressure differential across the HLR unit inlet and outlet connections, which will assist the induction of flow through the unit. An increase in in cross-sectional area of >= 30% recommended. Please see Figure 9.2 below showing the venturi effect.

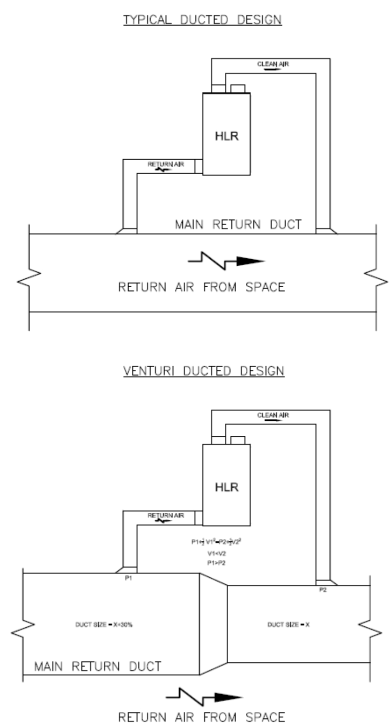



Figure 9.2: Venturi Flow Induction

## About enVerid

enVerid Systems, Inc. is committed to improving energy efficiency and indoor air quality worldwide through its innovative HVAC Load Reduction® (HLR®) solutions. Awarded the prestigious 2016 R&D 100 Award, enVerid is the only solution that helps commercial, education and government buildings remove carbon dioxide ($CO_2$), aldehydes, volatile organic compounds (VOCs) and particulate matter ($PM_{2.5}$) from indoor air, reducing the outside air intake required for ventilation. enVerid's HLR technology is ASHRAE-compliant and has been recognized by the U.S. Department of Energy, the US General Services Administration's Green Proving Ground Program, and the U.S. Green Building Council. For more information, please visit www.enverid.com

## Technical Support

For additional support required during installation or operation, please contact *enVerid Technical Support*:

www.enverid.com

+1.617.795.4000

infor@enverid.com

# Appendix A

# Engineer Toolkit

## AutoCad(*.dwg) Downloads

Drawing Blocks

- HLR-14M
- HLR-15R

Engineering Details

- HLR-14M
- HLR-15R

Equipment Schedules

- HLR-14M
- HLR-15R

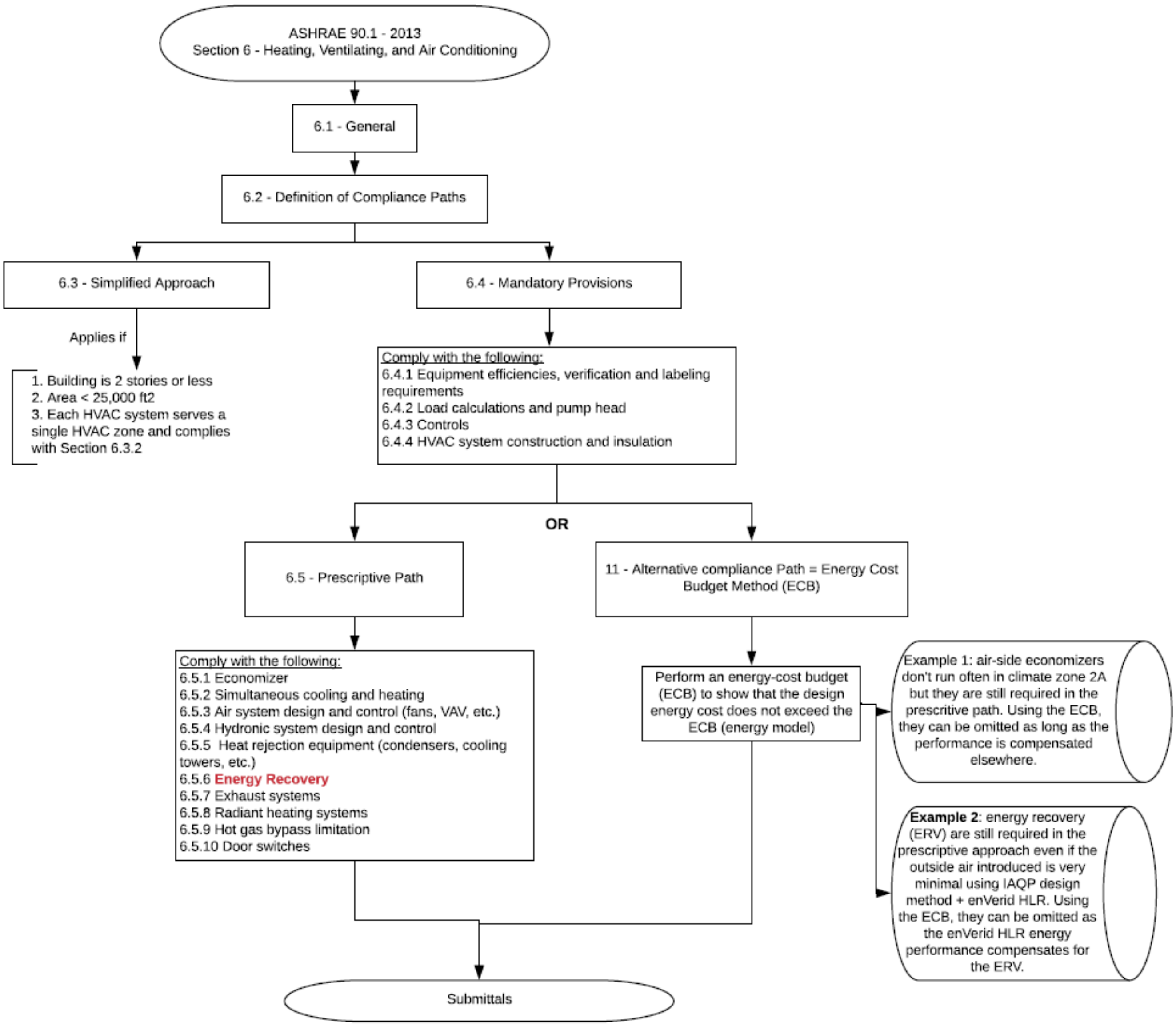
## Revit(*.RFA) Downloads

Equipment Families

- HLR-14M
- HLR-15R

# Appendix B

## ASHRAE 90.1 – 2013 Compliance Pathways Flow Chart.



# Thank you

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