CHAPTER/REGIONAL TECHNOLOGY AWARD - SHORT FORM

1. Category - Check one and indicate New, Existing, or Existing Building Commissioning (EBCx)

☐ Commercial Buildings	☐ New	☐ Existing or	☐ EBCx	
Institutional Buildings:				
☐ Educational Facilities	☐ New	☐ Existing or	☐ EBCx	
☐ Other Institutional	☐ New	☐ Existing or	☐ EBCx	
☐ Health Care Facilities	☐ New	☐ Existing or	☐ EBCx	
☐ Industrial Facilities or Processes	☐ New	☐ Existing or	☐ EBCx	
☐ Public Assembly	☐ New	☐ Existing or	☐ EBCx	
☒ Residential (Single and Multi-Family)				

2. Name of building or project: St. Louis County Residence Single Family New Construction

City/State: St. Louis County, Missouri

3. Project Description: Energy Efficient New Construction Single Family Residence

Project Study/Design Period: 02/2016 (Begin date (mm/yyyy)) to 02/2017 (End date (mm/yyyy))

Percent Occupancy at time of submission: 100%

4. Entrant (ASHRAE member with significant role in project):

a. Name: Malone, Brian M. (Last, First, Middle)

Membership Number: 8050506

Chapter: Illinois

Region: VI

b. Address (including country): 30 N. Wolf Road, 2nd Floor

Hillside (City) IL (State) 60162 (Zip) USA (Country)

c. Telephone: (O) 708-236-0300 x123 d. Email: bmalone@elaraeng.com

e. Member's Role in Project: Lead Engineer/Project Manager

f. Member's Signature:

5. Engineer of Record: Donald J. McLauchlan

By affixing my signature above, I certify that the information contained in this application is accurate to the best of my knowledge. In addition, I certify that I have discussed this entry with the owner and have received permission from the owner to submit this project to the ASHRAE Technology Awards Competition.

St. Louis County Residence (St. Louis County, MO)
Building Type: Single Family Residence
Gross Square Footage: 19,100
Stories: 3 plus basement
Amenities: Heated Outdoor Pool w/Pool House, Media Rm, Wine Cellar, Elevator, Roof Deck, Gardens
MEP Systems: Geothermal Water Source Heat Pumps w/ Vertical Well-Field, Makeup Air Unit w/ Heat Recovery, VRF, Humidification, Gravity Wall Units, In-Floor Radiant, High-Efficiency Lighting, Back-Up Generator, Integrated Digital Controls
Number of Geothermal Wells: 22 at 300 ft depth
Building Construction: 2017-2020 (Designed: 2016-2017)

Project Summary

This project constructed a new, luxury single-family home in the suburbs of St. Louis, Missouri incorporating green and state-of-the art technologies to achieve an energy efficient and comfortable home environment for the residential owner. The project engaged a European-based climate consultant at the conceptual phase to assist in establishing the project energy goals and resulting basis of design.

Elara Engineering was enlisted to develop, design, and detail the mechanical, electrical, and plumbing (MEP) systems for the new residence based on the initial concept and to serve as the project's Engineer of Record. Elara's work included close coordination with the international climate consultant, Architect, and Owner's representative to finalize and execute the basis of design. The final project included a vertical-well geothermal heating and cooling system serving water-to-water heat pumps providing the ability to independently heat or cool spaces throughout the new home as well as preheat domestic water. The primary delivery source of heating is radiant floors during the winter with low temperature hot water supplied from the geothermal heat pump system and heating supplemented by gravity wall units located within the spaces. The primary source of cooling for the home is accomplished by the gravity wall units that have a dual temperature coil with changeover valves at each zone. A dedicated outside air system (DOAS) with heat recovery and capability for recirculation provides mechanical ventilation, humidification, and supplemental cooling for event spaces. The outside air intake opening for the DOAS unit is located remotely from the residence and ducted via in-ground ducts. The in-ground ductwork was designed to provide pre-heating / cooling of the outside air.

The gravity wall units installed throughout the home (total 63) are the primary system for cooling and secondary for heating. Additionally, the gravity wall units provide transitional heating during the swing seasons due to the thermal mass and delay of the radiant floors. The DOAS system supplements the gravity wall units in cooling and will recirculate air when additional air is supplied beyond what is required for pressurization and indoor air quality. Each gravity wall unit is equipped with a single dual temperature coil connected to the 4-pipe geothermal heat pump loop via zone changeover valves and a has variable speed tangential fan. While normally operating in the passive mode (thermally induced draft), the fan provides the capability of active (fan assisted) heating and cooling controlled by the central building automation system via a local thermostat. The prefabricated gravity wall units are not yet manufactured or actively marketed in the United States and were sourced from a European-based company where this product has been developed. Each gravity wall unit is installed within a wall cavity (generally constructed as part of the casework) of the room it serves that has strategically designed air openings at the top and bottom. When in cooling the coil creates a cold column that generates thermally induced convection (via thermal buoyancy) and provides cooling to the space using similar principles to displacement ventilation. The gravity walls each have a tangential fan that enhances air flow down the coil to boost its cooling capacity to handle extreme load conditions such as large gatherings.

There are three remote buildings that constitute the pool house, lounge, and locker rooms. These buildings are conditioned by a geothermal-source VRF system employing a simultaneous heating and cooling arrangement.

Energy Efficiency: The geothermal field serves the entire heating and cooling needs of the home, as well as pre-heating of the domestic hot water. Energy is recovered from the exhaust via an enthalpy wheel in the geothermal source makeup air unit. Perhaps the greatest reduction in energy associated with heating and cooling of the home is represented by the use of gravity wall units and radiant floors which minimize the need for fan

energy associated with the heating and cooling of spaces. Energy is circulated through the residence primarily by pumps utilizing water produced by the geothermal heat pump system. Additionally, the entire residence is controlled by a state-of-the-art, digital control system.

Indoor Air Quality: Natural ventilation is available throughout the home via operable windows. Mechanical ventilation is provided via a 100% outdoor air MAU equipped with MERV 11 filters, bi-polar ionization, and a humidifier. Indoor air quality is monitored by carbon dioxide sensors to ensure sufficient air change rates. Additionally, the mechanical makeup air provided reduces the building negative pressure and decreases infiltration thereby protecting the building façade and reducing draft. The state-of-the-art BAS also provides enhanced control of outdoor air and thermal comfort.

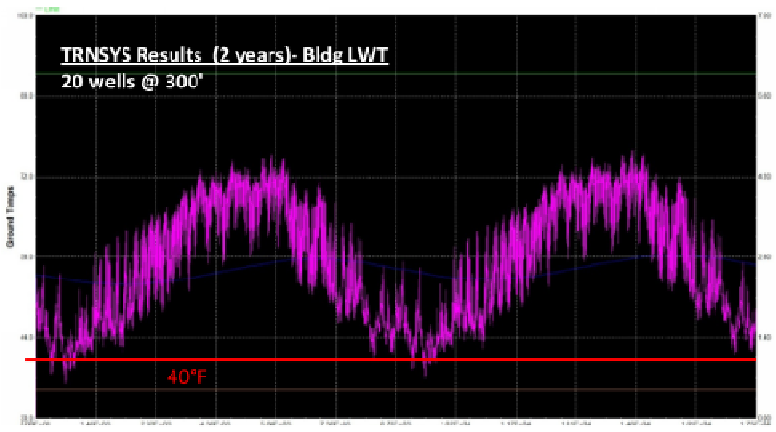
Innovation: Although the use of gravity wall units is new to the United States, the gravity wall units were selected for this residence for several reasons. First the residence is subjected to stringent zoning restrictions that limited the height of the residence resulting in limited ceiling space for ductwork and an inability to distribute the sufficiently sized ductwork for space conditioning while achieving the desired aesthetic. Additionally, the gravity walls normally operate quietly due to the natural induction of air flow. Finally, the gravity wall units fit with the desired sustainability performance and comfort expectations for the residence.

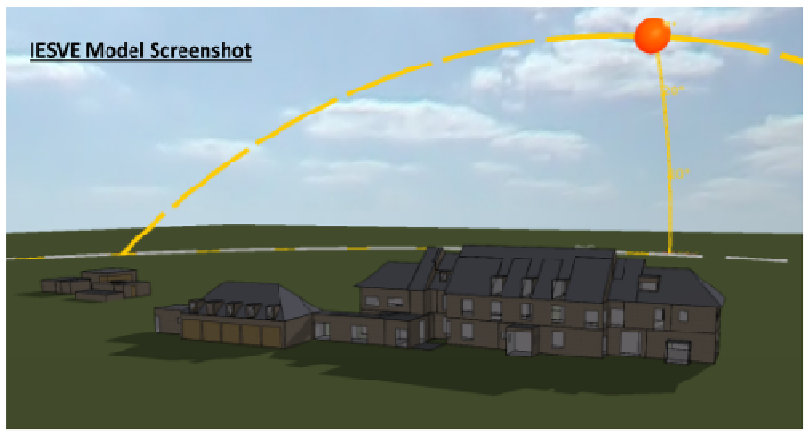
The performance expectations of the luxury residence owners are extremely high and there was significant sensitivity to aesthetic impact. Given these conditions, substantial effort was invested in performing detailed modeling and specification of the gravity wall units, including several operational mockups, both local to the residence as well as at Elara's office in Hillside, IL, for testing under a variety of conditions. The local mockup testing performed by Elara resulted in manufacturer design modifications to improve its condensate management. Additionally, a high level of coordination among the Owner's representative, the design team, and the construction team was required in order to mutually agree on the expectations, sourcing of the equipment/components, casework and trim, and installation of the gravity wall units and their associated valves. The integration of a new technology, not yet fully introduced in the US market, while making it beneficial to the overall operation of the new residence without substantial risk makes this a highly innovative component.

Operation and Maintenance: Despite the sophisticated controls and overall energy efficient design of the project, the system components were selected to allow for a large range of qualified personnel to service and maintain them. While gravity wall units are not commonplace in the US, their simplistic design and minimal components make them broadly serviceable. Additionally, though the gravity wall units were ultimately sourced from Europe, significant efforts were made during the design to ensure replacement components, specifically the gravity wall unit fans, could be sourced locally should repairs be required over the age of the building. Valve access was also carefully coordinated to allow for quick isolation of equipment and risers. Finally, the entire residence is backed up by a standby generator and the heat pump systems are capable of operating on standby power, heating the residence upon a loss of power and limiting the need for freeze protection.

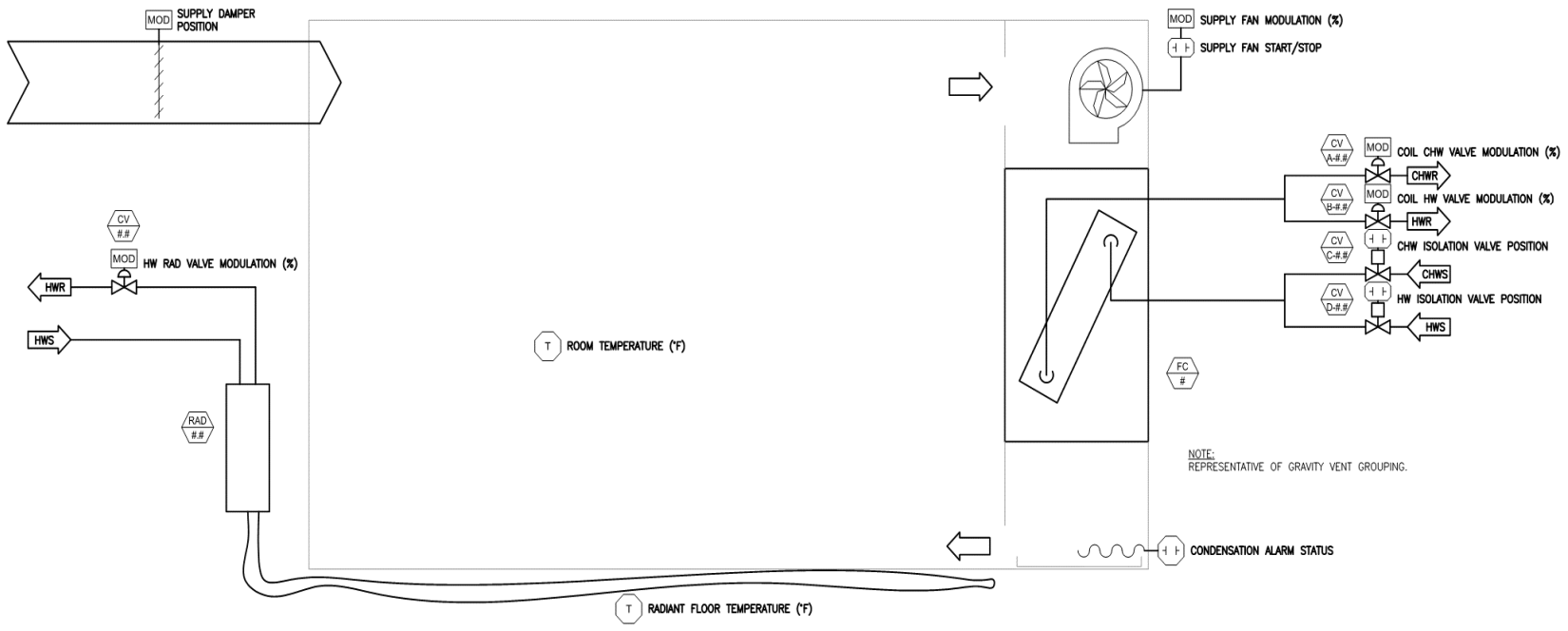
Cost Effectiveness: The new residence's systems and equipment were centered on sustainable design and high energy performance. While this attributed to a relatively high project capital cost, savings are realized in the annual energy reductions reflected in building operation and readiness to meet future carbon reduction goals and standards. Elara's design intent was to install systems and features that would outperform conventional measures in both energy performance and service life. Additionally, annual building loads were carefully analyzed in energy modeling software and a custom, parametric TRNSYS model to determine field performance and allowed for careful sizing to minimize project costs associated with the geothermal well field.

Environmental Impact: The systems designed as part of this project ultimately eliminate the residence's reliance on natural gas for space conditioning which reduces the greenhouse gas emissions associated with the building and prepares the site for potential carbon neutral or net zero operations in the future. Additionally, the use of a geothermal system with gravity wall units substantially reduced the amount of refrigerant present at the site when compared to typical split systems and other more commonly used residential/light commercial cooling equipment. The use of VRF was limited to remote buildings with seasonal usage.

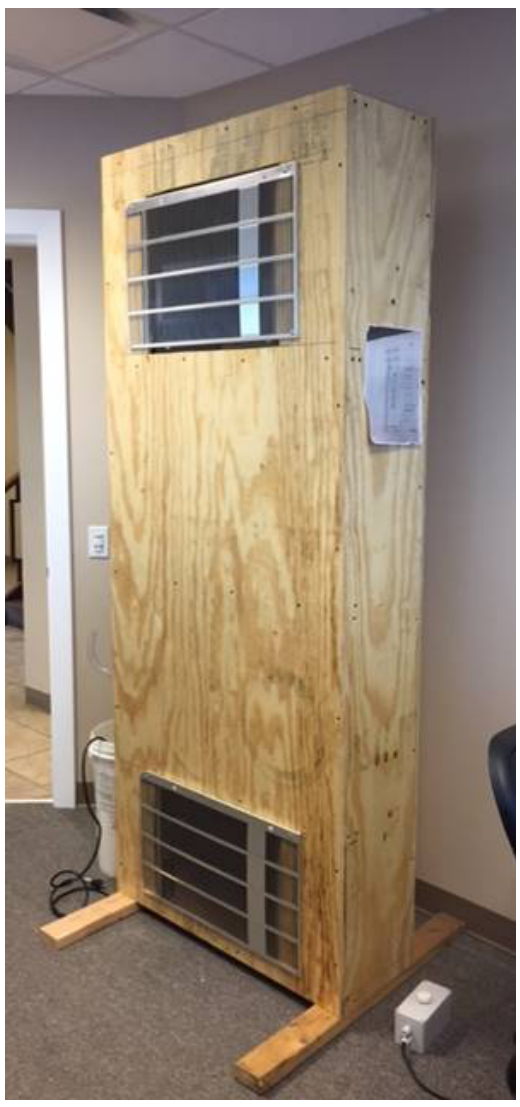




GEOTHERMAL ANALYSIS & ENERGY MODELING



1 **TYPICAL ROOM CONTROL DIAGRAM**
SCALE: NO SCALE



MOCK-UP #1

MOCK-UP #2

FINAL GRAVITY WALL UNIT