# ASHRAE TECHNOLOGY AWARDS APPLICATION FORM (Page 1)
## APPLICATION MUST BE COMPLETE TO BE CONSIDERED FOR JUDGING
## (Required for Society-Level Competition)

24

(For ASHRAE Staff Use Only)

## I. Identification (0 Points)

Name of building or project: Seattle Apartments

## II. Category - Check one and indicate New, Existing, or Retrocommissioning (RCx)

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

## III. Project Description (0 Points)

1. Type of building or process: Multifamily with Commercial TI
2. Size – gross floor area of building (ft. sq. or m. sq.): 425,747
3. Function of major areas (such as offices, retail, food services, laboratories, guest/patient rooms, laundry, operating rooms, warehouse/storage, computer rooms, parking, manufacturing, process, etc., or industrial process description:
   Multifamily, Retail, Offices, Parking
4. Project study period: 12/2010 (Begin date (mm/yyyy)) to Current (End date (mm/yyyy))
5. Project Occupancy and Operation Period: 07/2013 (Begin date (mm/yyyy)) to 03/2015 (End date (mm/yyyy))

## Project Description

The [redacted] Apartments project includes two new multifamily buildings and one adaptive reuse of an historic [redacted] building. The project covers an entire city block in the [redacted] neighborhood of Seattle, WA.

**Figure 1:** [redacted] **Aerial**

[redacted] provided HVAC and plumbing engineering services, energy efficiency consulting, and energy performance modeling. Innovative mechanical systems include a central heat pump water heating system in the largest of the two multifamily buildings, ductless heat pumps for 40% of the apartment units and common spaces, and rainwater catchment and reuse for urban agriculture on the roof. The historic [redacted] building took part in the City of Seattle's pilot of an outcome-based energy code; the first program in the nation to predicate energy code compliance on post-occupancy proof of highly efficient operations. The project also participated in a stormwater treatment pilot project with Seattle Public Utilities with two biofiltration swales providing primary treatment to stormwater run-off from the [redacted] neighborhood before discharging to [redacted].

This project is setting the tone for high levels of energy efficiency and sustainability in the rapid redevelopment of [redacted], one of the fastest growing neighborhoods in Seattle. The apartments are among the most energy efficient in the Pacific Northwest with measured EUI's of **19.8 kBtu/sf-yr** for the West Building and **27.1 kBtu/sf-yr** for the Southeast Building. The project also saved a beautiful old building to help retain some of the historic character of the neighborhood. The project achieved **LEED for Homes Platinum** certification and won the national 2013 *LEED for Homes Project of the Year* from the US Green Building Council. The project won 2014 PCBC Gold Nugget awards for Best Multifamily Housing Project and Best Sustainable Residential Community, and a 2014 Merit Award from the Washington Chapter of the American Society of Landscape Architects. The commercial portion of the project won a 2014 Sustainable Preservation award from Historic Seattle.

## Energy Efficiency

The project achieved ambitious targets for energy and water use reductions. These included:

- 50% energy reduction over ASHRAE 90.1-2007 baseline for multifamily buildings.
- 60% water use reduction over baseline for multifamily buildings.

These targets were achieved by focusing the design on known areas of high energy use:

**Domestic Hot Water:** The largest end-use in typical new Seattle midrise multifamily buildings is the DHW system[1]. The project uses an innovative Reverse Cycle Chiller (RCC) system for the larger West Building to reduce the DHW energy use by a factor of 3 compared to individual electric water heaters or a central gas boiler.[2]

**Apartment Space Heating:** The vast majority of midrise apartments in the Seattle market are heated with electric resistance. The space heating energy use was reduced by improved glazing and by providing ductless heat pumps (DHPs) for 40% of the apartments. Apartment units facing South and West were selected to receive DHPs as these apartments have the highest seasonal cooling loads. DHPs reduce heating energy by approximately a factor of 3.0 while adding only a very small amount of cooling energy in the relatively mild Seattle summer.

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1 [redacted] *Multifamily Billing Analysis: New Mid-Rise Buildings in Seattle.* [redacted]. Dec. 2009. Prepared for City of Seattle Department of Planning & Development.

2 [redacted]. *RCC Pilot Project Report: Multifamily Heat Pump Water Heaters in Below Grade Parking Garages in the Pacific Northwest.* [redacted]. August 2015. Prepared for Bonneville Power Administration Emerging Energy Efficient Technologies.

**Common Space Heating:** Tempering of ventilation air for the residential corridors in a typical new Seattle apartment with double-loaded corridors consumes as much energy as all of the apartment heating put together.[3] This is due to relatively large quantities of ventilation air continuously tempered by rooftop make-up air units; typically more than double the air required by ASHRAE Standard 62. This project targeted this portion of the energy use in a couple ways. First, the primary circulation stairs and elevator core are unconditioned and separated from the double-loaded corridors by weather-stripped doors. This creates a transition buffer zone between inside and outside, significantly reduces the envelope heat loss, and eliminates the leakiest portions of the corridors. The ventilation in the fully conditioned portion of the corridors is limited to 150% of the ASHRAE 62 minimum requirement and the corridors are conditioned with ductless heat pumps.

**Lighting and Appliances:** No incandescent lighting was used in the project. LED and flourescent lights allowed lighting power to be reduced to less than half of the code allowable levels. Motion sensors were used to control lights throughout residential common areas and in the drive aisles of the parking garage. All appliances are *EnergyStar* rated. Low flow plumbing fixtures were also used throughout.

The following table details the modeled and actual energy usage for the project shown as Energy Use Index (EUI) in kBtu/sf/yr.

**Table 1: Modeled Energy Performance (kBtu/sf-yr)**

| Building | 90.1 Baseline | Proposed | Actual | % Savings |
|---|---|---|---|---|
| **Southeast** | 41 | 29 | **27.1** | 34% |
| **West** | 48 | 28 | **19.8** | 59% |
| **Total** | 46 | 28 | 22.2 | 51% |

[3] Ibid 1.

## Indoor Environmental Quality

All occupied areas of the multifamily buildings (apartments, amenities, and corridors) receive continuous 100% outside air ventilation with rates based on ASHRAE Standard 62. In addition to continuous low flow ventilation in the apartments the occupants have control over spot ventilation fans for high speed exhaust. Continuous ventilation in the amenity areas is provided by energy recovery ventilation. Low/No VOC paints and finishes were used throughout the project. No occupant comfort or indoor air quality complaints have been registered by the property manager.

## Innovation

This building is among the first in the Pacific Northwest to utilize an innovative heat pump water heating system set up to reclaim heat from the below grade parking garage to heat domestic hot water for the apartment tenants. In 2009 [redacted] completed a feasibility study for the Bonneville Power Administration's Emerging Energy Efficient Technology (BPA E3T) program.[4] The study examined the use of Reverse Cycle Chillers (RCC) to produce domestic hot water for multifamily buildings in the Pacific Northwest. An RCC is commercial chiller technology set up to operate in reverse as a heat pump water heater and equipped with a double-walled copper heat exchanger so that it can process potable water directly. The RCCs selected use R-134a refrigerant which has performance limitations at supply air temperatures below about 40F but is able to produce water hot enough for residential domestic water purposes (~130F). The primary innovation in this design is to take advantage of the thermal buffering effects of the below grade parking garage to allow the use of this heat pump technology year-round in the Seattle climate. The thermal buffering of the garage derives from the heat provided by the lights,

[4] *Reverse Cycle Chillers for Multifamily Buildings in the Pacific Northwest: Phase I Final Report*. [redacted] Inc. September 2009. Produced for the Bonneville Power Administration.

warm vehicles, heat loss from the building and piping systems, and most importantly from the large concrete surface area connected to the ground. Deep ground temperature in the Seattle area is about 52F. Temperature measurements of a similar system in a nearby building have not dropped below 50°F in the parking garage, even during peak winter cold snaps. 50F is well within the very efficient operating range of these heat pumps. By using the parking garage air as the source these heat pumps function year-round at an average Coefficient of Performance (COP) of about 2.6. An electric resistance commercial water heater is used only as emergency back-up in the event of equipment failure. Since the RCCs take garage air and exhaust it directly to the outside, they also act as the first stage of garage exhaust; harvesting heat out of the air before exhausting it to the outside. This allowed the garage exhaust fans to be downsized significantly and they function only as back-up (they are rarely triggered by the CO control system).

The configuration of the hot water storage and the controls of the RCCs is another innovative aspect of this design. The storage is designed as a series of small tanks to increase the ability to maintain temperature stratification from the cold entering water end to the hot supply water end. The RCCs are set-up in a “single pass” rather than a “multi pass” mode. This means that instead of a constant flow and constant $\Delta T$ through the RCCs, they are set up with a modulating flow control valve and a refrigerant pressure setpoint. This allows for a nearly constant output temperature of ~130°F regardless of the incoming water temperature. This eliminates the need for a “finishing tank” because water of usable temperature is delivered directly to the top of the last tank recovering usable water immediately rather than slowly reheating the entire storage volume in a multi pass configuration. A buffer tank was added upstream of the RCC to ensure that it is always receiving the coldest water possible (see Figure 3).

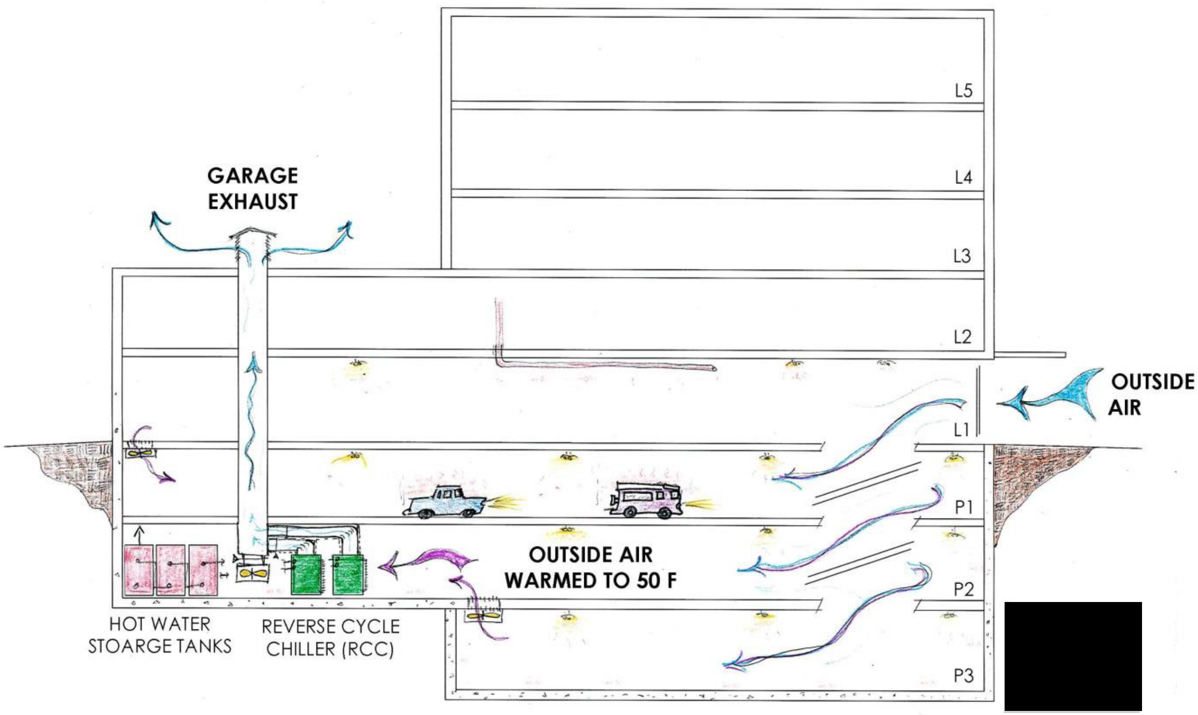


**Figure 2: RCC Configuration in Parking Garage**

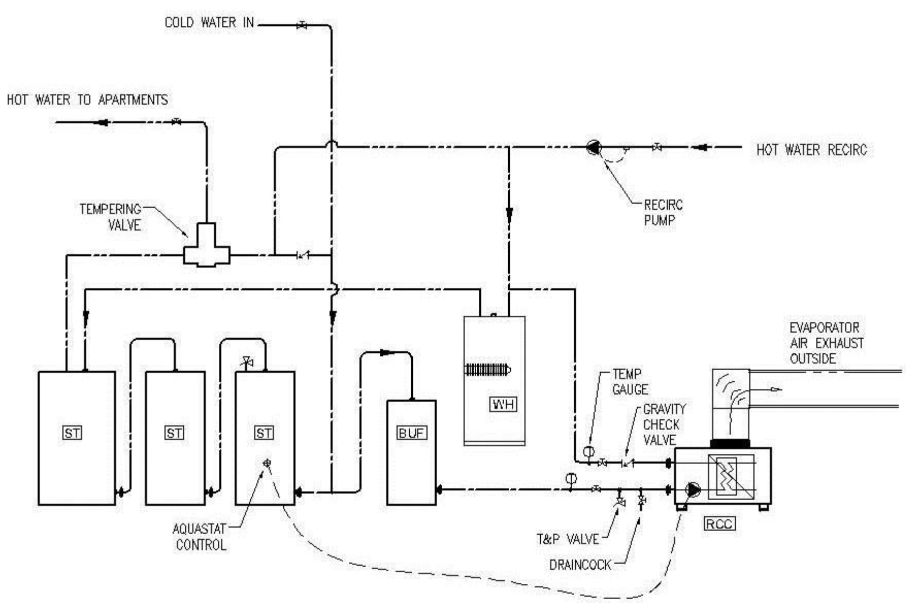


**Figure 3: RCC Schematic**

**Figure 4: Historic [redacted] Building**

This project also took a very innovative approach to meeting the Seattle Energy Code. The [redacted] building was the first to participate in a pilot Outcome-Based Energy Code.[5] This means that the typical prescriptive energy code requirements for the building were mostly waived in favor of a promise from the developer that the building would achieve a performance of at least 50% better than the ASHRAE 90.1-2007 baseline. This performance must be proven with 12 months of actual bills from the fully occupied building. If the building falls short of the target an energy audit and repairs must be completed to address the increased energy use. This is an innovative method to ensure that not only is the building designed to be efficient, but focus is put to guarantee that the operations and maintenance actually deliver an energy efficient building.

Another innovative aspect of this project is its participation with the Seattle Public Utilities to include a large biofiltration swale along two sides of the property. The swales daylight the storm water run-off from the [redacted] neighborhood and run it through a series of swales planted with wetland plant species selected for their ability to absorb contaminants from the storm water before it is discharged to [redacted]. The swales will treat an average of 190 million gallons of run-off annually providing a planted buffer between the project and the street and cleaning up the urban lake.

## Operations & Maintenance

By centralizing the domestic hot water plant instead of providing electric water heaters in each apartment unit, future maintenance costs are significantly reduced. With over 300 small

[5] This has since been adopted as a path in the Seattle Energy Code making it the first energy code in the nation to tie the energy performance as measured by actual bills to the energy code compliance of the building.

electric tanks with a lifespan of ~12 years, the maintenance staff could expect to be replacing 2+ tanks per month forever. Instead, all maintenance is concentrated in a single mechanical room. The hot water plant is designed with back-up electric water heaters in line with the heat pumps. The heat pumps are set up to deliver water at 130F. The electric water heaters are set to come on if water temperatures drop below 125F, so if for whatever reason the heat pumps are not functioning the electric tanks will come on automatically to back-up the system. At the same time an alarm system has been set up to send an email alarm to the apartment manager if there is a fault with either of the heat pumps so that maintenance can be scheduled. When the flow control valve in one of the heat pumps failed the system was able to continue to provide hot water to the tenants while the problem was diagnosed and repaired.

The ventilation system in the residential corridors is designed to run only essential equipment. In lieu of rooftop make-up air units the project uses small simple inexpensive supply fans to provide outside air directly to the corridors. Ductless heat pumps in the corridors cycle only as needed to maintain the setpoint. This significantly reduces the operation of the heat pump unit fans and associated filter maintenance.

## Cost Effectiveness

While the highly efficient mechanical systems in this building increased the capital cost of the project, the developer determined that they were well worth the extra investment. The energy efficiency measures were primarily responsible for the project achieving LEED Platinum certification which was in turn a major marketing point for the building helping it to fill up in a very short period of time.

The RCC system was a win-win economic strategy for both the tenants and the developer. The incremental cost of the RRC system was approximately $100,000. The local utility rebated just over 50% of that for a net cost to the developer of $47,000. Including the cost of capital, the developer was able to recoup their investment in the RCC system by charging an additional $3/month in rent per apartment. Meanwhile, the tenants are savings approximately $8/month on their electric bill, so by paying slightly higher rent they are each actually saving $5/month overall. This project was an excellent example of how investments in energy efficiency can benefit both the tenants and the developer.

## Environmental Impacts

This project has multiple positive environmental impacts for the tenants, the neighborhood, and the world. The energy savings are significant; placing this project among the most energy efficient multifamily buildings in the region.

**Figure 5:** [redacted]

The project includes 8,000 SF of green roof. This filters rainwater, reduces the urban heat island effect, and provides bird and insect habitat in the city. Half of one roof is devoted to urban agriculture with a gardening team providing free organic vegetables to the tenants of the project. A rainwater catchment system collects rain from the roof and provides 43,000 gallons of storage to supply the irrigation for the urban agriculture and other landscaping. This reduces the demand on the City water supply and slows the discharge of stormwater to the sewer system. The biofiltration swales significantly reduce the contaminants discharged to the lake, and provide additional greenery and habitat. The project also includes a beautifully landscaped park-like pedestrian courtyard open to the public.

## Lessons Learned

RCC System: Since the RCC system is a new application of this type of equipment in the region, the design, specification, procurement, installation, and commissioning of the system was new to everyone involved. Additional time is required in everyone's schedules whenever new technologies are introduced into a project. Balancing the hot water circulation temperature, RCC output water temperature, and supply water temperature from the tempering valves was critical to getting the system to satisfy the tenants' water demands, maintain a high coefficient of performance (COP), and not trigger nuisance high head pressure failures from the compressors.

Commercial building outcome-based energy code: Since space in the commercial portions of the project were leased to tenants who installed their own mechanical systems, it was not possible to have total control over the HVAC system design for those spaces. To ensure a high level of energy efficiency (of particular importance in this building due to the outcome-based energy code requirements), tenant guidelines for the HVAC system design were developed. Guidelines must be specific enough to achieve the efficiency goals, but not so restrictive that they discourage tenants from leasing the space. Through the course of this project we learned that spending time on the details of those tenant guidelines is extremely important to guarantee an efficient outcome. The final HVAC design in this case ended up as a negotiation between [redacted] as the Design-Assist consultants and the engineers hired by the tenant to achieve the targets originally set forth.