

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: _____

City/State: _____

3. Project Description: _____

Project Study/Design Period: _____ to _____
Begin date (mm/yyyy) End date (mm/yyyy)

Percent Occupancy at time of submission: _____

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

a. Name: _____
Last First Middle

Membership Number: _____

Chapter: _____

Region: _____

b. Address (including country): _____

_____ City State Zip Country

c. Telephone: (O) _____ d. Email: _____

e. Member's Role in Project: _____

f. Member's Signature: _____

5. Engineer of Record: _____

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.



Introduction

The Willis Tower Podium Repositioning project is a 300,000 square-foot renovation and addition to the bottom six floors of the iconic Willis Tower located in downtown Chicago, Illinois. The project includes three focal entrances designed to engage the community surrounding, retail/dining/services tenant spaces, a conference center, and an outdoor terrace located at Level 4. The footprint of Levels 1-3 was extended to the street to encompass the entire city block. Lower Level (LL) 3 through LL1 are located below grade and house mechanical rooms, tenant spaces, the Skydeck, and back of house storage and offices.

The HVAC upgrades include the replacement of 40+ year old boilers to high-efficiency natural gas boilers, conversion from constant volume fans to variable volume for 20 existing air handling units (AHUs), modifications to the existing chilled water system pressure zones, addition of an after-hours chiller plant, central kitchen exhaust system, and a kitchen exhaust heat recovery system.

The existing building utilizes a central chilled water plant located on the 29th floor and has a dedicated heating hot water system located on LL2. The major mechanical rooms are located on LL3 and the Level 3 mezzanine level that house chilled water and hot water AHUs.

Energy Efficiency

Kitchen Exhaust Heat Recovery System

There are no alleyways or roof which is typically the desired location for discharge of kitchen exhaust, generator exhaust, odorous exhaust, and more. To maintain the architectural integrity, a central kitchen exhaust system was designed for the future tenant spaces. The central system includes four Pollution Control Units (PCU) or kitchen scrubbers totaling 95,000 CFM of total kitchen exhaust. Due to the scale of the system and the number of operating hours anticipated, ESD saw an opportunity to capture the heat loss of this airstream. ESD implemented a heat recovery system with a run-around loop system tied to a packaged heat recovery pumping system. The packaged pump skid included pumps, heat exchangers, air separator, expansion tank, and control panel. Control valves and coils were provided by the same manufacturer with a magnesium coated coil installed in exhaust air stream and a factory installed heating coil in each of the two DOAS units. When all systems are operating at peak capacity in peak conditions, it is estimated the heat recovery from the kitchen exhaust can provide 92-95% of the required heating capacity of the make-up air, greatly reducing the demand on the boiler system. When the kitchen exhaust is not at full capacity and the call for heating is greater than the heat recovered, the base building hot water is piped directly to the pumping skid and will provide the additional heat required for the DOAS unit. This configuration allows for only a single coil in the DOAS units in lieu of the traditional arrangement of a heat recovery coil and a heating coil, reducing the footprint of the units. The heat recovery system is always monitored remotely and will send alerts to the building if they notice the system operating oddly or if the building personnel require assistance with operation of the system.

Constant Volume to Variable Volume Conversion

The hot water, chilled water and AHU systems operated with constant volume fans and pumping schemes. The project upgraded the systems to allowing for variable volume pumping and fan system to allow the systems to modulate down during off peak hours and save cost operating the building. Valves were replaced on all existing hot water and chilled water coils. VFD were added to the existing supply and return fans and new pumps with VFDs were provided for the hot water and chilled water systems.

Indoor Air Quality

The 20 existing AHUs serving the Podium were refurbished to include removal of asbestos containing material (ACM) as well as controls upgrades to include full economizer mode as well as demand control ventilation in the large transient public spaces to allow for more outside air in instances of high occupancy. All existing ducts were also cleaned, and pressure tested.

Innovation

VAV Central Kitchen Exhaust System with Heat Recovery

A central kitchen exhaust system was provided as a means for future tenants to connect to the system, provide the Landlord flexibility and maintain the integrity of the outdoor terrace. Four PCUS were provided to serve Level 1 and Level 2. Each PCU serves tenants located on a single floor. The PCUs are each equipped with a control panel, VFD, and multiple levels of filtration. The final stage is carbon filtration to remove the odor from the airstream. At the time of design, future tenant kitchen exhaust requirements were unknown. To



provide flexibility for Ownership and the leasing team, the central system allows for tenants to connect when the space is leased and not interrupt the operation of the other tenants. The variable operation also allows for energy savings as the fan does not have to operate at full capacity as each space comes online.

Typically, central exhaust systems across multiple tenants are prohibited by City of Chicago Code. To allow for this installation, ESD and the AOR were granted relief through the Chicago Committee on Building Standards and Tests by meeting the following items: the use of Automatic Balancing dampers at each hood, all interconnected hoods are at the same level, single manufacturer for kitchen hoods, PCUs with integral Ansul Systems, enhanced control system, and variable operation.

Existing Chilled Water Plant Re-use

The capacity of the existing chiller plant was studied and reviewed with the building operations team and verified that the capacity of the existing chiller plant was able to serve the additional square footage of the Podium. The building was designed as a "heat by light" building and since 1970s, the cooling load has significantly reduced. The existing 16,000-ton plant was operating at approximately 75% on a peak day. In lieu of adding a new 2,000-ton chiller plant just for the Podium, the existing infrastructure was re-used to serve the new Podium spaces.

The existing chiller plant located on the 29th floor feeds up to the 110th floor and down to LL3 with no pressure breaks in the mains. There are pressure breaks located on each of the mechanical floors that feed each zone of induction units. The Podium AHUs located at LL3 and L3 mezzanine have cooling coils rated for 700psi. Typical coils are rated at 150-300psi. Coils rated at 300psi+ would not be cost effective for tenants to provide and therefore ESD designed to provide pressure breaks at the 64th floor mechanical room and on the 4th floor to allow plate and frame heat exchanges to act as the pressure break. Plate and frame heat exchangers allowed for a reduced footprint but are only available with a max pressure rating of 450psi and allow for a differential pressure of 450psi, which required the pressure break in multiple locations. Shell and tube heat exchangers were explored but the size and footprint required to meet the required capacity was not feasible.

Operation and Maintenance

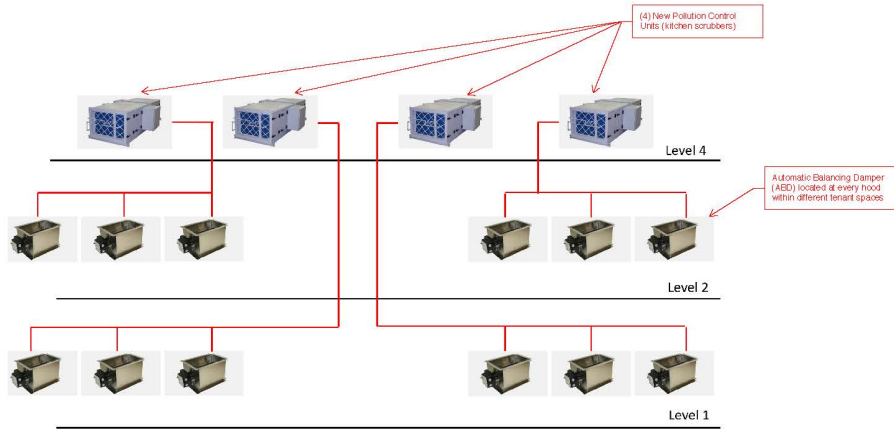
ESD engaged with the building engineering personnel to understand the operation of the existing systems and what operating challenges were seen at the building. One of the major items was the stack effect. Motorized back-draft dampers were added to all new exhaust air paths to allow the facilities team to turn off fans in low temperatures and prevent cold air infiltration through the exhaust ductwork and cause freezing. All fans were also sized to have the capacity to overcome the extreme stack effect pressure (~-2.5" w.c.) experienced at the base of the building. VFD or ECM were also added to all new equipment to allow the facilities team to adjust operation after monitoring the different systems. Pressure independent valves were required on the project which will allow new tenants to connect to the existing systems without impact other tenants and base building equipment.

Cost Effectiveness

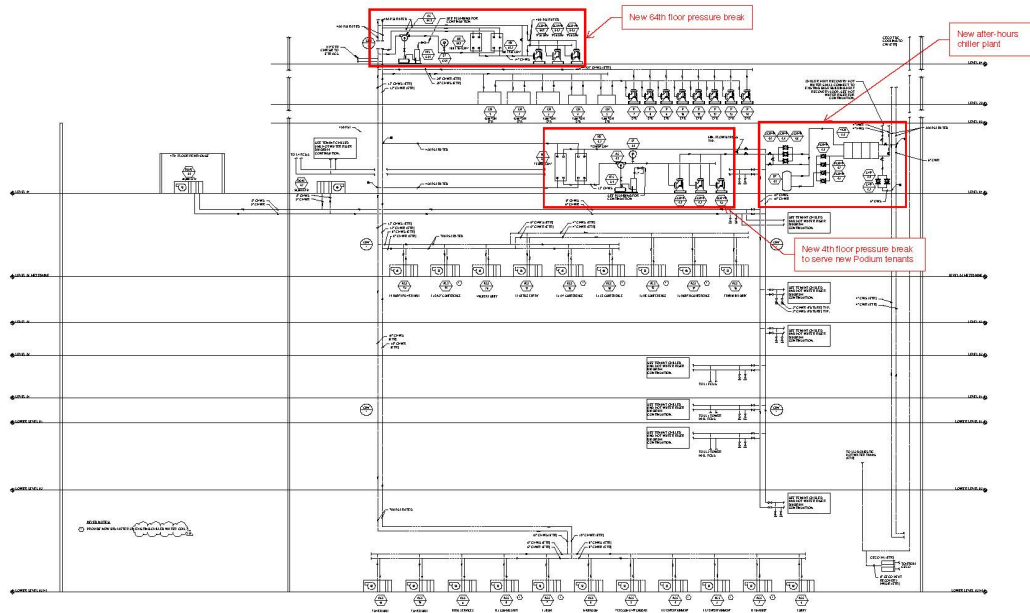
To provide Ownership and the leasing team with the greatest amount of flexibility for the type of spaces, MEP capacity provisions were estimated based on estimated usage of the space and envelope requirements. In lieu of providing each tenant space with full HVAC conditioning, chilled water, hot water, natural gas, outside air, and exhaust air, provisions were provided for each tenant space. The cost of conditioning the space was the responsibility of the tenant and allowed the tenant the most flexibility to fully design their space. Tenants are also required to provide metering for hot water and chilled water that allows for the Landlord to bill the tenant for their usage.

Environmental Impact

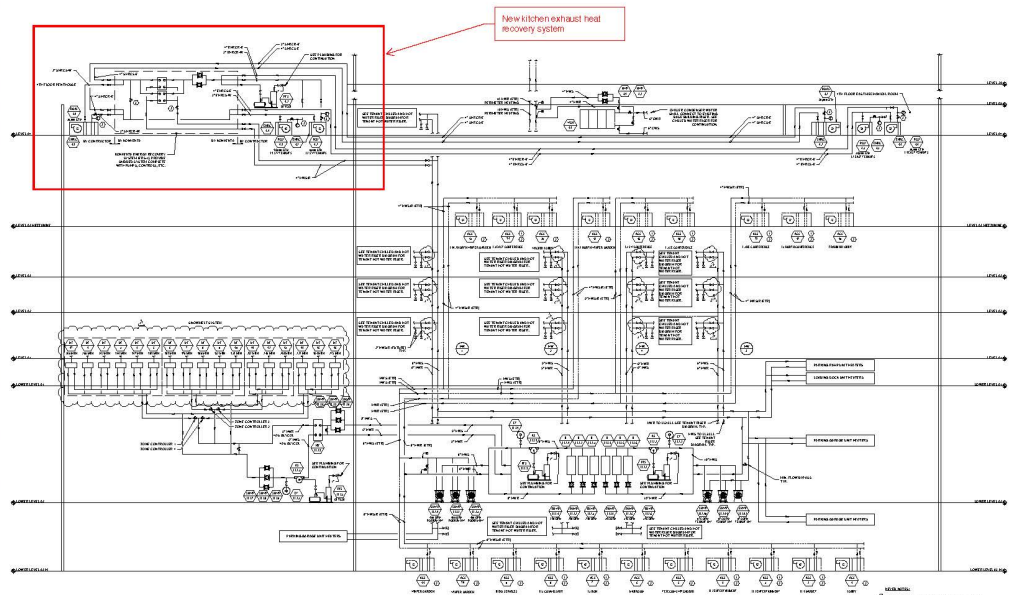
In lieu of demolishing the existing AHUs and adding in a large chiller plant at the base of the building, the project re-used the equipment, reducing the waste from the project. The project also enacted the use of several energy reducing strategies such as the kitchen exhaust heat recovery and variable flow for all new hydronic and fan systems to reduce the overall energy usage of the additional building square footage that was added.



Central Kitchen Exhaust Diagram



Chilled Water Riser Diagram



Hot Water Riser Diagram

