Cambridge – LBJ

Envelope: The Lyndon Baines Johnson Apartments is a 130,218 square foot (including conditioned basement), 12 story building designed for multifamily habitation. The 180 unit building is located on Erie St in Cambridge, MA. The building was constructed in the early 1970's and has one 5-story wing and one 12-story wing. Most units have balconies and all have floors and walls that extend from inside to outdoors without insulation. Starting with precast concrete construction with modest interior insulation and large areas of thermal bridging, the building is to be rehabbed with an air barrier and an exterior insulation and finish system including 2" exterior foam. The main roof of the building is composed of 6" pre-stressed concrete, and the roof was replaced in 1985 with a tapered layer of foam insulation with a specified R-25. As part of the renovations, a new attic roof will be added above the existing roof to house the mechanical equipment and ductwork. The attic space below the roof will be minimally conditioned, and the new roof will have R-30 insulation. Windows are currently double glazed aluminum frame (assumed U-value = .72, SHGC = .66) and will be replaced with low-e thermal break glazing with double Low E, Krypton, and thermal frames which yields a .36 U Factor and .27 SHGC. Completing the envelope, the floors above the garage areas will have 4" polystyrene insulation, and above grade foundation areas will be EIFS with extruded polystyrene, with 2" on exterior foundation walls. A band of tiled masonry at ground level will be insulated on the inside. Of great importance will be air sealing of the building, with air barrier at the envelope, air sealing between units and at floors, which is expected to reduce infiltration heat losses by 25%. Envelope improvements alone are expected to result in an approximate 25% decrease in energy use.

Equipment: The existing building is heated by electricity (baseboard for units, electric furnace for ventilation, etc.). Cooling, which exists in approximately 30% of the units, is achieved by window air conditioners with an approximate SEER (Seasonal Energy Efficiency Ratio) of 7. The new mechanical system will be water based for both heating and cooling, with vertical fan coils in the units and fan coils heating and cooling the ventilation air as well as heat recovery from the unit exhaust air. Heating water is supplied by a 94% efficient condensing boiler, and cooling is supplied by a super efficient SMARDT Chiller, which operates better at part load (most of the time) with .377 kW/ton IPLV (Integrated Part Load Value) and a full load rating of .577 kW/ton. For the first floor, except the kitchen which is heated and cooled by a hydronic fan coil, the system is completely different with a Mitsubishi City-Multi heat pump system providing both heating and cooling through multiple direct refrigerant exchange fan coils. This is a variable speed/refrigerant volume system with high energy efficiency (cooling SEER 12.7 Heating COP 3.7) in both heating and cooling modes. In addition, there are several other minor mechanical systems such as commercial kitchen exhaust, laundry make up air, kitchen appliances, ECM motors for fan coils, VSD pumping, etc., which add to the energy and cost savings.

Ventilation savings were achieved by using an energy recovery ventilator (ERV), which supplies the corridor make-up air. The apartments have exhaust only ventilation, and provide the exhaust side of the

ERV, which recovers both sensible and latent heat from the outgoing stream of air. The sensible heat recovery has 72% average effectiveness for the two systems (normalized for airflow). The offices on the first floor are supplied with fresh air by a small heat recovery ventilator.

Envelope losses were dramatically reduced by a combination of envelope improvements, ventilation efficiency measures, and air sealing. Lighting improvements also save energy and reduce cooling loads. Envelope and glazing improvements, lighting power reductions (many already in place), high efficiency mechanical heating, and ventilation and cooling design combine to save over 423,825 kWh in electric energy or about 22%. Because of the switch to gas heat, there is an increase in fossil energy relative to current use, but the code base case requires specific equipment corresponding to the installed equipment. So for the code case, we will have minimum efficiency water cooled centrifugal air conditioning for the upper building and Packaged Terminal Heat Pump for the first floor rather than the actual electric heating systems.

Renewables: In addition to the Envelope, equipment and ventilation improvements described above, the building will have two types of renewable energy supply. A solar Matrix aspirated wall air heater will preheat incoming fresh air before it goes to the corridor make-up air system. This inexpensive air heater consists of perforated metal panels which heat air as it is drawn through the holes when the panel is heated by the sun. Due to the close contact between air and metal and the low operating temperature of the panels (they only need to heat air a few degrees to be effective), these panels operate at the highest possible thermal efficiency for solar collectors. In addition, there will be a rooftop photovoltaic array, calculated for a system of 80 peak watts. This is the approximate maximum size system that can fit on the roof of the twelve storey building. The lower roof will have too much shading for added panels. The electricity produced will be subtracted from the purchased electricity and will be eligible for the new Massachusetts feed-in tariff. Other incentives may reduce the initial cost of the system, so that the rate of return on this investment may be very high, and the pay back short.

Cogeneration: In the current phase of design, two 75 kW cogenerators are specified. These generators will use natural gas to generate electricity and capture much of the waste heat for heating domestic hot water first and space heat second. Approximately 54% of the fuel energy will be captured as heat, and 28% as electricity. Thus the cogenerator acts as a low efficiency boiler while producing substantial amounts of electricity as a primary product. The cogenerators provide a substantial fraction of the electric use of the building and reduce the electric use by 36% for the first generator (which can operate nearly full time heating domestic hot water), and an additional 22% for the second (which operates more in the winter for space heat). However, the production of electricity and heat results in an increase in gas use, since we are operating an low efficiency boiler instead of high efficiency, therefore, with cogeneration, gas use increases, though electric use decreases dramatically. Overall, the site energy usage increases slightly, while both the source energy and cost decrease dramatically. The overall cost savings for both cogenerators is a little over $50,000 per year.