

Executive Summary

The purpose of this evaluation is to investigate alternative mechanical system designs of the Morton Hospital Expansion Project, and their impact on the additional building disciplines. The main criteria in which the redesign was evaluated was the mechanical system first cost, energy consumption, and an overall economic analysis. It should be noted that this report in no way suggests that the current design of the Morton Hospital design is flawed in any way. This investigation was done purely for educational purposes.

The current mechanical system receives its heating from the existing building steam system, providing low pressure steam that enters steam to hot water heat exchangers that provide building reheat, preheat, perimeter heating, and domestic water heating. The primary cooling source is an air-cooled chiller providing chilled water to 2 air handling units chilled water coils. The first AHU supplies conditioned air to Phase 1 of the project by a rooftop packaged DX unit containing a steam preheat coil and direct expansion cooling coil. The second AHU supplies air to Phase 2 of the project and contains a hot water preheat coil and chilled water cooling coil. Both will be variable air volume, supply return type, controlled by minimum outside air monitoring and airside economizer control. Humidifiers are included within the units, and supply and return fans are driven by variable frequency drives. Phase 1 will have electric reheat coils at each zone, while Phase 2 will utilize terminal supply boxes with hot water reheat coils.

The proposed redesign includes two alternative system designs. Alternative 1 replaces the air cooled chiller with a water cooled chiller and cooling tower, and also utilizes an air-to-air heat recovery. Alternative 2 employs variable refrigerant flow and dedicated outdoor air units. Alternative 1 will utilize two air handling units (AHU). AHU-1 supplies air to critical zones that require isolated, 100% exhaust to the outside, and has an EAHU that utilizes a glycol solution heat recovery coil that transfers heat from the EAHU to the AHU without cross-contaminating the infectious exhaust air with the supply air. AHU-2 supplies air to other non-critical zones, and has an EAHU with an enthalpy wheel that transfers both sensible and latent heat from exhaust air to supply air, where cross-contamination is not a problem. AHU-1 and AHU-2 will both receive cooling from a water-cooled chiller and cooling tower. Alternative 2 will use VRF technology in applicable zones, as well as employing dedicated outdoor air units to satisfy the ventilation requirements. Critical zones will be supplied by a separate DOAS unit. Both units employ the same air-to-air heat recovery system, and also receive cooling from a smaller chiller and cooling tower, since the load on the air handlers is reduced by the use of VRF heating and cooling.

When compared to the baseline design, both alternatives are more costly up front, but more cost effective over the lifetime (25 years) of the system, and also more energy conscious. Alternative 1 has an estimated cost savings of 14% over the 25 year lifetime with a 1.5 year payback period. As well, Alternative 1 has a 10% estimated annual energy consumption savings. Alternative 2 has an estimated cost savings of 23% over the lifetime, and a payback of 4.6 years. There is a 26% annual energy savings for this alternative.

An electrical breadth study as well as a structural breadth study were completed to evaluate the impact the proposed design has on these disciplines. Electrically, a photovoltaic array analysis was completed in conjunction with the Alternative 2 mechanical redesign. This was evaluated in an attempt to achieve a zero carbon footprint, and reduce the overall electric consumption. The more on site electric generation there is, the less grid production is required, and the smaller the resulting footprint. This resulted in employing a system with a payback period of 14.6 years, and saving 8% annual energy consumption. Structurally, calculations were completed to see if the added cooling tower of Alternative 1 would affect the current roof structure. It was found that the current roof structure, including the metal roof deck, steel beams, and steel girders, is sufficient in supporting the new cooling tower.