Executive Summary

The Duke Cancer Center Expansion is a 265,457 square foot addition to the existing Morris Cancer Center in Durham, North Carolina that was recently turned over to the owner in February 2012. The building has been designed to house almost all of Duke's clinical cancer services as well as designated spaces for research and administrative support. A majority of the heating and cooling for the Cancer Center is supplied by three variable air volume air-handling units with reheat at the terminal boxes, one of the units in a dedicated outdoor air unit (DOAS) coupled with an exhaust unit that utilizes an energy recovery wheel. The purpose of this report is to analyze an alternative design solution to the existing VAV system to determine any potential cost or energy savings. Two additional investigations on non-mechanical related breadths were completed to determine the impact of chilled beams on other building systems.

The first mechanical depth explores the implementation of a chilled beam system over the current system. By decreasing supply airflow and the associated air side equipment, the chilled beam system resulted in a first cost net savings of $6,086,950. Additionally, the chilled beam system also reduced energy consumption by 13,852 MMBtu/year which corresponds with an annual cost savings of $186,665 for utilities.

While the first depth explored the economic benefits of an alternative system, the second mechanical depth targeted the resulting indoor air quality and thermal comfort of a chilled beam system. Using CFD modeling software to simulate both the variable air volume and the chilled beam system in cooling mode, the results of the analysis show the chilled beam alternative to provide better cooling for the modeled case providing an average room temperature of 73.8°F compared to the 75.7°F that resulted from the VAV system distribution. The CFD analysis also showed that the resulting average air velocities and CO_2 concentrations were acceptable by ASHRAE standards.

The ripple effect caused by introducing a chilled beam system in place of the current VAV system for the Duke Cancer Center presents multiple savings and advantages throughout other facets of the building design and construction process. A structural breadth evaluated the effect of the downsized air handling units on the roof load which resulted in a first cost steel savings of $11,481.30. Furthermore, the analysis of electrical distribution equipment serving the associated resized mechanical equipment allowed for a 547 kVA reduction in electrical load that is not only seen as energy savings, but also as a upfront savings in regards to material, equipment and labor costs.

After thorough investigation of an alternative system, it can be recommended that due to the substantial cost savings of the system seen in both first and operational costs, as well as maintained or improved environmental conditions for the building occupants, a chilled beam system should be implemented in place of the existing VAV system.