1.0 Executive Summary

The David H. Koch Institute for Integrative Cancer research lab presents a multitude of HVAC design challenges. With MIT's expectation of achieving LEED Gold Certification, design engineers were forced to provide innovative design solutions, resulting in an energy efficient HVAC system. In this report, the mechanical systems of the Koch Institute are evaluated, critiqued and redesigned.

The existing design for the Koch Institute utilizes a central VAV ventilation cooling system, with heat pipe heat recovery between the supply and exhaust airstreams. Comprised of (10) 50,000 CFM Factory Built-Up AHU and EAHU's, the central system is responsible for the majority of heating and cooling in the building. An additional 13 packaged modular air handlers provide spot cooling for mechanical and electrical rooms and stair-shafts. The building is heated with hot water reheat coils and a perimeter radiant panel heating system. High intensity load and perimeter spaces are conditioned via fan coil units and chilled beam induction cooling to aid the central VAV system.

Supplying energy to this system is MIT's cogeneration plant which utilizes a 25MW Combustion Turbine Generator. This generator provides 80% of the electricity consumed by the campus by burning Natural Gas purchased from NSTAR based on a large commercial service rate (G-43). A heat recovery steam generator utilizes the exhaust from the generator creating high pressure steam. This steam is distributed to campus as well as to absorption chillers that use the steam to create chilled water for the campus which is fed through 24" mains.

In this report, alternative methods were evaluated to provide spot cooling and stair heating/cooling. A vertical closed loop ground source heat pump was designed to provide chilled water to the 13 packaged modular air handlers for spot cooling of the penthouse, basement, stairs and electrical rooms. The required length of pipe for the GSHP was sized utilizing equations from *Chapter 32 of the 2007 ASHRAE Handbook-HVAC Applications* entered into EES. The resulting ground source heat pump design cost an additional **$191,765** and provided an annual savings of **$87,651**. Therefore, the payback for the system would be **2.21** years.

A glycol run around heat recovery loop was added to the design to recover energy from 12 exhausts to heat the east and west stairwells. The existing design employed (4) 3,600 cfm packaged air handlers to heat and cool the stairs. The heat recovery loop added two preheating coils to the stair pressurization fans that supplied outdoor air to the space, allowing for the removal of 2 AHU's. With the savings from the elimination of 2 AHU's, the heat recovery loop costs **$4,143** with a **4.29** year payback.

The Construction Management Breadth of this report consists of a borehole optimization study that calculates the optimum number and depth of boreholes utilizing pricing estimates from *RS Means Mechanical Cost Data – 2009*. This study compares construction duration with overall pricing and provides alternate drilling schemes if problems arise in the drilling process.

The Electrical Breadth evaluates the increased load on the building electrical system with the addition of mechanical equipment loads. A distribution panel and feeders were sized to incorporate all of the new mechanical equipment into the existing system. A one line schematic shows how the new distribution panel is tied into the building electrical system.