Executive Summary

The TED is a 67,000 ft^2 building designed to provide technical support to the Continuous Electron Beam Accelerator Facility at the Thomas Jefferson National Accelerator Facility located in Newport News, VA. It is a two story building with technical workspaces on the first floor, open office and administrative spaces on the second floor, and an adjacent two story high bay assembly area. This report analyzes the existing mechanical system design and proposes two alternative mechanical system designs for the TED. Additionally, two breadth analyses are performed on the project construction of these systems and their effects on the currently designed electrical system.

The existing mechanical system consists of a variable air volume system that provides conditioned air to zones throughout the TED. Two air handling units, located on the roof, split the building into two air systems. One serves the first floor and high bay area, while the other serves the second floor. Hot and chilled water are produced by twelve central water to water heat pumps that are staged appropriately to meet the demand of heating or cooling. Additionally, a boiler is used as backup heat or in case of heat pump failure. The condenser system serving the heat pumps is comprised of a vertical bore geothermal well field along with a closed circuit cooler designed for 28% of the cooling load. Variable frequency drives are used to operate hot water, chilled water, and condenser distribution pumps as well as the air handling units' supply and return fans. The building automation system uses DDC to control the components of the system. The total first cost of the mechanical system is $2.45 million. This equates to approximately $35/$ft^2$ and accounts for close to 16% of the total building cost. The projected annual operational cost, based on a block energy model produced in Technical Report 2, is $115,175 and equates to approximately $1.68/$ft^2$.

One proposed alternative includes the implementation of a geothermal well field using Horizontal Direction Drilling (HDD) to meet the load currently met by the closed circuit cooler. HDD is used to install this field under a group of trees the owner would like to keep. The total annual energy savings from this replacement are estimated to be 89,430 kWh, equating to an annual cost savings of approximately $6,000. After completing a construction

management breadth analysis, the addition of the geothermal well field is expected to cost an additional $178,000 and take approximately 3 weeks to install. The simple payback period is calculated as 30 years.

The second proposed alternative involves the implementation of a radiant concrete floor slab. An analysis was performed to examine not only the cooling capacity of the slab, but also its thermal storage capabilities. A number of excel spreadsheets were created using Microsoft Excel that, together, attempt to model the effectiveness of the radiant slab through a cooling design day. The slab was found to not have enough cooling capacity to meet the entire sensible load; preventing the use of a DOAS system. For supplemental cooling, a VAV system was modeled in parallel with the cooling slab. By pre-cooling the slab in the morning, the peak cooling electricity demand was decreased by 27.5% and the total cooling energy use for the day was decreased by 13%. Additionally, an electrical system breadth analysis showed that the motors, feeders, breakers, and the distributional panel associated with the cooling equipment could be downsized.