(1.0) Executive Summary

For this senior thesis project, three mechanical depth studies were performed to investigate possible energy-saving or better-controlled systems for the New Braunfels Regional Rehabilitation Hospital (NBRRH). The first depth study performed proved the hypothesis that a central plant re-design, including condensing boilers and the addition of a chilled water system, would not be a cost-effective alternative design. While all central plant alternatives decreased energy consumption, the increased first cost was too great to overcome in a twenty year lifecycle analysis. A basic, water-cooled chilled water plant had a simple payback period of over 48 years.

The second depth study performed involved introducing six multi-split, variable refrigerant flow (VRF) systems to serve the heating and cooling needs of patient room and office zones. These systems would work in heat recovery operation to allow for simultaneous heating and cooling of zones connected to the same outdoor condensing unit. These systems allowed for the removal of the largest rooftop air-handling unit and required the introduction of a dedicated outdoor air unit to serve the ventilating and dehumidifying requirements of these spaces. VRF technology is relatively unused in the United States, but an energy model showed a simple payback period of just under 6 years.

The third depth study investigated the viability of installing a solar thermal system to heat domestic hot water, water in the therapy pool, and supplement space heating energy needs. An in-depth analysis of a forced-circulation solar thermal system with flat-plate collectors showed the optimal collector area to be 390 square feet of rooftop-mounted collectors at an angle of 40° from horizontal, facing 33° degrees from true south. This arrangement, with a stratified hot water storage tank for thermal storage, allowed for the following loads to be met by the solar energy collected:

- 76% of the domestic hot water load, 38% by direct gains, 38% by storage
- 22% of the space heating load, 8% by direct gains, 14% by storage

These energy savings resulted in a simple payback of just over 2 years, and a decrease in the net present value of the system by over $325,000.

Two breadth studies were also performed to analyze the impact of the new rooftop units on the structural roof framing design and the impact of the VRF system on patient room acoustics. The elimination of the largest rooftop unit was able to save $2,900 in material costs and is factored into the economic analysis of the VRF system. The patient room acoustics study showed a slight increase in the noise criteria (NC) sound pressure level in a typical patient room from 36 dBA to 39 dBA. While this slight increase is noticeable, it still fits into the acceptable NC levels for a private hospital room.

This thesis shows the viability of three potential mechanical system redesigns or additions and determines that, while a chilled water system is not economically viable, a VRF system may be depending on the owner's payback threshold and a solar thermal system is a very economically-plausible alternative to create energy savings.