Texas State University
Utilities Review

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San Marcos, Texas  78666

Re: Final Report for Texas State University Utilities Infrastructure Review

Dear Nancy:

We are transmitting herewith the final report from our review of your utilities infrastructure and master planning. We found Texas State to be a vibrant, growing community; and we truly enjoyed working with you, Juan, Sheri, and all the others on this project. We wish you well on your ambitious and exciting future as you continue to develop and expand.

Meeting the current and growing needs of the University with reliable and efficient utilities will always be a challenge, and we hope our small part has been helpful. We very much appreciate the opportunity you have given us to participate in your efforts.

If you have any questions about the report or need additional information or assistance, please feel free to contact us.

Yours truly,

Jerry A. Schuett, P.E.  
Affiliated Engineers, Inc.

Ray DuBose, P.E.  
The University of North Carolina at Chapel Hill
Introduction

Texas State University engaged Mr. Schuett and Mr. DuBose to review Texas State University’s existing utilities master plan and infrastructure systems and to make recommendations based on their experience with other institutions of higher education. This report summarizes those recommendations.

Texas State University is a growing institution, in both student population and more recently in research. The University has increased annual sponsored research expenditures approximately 300 percent in the past five years. We believe that growth in research has exacerbated the need for highly reliable, functional and efficient utility systems. Although all institutions of higher learning require the need for reliable utilities, that need is increased many times when research functions are involved. Short momentary power outages that were before a nuisance have become a detriment to continued research activities. It is our observation that the current utility systems at Texas State University are lacking in their level of redundancy and robustness when compared to other Universities around the country.

In addition to the utility reliability issue, there is a need for significant expansion of on campus residences for students and higher tech facilities such as the planned engineering and sciences building. Existing facilities are in need of renovations to adapt to increased technological needs. Infrastructure is operating at capacity with little capability to accommodate the expanding needs. Many specific needs have already been defined and some excellent plans are in process for replacement, expansion and renovation of utility systems. This report emphasizes some of those plans, recommends priorities, and makes suggestions for some additional considerations which are important for long-term growth, efficiency improvement, and reliability of the campus utility systems.

Brief Summary of Existing Utility Systems

Steam/Heating Systems

Texas State University currently operates its own steam/heating system. There are significant opportunities for improvement of the steam and condensate systems. Limiting factors which contribute to inefficiencies were found throughout the existing systems. Condensate returns to the central plants in the range of 50 to 60 percent indicate a significant loss of energy and also requires an excess amount of water to be purified for boiler feedwater make-up. There is a need for condensate quality monitoring and expedited resolution of contamination issues. Systems are under construction to connect new buildings and planned to replace existing inefficient underground piping, but standards consistent with a long term, reliable system are not in place or being used. Life cycle analyses are not being conducted to determine optimum component selection. Maintenance programs for steam traps are non-existent, a
considerable weakness. Steam manholes are not suitable for regular entry for routine maintenance. One steam manhole was steaming out its cover and water could be heard boiling inside.

Finally, most highly reliable utility systems have significant metering and monitoring systems in place to track consumption, outages and other critical system parameters. Texas State University currently has little to no monitoring or metering of campus utilities.

**Electric Distribution Systems**

The existing electrical system at Texas State University consists of two feeders from the City entering the Campus at the Cogen Plant and being distributed to the buildings via a series of radial feeders. Electric distribution components are largely at the end of their useful life and are operating at capacity with little redundancy. Additionally, there is insufficient redundancy in the feeders from the City. There is also no redundancy with the systems on campus during periods when components must be isolated for maintenance or when components fail.

The University has plans for significant replacement of primary switchgear and additional feeds from the city power utility, which will run through downtown and enter the University from the south, all of which are critical needs. Electrical coordination of breaker trip settings is a significant issue and there are plans to conduct a coordination study to determine the specific needs. There are no dedicated feeds from the city utility and no guarantees that the new feeders will be dedicated. A direct transmission feed from Lower Colorado River Authority (LCRA) has been discussed but not studied in detail.

There is no Supervisory Control and Data Acquisition (SCADA) system in place to monitor and record power quality and outages on the electrical systems. There are some momentary and extended interruptions but records are not kept to quantify them for analysis.

There is an existing NG fueled engine driven cogeneration system that exists, but is currently not functional due to failures in the heat recovery steam generator. The permits, however, have been kept current making the installation of a replacement system much simpler.

**Chilled Water Systems**

There appears to be sufficient chiller capacity in central plants, especially with the addition of the new South Chill Plant, which is planned. The plants are somewhat interconnected, but this is accomplished through relatively small piping that makes transfer of loads between plants difficult. The system Delta T (difference between supply and return temperatures from the buildings) is very low, about 10 F, which is much below the 12-16 F seen on newer efficient systems. The overall system operating performance
and efficiency is below par and could be improved significantly. Although these improvements may be more difficult in the existing plants, they should be considered for the new South Chill Plant as it is not yet constructed. One of the critical components of a highly efficient chiller plant is the use of variable speed chiller compressors, a technology that Texas State does not currently utilize, but should be implemented in the new South Chill Plant.

**Potable Water System**

Currently, the campus maintains water rights and is able to pump/provide all needed potable water from on-campus wells. However, the potable water system is at capacity and storage is limited. There is a question whether a tie to the city water system for emergency back-up purposes is still in existence and, if so, whether this connection provides sufficient pressure to satisfy Campus needs. All other ties between the University and city systems have been cut and capped. The well water has very high hardness which is a problem in heat exchangers in buildings and in the steam plants for use as boiler makeup water.

**Sanitary Sewer System**

Texas State University utilizes the City of San Marcos’ sanitary sewer service and wastewater processing services. Sanitary sewer systems are at capacity at two of the three connections into the city system, and the anticipated growth of on-campus fixture counts may trigger upgrades in certain locations. Studies are needed to define specific needs and develop priorities for system improvements, and it is recommended that the University coordinate plans for growth with the City to ensure that system improvements are provided in an appropriate timeline.

Additionally, it appears that the City is considering implementing a waste-water recycling program that would provide treated, reclaimed water for non-potable use (i.e., landscape irrigation) at a reduced cost to certain customers. This option may be worth investigating in the future related to water conservation, but since the University currently is able to provide all domestic water from on-campus wells, investigation of this option is a low priority.

**Stormwater System**

Texas State University’s storm water management system integrates into the City of San Marcos’ system; however, the system is not currently well-coordinated. The city is open to a joint study of stormwater systems. Future use of stormwater harvesting and use needs to be studied. Current and future stormwater regulations regarding detention and use of best management practices need to be defined and advance planning done to be compliant.
Sustainability

The campus utilities offer significant opportunities for sustainability, primarily in the area of conservation, efficiency and reuse. Many of the recommendations included herein contain an element of that. Specifically, the sustainability opportunities can be summarized by the following:

- Reduce losses in steam distribution systems, resulting in significant cost avoidance.
- Install metering and a “dashboard” system to track utility consumption in a venue that is accessible to students and others.
- Look at individual building energy consumption and develop energy conservation measures to reduce consumption and waste.
- The chilled water differential temperature (Supply sent to buildings versus return coming back from buildings) is relatively low and can be raised to use less pumping energy and maximize chiller performance.
- The chiller plants overall performance is less than most new higher efficient plants, so significant energy reduction possibilities exist.
- There is a significant amount of heating and cooling overlap where both are required simultaneously. The use of a heat recovery chiller can take the energy normally dissipated through a cooling tower and “recycle” it back to the heating system.
- The Campus currently uses separate heat and power with natural gas fired steam boilers and purchased electricity to meet their energy demands. The use of combined heat and power can greatly improved overall efficiency while improving reliability and redundancy.
- The use of reclaimed water from the City waste water treatment plant as a source of make-up water for the utility plants can reduce the demand on the well water system and reduce operating costs, especially if water treatment systems are added to reduce hardness levels.
**Specific Recommendations**

Specific recommendations are listed below. Those items in the high priority category are considered to be needed immediately to improve the reliability of the utility systems. These upgrades must begin as soon as possible in order to meet minimum reliability standards and to meet on-going campus growth. The medium priority category list items that are very important for improved system performance and efficiency and their development needs to begin soon. Note that many of the Medium Priority items result in significant energy savings which can help finance their implementation. The other measures category lists items that are considered to be important items which need to be addressed over time.

**High Priority**

1. **Continue the electrical system upgrades that are currently underway including**
   - Replace the switchgear at the Cogen Plant
   - Install new switchgear at the South Chill Plant with two new 800A feeders from the City
   - Install the interconnection between the Cogen and South switchgear for improved reliability
   - Convert the 15 kv feeders to a looped system from the current radial feed system
   - Initiate a phased cable replacement program to replace the aged 15 kv cable and building transformers
   - Complete electrical coordination study for campus
   - Investigate most reliable service options
     - Multiple 800 A dedicated circuits from City
     - Direct connection from LCRA

2. **Upgrade the steam distribution system**
   - Use materials for a 30-50 year life with high levels of insulation
   - Coordinate location of replacement piping with other utility needs and attempt to organize in a utility corridor
   - Consider “pockets” of hot water distribution at edges of Campus that are furthest distance from the generation plants
     - East Plant
     - Areas east of the river
     - West campus residence hall expansion
   - Implement steam trap maintenance program
   - Resolve condensate contamination issues
3. **Verify adequacy and improve domestic water system**
   - Add water treatment to reduce hardness levels
   - Verify adequacy of piping systems through hydraulic modeling
   - Confirm adequate storage capacity for campus usage and fire fighting needs
   - Test and confirm adequacy of interconnection with City Water

4. **Start planning for expansion of sanitary sewer to service new Residence Halls**
   - Define locations and loads
   - Work with City to identify bottlenecks and improvements outside of Campus property

5. **Advance the building metering and controls upgrades**
   - Install meters on all primary utilities at each building
   - Interconnect control systems of all plants and building metering
   - Develop a “dashboard” of consumption that is web accessible
   - Analyze data to determine areas of greatest losses/energy consumption and develop corrective plans
1. **Develop an energy conservation program for the buildings and set goals for annual consumption**
   - Use new metering data to identify highest energy consumers
   - Study and identify ECM’s (Energy Conservation Measures) in each building
   - Implement ECM’s in as many buildings as possible
   - Improve chilled water Delta T in all buildings

2. **Improve the Chiller Plant Operating Efficiency**
   - Review on-going South Plant design to incorporate measures
     - Variable speed chiller compressors
     - Variable primary chilled water pumping
     - Variable speed condenser water pumps and tower fans
     - Additional cooling towers in Phase I to improve efficiency
     - Design connected buildings for 16-18 F Delta T
   - Continue to advance the concept of converting stand-alone equipment to central chilled water, especially in buildings adjacent to the new South Plant
   - Investigate efficiency improvements in Harris Plant, Cogen and East Plants

3. **Investigate Combined Heat and Power Options in Cogen Plant**
   - Provides more reliable source of power for critical research loads
   - Define essential electrical loads in an “island” mode
   - Investigate GT versus IC engine options
   - Determine potential reuse of absorption chillers

4. **Install a Heat Recovery Chiller in the East Plant to reduce energy costs and water consumption**
   - Verify minimum summer heating and winter cooling loads
   - Utilize existing hot water and chilled water piping to the extent possible
   - Consider Harris Plant as well for a Heat Recovery Chiller in conjunction with new Residence Hall loads
Other Measures

1. Define future steam loads and determine if additional production equipment is required
   - Use energy conservation program to help reduce peak loads
   - Upgrade of steam distribution piping will reduce losses
   - Heat Recovery Chillers will reduce load on plant
   - Cogen system will provide additional heating source

2. Separate process cooling loads in buildings
   - Provide separate loop cooling by district chilled water system through a plate and frame heat exchanger
   - Provide increased filtration on process water for higher water quality

3. Update design criteria for all utility systems
   - Design parameters including building chilled water Delta T
   - Materials of construction for steam system should be reviewed and updated for systems having 30-50 year life
   - Define metering requirements and reporting

4. Review condensate pump and manhole maintenance program
   - Central utility plant operations responsible for condensate pumps
   - Periodic inspection of steam manholes to make sure they are dry and leaks are minimized

5. Investigate options for reuse and renewables
   - Solar thermal at swimming pools or Dining Halls
   - Stormwater collection and reuse
   - Use of reclaimed water in campus utility plants from City