Central Plant and Utility Infrastructure Study

Texas A&M Project: CP Expansion Study

Final Report—Addendum #1

Presented by: Bath Engineering Corporation
Executive Summary

The campus of Texas A&M University – Corpus Christi (TAMU-CC) is currently undergoing and is projected to continue to undergo rapid growth and expansion. According to the latest campus master plan which was completed in 2007, the student enrollment was 8,585 students in 2006 and is projected to increase to as much as 16,000 students by 2020. Current enrollment is more than 9,100 students. With this level of growth in enrollment comes the need for additional facilities that can support the goals and needs of university administrators, faculty, and most importantly, the students.

Most of the new and future buildings will be required to have interiors which are climate controlled through cooling and heating systems. The TAMU-CC campus currently utilizes a central plant to house the cooling and heating equipment as part of a system that serves the cooling and heating requirements of most of the main buildings on campus. Inside the Central Plant, chilled and heating water are produced and then distributed, through water distribution loops and piping, to the many air handling units inside these buildings. The use of a central plant allows for all of the major cooling and heating equipment, i.e. chillers and boilers, to be located in one area. This allows for maintenance, inspection, and repair of this equipment to occur without disrupting the operations of the facilities served by the Central Plant. The new buildings required at the campus will need to be connected to the chilled water and heating water distribution loops to use the chilled and heating water for their cooling and heating demands. As more buildings are added to the system, there will be a need for additional chillers, boilers, pumps, piping, and electrical distribution systems.

The purpose of this study is to analyze the current and projected future cooling and heating demands of the Campus and make recommendations to meet these projected needs. The campus expansion is divided into four (4) phases per the TAMU-CC Campus Master Plan 2007. These phases are as follows:

- Phase 0.0 – Immediate Term (present to 2010),
- Phase 1.0 – Near Term (2011 – 2015),
- Phase 2.0 – Near Future (2016 – 2020),
- Phase 3.0 – Distant Future (2021 to beyond),

Phase 0.0 includes three (3) projects which are currently under construction or are in the design phase and projected to be completed by 2010. Five (5) additional buildings and expansions to existing buildings are projected during Phase 1.0. Phase 2.0 is predicted to include the construction of four (4) additional buildings. Finally, Phase 3.0 includes an estimation of the maximum size of the campus and the Central Plant.

The existing central plant currently has partial redundancy designed into its cooling and heating systems and this redundancy allows the Central Plant cooling and heating systems to maintain a firm capacity. The firm capacity is the resulting cooling or heating loads that can be produced if the largest piece of cooling or heating equipment is off-line due to maintenance or malfunction. The Central Plant systems are currently designed so that the firm capacity meets or exceeds the actual peak cooling or heating demands of the campus. For example, if the largest chiller currently located inside the Central Plant went off-line for maintenance, the remaining operational chillers could still meet the cooling demands of the campus.
Phase 0.0

Based on calculations of the current campus cooling and heating demands and the additional demands that will be required due to Phase 0.0 construction projects, the following items are recommended to be implemented to allow the Central Plant to continue to meet the firm capacity demands of the campus:

- Provide and install one (1) new 1,500-ton water-cooled chiller. Install at least one (1), but preferably two (2), new 2000-ton cooling tower cells. Additional cells are not estimated to be required to meet the cooling demands of this phase, but will be used for future expansions.

- Existing firm heating capacity will continue to meet heating demand of campus, so no boiler additions are recommended for this phase.

- Add one (1) new 2000-kVA, 12.47kV - 4,160 V, 3 phase pad mounted transformer, one (1) new 15 kV 2 Line/2 Load pad mounted switch, one (1) new 500-kVA, 4,160 kVA - 480Y/277 V, 3 phase, 4 wire transformer, and one (1) new 480V motor control center with starters for chilled water pumps and cooling tower. The additional building electrical requirements for this phase will be added to each respective building design as applicable. This phase will add an estimated 3,581 KVA electrical load to the campus electrical system.

- Add additional piping and valves required to connect new buildings to Central Plant chilled water and heating water loops.

- Provide expansion to Central Plant Building that will accommodate the new chiller, chilled water pump, condenser water pump and associated electrical equipment. It is also recommended that during this expansion, spaces be provided for a sixth chiller which is estimated to be required during Phase 3.0, and two additional boilers which are projected to be required during the Phase 1.0 and Phase 3.0 additions. As mentioned above, it is also recommended that two (2) 2000-ton cooling tower cells be added during this expansion. Refer to Figure 1.1 in Appendix A for a floor plan showing possible expansion of the Central Plant.

- Estimated construction cost of the Central Plant expansion, including cost of materials and labor, including inflationary factors will be approximately $5.48 million. Refer to Appendix I for cost estimate tables. Note that the cost estimate indicated is an order of magnitude estimate, and as such has an accuracy of ± 50-percent. This estimate includes work at the main campus and at the Central Plant only.

Phase 1.0

Due to projected Phase 1.0 construction projects, the following items are recommended to be implemented to allow the Central Plant to continue to meet the firm capacity demands of the campus:

- Provide and install one (1) new 1,500-ton water-cooled chiller.
- Activate cooling tower cell, CT-5. Install fan and fan motor with VFD (variable frequency drive) on tower fan motor.

- Add one (1) new 13,600 MBH output boiler to Central Plant. Refer to Figure 1.1 in Appendix A

- Add one (1) new 2000-kVA, 12.47kV - 4,160 V, 3 phase pad mounted transformer, one (1) new 15 kV 2 Line/2 Load pad mounted switch, one (1) new 500-kVA, 4,160 kVA - 480Y/277 V, 3 phase, 4 wire transformer, and one (1) new 480V motor control center with starters for chilled water pumps, cooling tower feeder, and boiler feeder. The additional building electrical requirements for this phase will be added to each respective building design as applicable. This phase will add an estimated 3,878 KVA electrical load to the system.

- Add additional piping and valves required to connect new buildings to Central Plant chilled water and heating water loops.

- Estimated cost of equipment, including labor and inflation, for this phase of expansion was estimated to be $2.09 million. Refer to Appendix I for cost estimate tables. Note that the cost estimate indicated is an order of magnitude estimate, and as such has an accuracy of ± 50-percent. This estimate includes work at the main campus and at the Central Plant only.

Phase 2.0

Phase 2.0 construction projects will cause the need for additional modifications to the Central Plant. The following items are recommended to be implemented to allow the Central Plant to continue to meet the firm capacity demands of the campus:

- No changes to chiller configuration will be required for this phase.

- Activate cooling tower cell, CT-6. Install fan and fan motor with VFD (variable frequency drive) on tower fan motor.

- Existing firm heating capacity after Phase 1.0 expansion will continue to meet heating demand of campus, so no boiler additions are recommended for this phase.

- The additional building electrical requirements for this phase will be added to each respective building design as applicable. This phase will add an estimated 1,616 KVA electrical load to the campus electrical system.

- Add additional piping and valves required to connect new buildings to Central Plant chilled water and heating water loops. Depending on the final location of Phase 2.0 projects, it may become reasonable to install an outer utility loop around the west side of the campus. The buildings projected to be constructed during this phase appear to be research-type facilities. In keeping with the current campus criteria to locate research facilities at the west side of the campus, it will then become practical and necessary to install an outer piping loop in this area to facilitate the connection of these buildings to the Central Plant systems.
Refer to Appendix D, Figure 4.2 for a campus distribution piping layout plan with proposed chilled water and heating water outer loops.

- Estimated cost of equipment for this phase of expansion, including labor and inflation was estimated to be $719,625. Refer to Appendix I for cost estimate tables. Note that the cost estimate indicated is an order of magnitude estimate, and as such has an accuracy of ± 50-percent. This estimate includes work at the main campus and at the Central Plant only. The cost of proposed distribution piping additions is not included.

Phase 3.0

Projected Phase 3.0 campus expansion indicates the estimated maximum cooling and heating demands of the campus. Therefore the following items are recommended to be implemented at that time to allow the Central Plant to meet the estimated maximum firm capacity demands of the campus:

- Replace (3) existing 1,000-ton chillers with (3) new 1,500-ton water-cooled chillers. Upgrade existing cooling tower cells, CT-1 and CT-2 to increase tower capacity.

- Add one (1) new 13,600 MBH output boiler to Central Plant. Refer to Figure 1.1 in Appendix A.

- Add (3) new 2000-kVA, 12.47kV - 4,160 V, 3 phase pad mounted transformers and (3) new 15 kV 2 Line/2 Load pad mounted switches. The additional building electrical requirements for this phase will be added to each respective building design as applicable. This phase will add an estimated 5,810 KVA electrical load to the campus electrical system.

- Add additional piping and valves required to connect new buildings to Central Plant chilled water and heating water loops. Also, depending on the actual location of all future buildings constructed on the island, it may become necessary to install outer loops for chilled water and heating water around the east side of the campus. Refer to Appendix D, Figure 4.2 for a campus distribution piping layout plan with proposed chilled water and heating water outer loops.

- Estimated cost of equipment for this phase of expansion, including labor and inflation was estimated to be $7.70 million. Refer to Appendix I for cost estimate tables. Note that the cost estimate indicated is an order of magnitude estimate, and as such has an accuracy of ± 50-percent. This estimate includes work at the main campus and at the Central Plant only. The cost of proposed distribution piping additions is not included.

Depending on the actual size and construction dates for the projects in Phase 1.0, Phase 2.0, and Phase 3.0, the expansion of the Central Plant may proceed more rapidly or slowly than indicated in this study. Therefore, it is recommended that the Central Plant expansion, including the addition of chillers, boilers, pumps, electrical distribution and piping distribution be revisited prior to the implementation of each phase of expansion.
### Estimated Chiller Costs

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Current Cost ($)</th>
<th>Rate of Annual Price Increase</th>
<th>Phase 0.0 Cost ($)</th>
<th>Phase 1.0 Cost ($)</th>
<th>Phase 2.0 Cost ($)</th>
<th>Phase 3.0 Cost ($) (Includes three chillers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trane</td>
<td>380,000</td>
<td>3%</td>
<td>$391,400</td>
<td>$453,740</td>
<td>$0</td>
<td>$1,829,365</td>
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<tr>
<td>York</td>
<td>375,000</td>
<td>5%</td>
<td>$393,750</td>
<td>$502,536</td>
<td>$0</td>
<td>$2,455,734</td>
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<td>McQuay</td>
<td>375,000</td>
<td>4%</td>
<td>$390,000</td>
<td>$474,495</td>
<td>$0</td>
<td>$2,107,104</td>
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*Source: Equipment Manufacturer*

### Estimated Boiler Costs

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Current Cost ($)</th>
<th>Rate of Annual Price Increase</th>
<th>Phase 0.0 Cost ($)</th>
<th>Phase 1.0 Cost ($)</th>
<th>Phase 2.0 Cost ($)</th>
<th>Phase 3.0 Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bryan</td>
<td>104,720</td>
<td>5%</td>
<td>$0</td>
<td>$140,335</td>
<td>$0</td>
<td>$228,591</td>
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*Source: Equipment Manufacturer*

### Estimated Pump Costs

<table>
<thead>
<tr>
<th>Manufacturer/Model #</th>
<th>Type/Use</th>
<th>Current Cost ($)</th>
<th>Rate of Annual Price Increase</th>
<th>Phase 0.0 Cost ($)</th>
<th>Phase 1.0 Cost ($)</th>
<th>Phase 2.0 Cost ($)</th>
<th>Phase 3.0 Cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bell &amp; Gossett/</td>
<td>Split Case/Secondary Chilled Water System</td>
<td>$61,000</td>
<td>5%</td>
<td>$0</td>
<td>$81,746</td>
<td>$0</td>
<td>$133,155</td>
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<tr>
<td>Bell &amp; Gossett/</td>
<td>Split Case/Heating Water System</td>
<td>$15,700</td>
<td>5%</td>
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<td>$21,040</td>
<td>$26,852</td>
<td>$0</td>
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<tr>
<td>Bell &amp; Gossett/</td>
<td>Primary Chilled Water Pump</td>
<td>$29,300</td>
<td>5%</td>
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<td>Bell &amp; Gossett/</td>
<td>Condenser Water Pump</td>
<td>$61,000</td>
<td>5%</td>
<td>$64,050</td>
<td>$81,746</td>
<td>$0</td>
<td>$399,466</td>
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*Source: RS Means Mechanical System Cost Guide, 2007*

### Estimated Cooling Tower Costs

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Rate of Annual Price Increase</th>
<th>Phase 0.0 Cost ($)</th>
<th>Phase 1.0 Cost ($)</th>
<th>Phase 2.0 Cost ($)</th>
<th>Phase 3.0 Cost ($)</th>
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<tbody>
<tr>
<td>Tower Engineering Inc.</td>
<td>5%</td>
<td>$1,340,096</td>
<td>$227,816</td>
<td>$290,758</td>
<td>$654,862</td>
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</table>

*Source: Equipment Manufacturer*

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Central Plant Study
Texas A&M University
Corpus Christi, Texas

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Appendix I

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### Building Construction Cost Estimate

<table>
<thead>
<tr>
<th>Size of Expansion (S.F.)</th>
<th>Cost Ratio ($/S.F.)</th>
<th>City Factor</th>
<th>Historical Price Increase</th>
<th>Total Cost of Building Expansion</th>
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<tbody>
<tr>
<td>10,022</td>
<td>50.00</td>
<td>0.778</td>
<td>1.24</td>
<td>$501,100</td>
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### Total Estimated Cost per Phase

<table>
<thead>
<tr>
<th>Phase</th>
<th>Total Equipment Cost</th>
<th>Labor Cost</th>
<th>Overhead and Contingency</th>
<th>Total Estimated Cost</th>
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<tr>
<td>0.0</td>
<td>$3,320,643</td>
<td>$1,660,321</td>
<td>$498,096</td>
<td>$5,479,060</td>
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<td>1.0</td>
<td>$1,264,396</td>
<td>$632,198</td>
<td>$189,659</td>
<td>$2,086,253</td>
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<td>2.0</td>
<td>$436,137</td>
<td>$218,068</td>
<td>$65,420</td>
<td>$719,625</td>
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<tr>
<td>3.0</td>
<td>$4,668,427</td>
<td>$2,334,213</td>
<td>$700,264</td>
<td>$7,702,904</td>
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</tbody>
</table>