CHILLED WATER PRODUCTION SUB-ELEMENT

The University of Central Florida employs three chilled water production plants combined with a three million gallon thermal energy storage tank to augment the chilled water district distribution-cooling loop. The total cooling capacity is approximately 17,000 tons. The campus distribution system is extensive and interconnects the vast majority of the buildings, generation and storage facilities. The plants are composed of:

1.) Main Plant (Building 003): 8000 tons of electrically driven refrigeration machines with additional 1000 tons of capacity recovered from the combined heat and power plant's absorption chiller that is directly coupled into the distribution infrastructure of the main plant.
2.) Satellite Plant One, (Building072) Plant two includes approximately 4000 tons of electrically driven refrigeration
3.) Satellite Plant Two (Building 072) Plant three includes approximately 4000 tons of electrically driven refrigeration.

Analysis:

The demand for chilled water is evaluated in terms of capacity (tons of refrigeration) and flow, measured in gallons per minute (gpm). The peak demand for refrigeration for the campus is currently estimated in excess of 12,000 tons and approximately 20,000gpm. The future addition of the proposed 368,000 square feet of educational facilities to the northeastern quadrant of campus is estimated to add approximately 1,500 tons of refrigeration and about 2,500 gpm of demand. Thus, the future peak demand for campus refrigeration during this planning period is currently estimated to be 13,500 tons and approximately 22,500 gimp.

Generation of refrigeration capacity should be evaluated with consideration for equipment failures and normal preventative and predictive periodic maintenance cycles when adding cooling demand to the district loop. The criterion for evaluation of this paradigm is to allow for one machine to be undergoing maintenance and for a second machine to fail. This is commonly referred to as having a firm capacity of N+2, where "N" is the number of machines available for use and N+2 is the total number of machines. With two refrigerant machines unavailable for chilled water production, the campus generation capacity is estimated to be about 12,000 tons. The additional 1,500 tons of demand is anticipated to compromise the redundant capacity.

The thermal energy storage tank is equivalent to approximately 2,000 tons of refrigeration while discharging and requires over 3,000 tons of refrigeration while charging. This capacity does supplement the available refrigeration capacity but is somewhat dependent on available capacity to charge, and is therefore less reliable.

Hydraulic distribution (flow) provides its own set of unique operational challenges to the current cooling district under specific operating scenarios, with or without the addition of the proposed northeastern quadrant utilizing the existing plants. These key performance

metrics include peak summer cooling demand, winter tank charge during peak, and winter tank discharge during peak. Supporting hydraulic modeling engineering has been analyzed that illustrates the current challenges under each scenario, clearly defining what areas of campus are, and /or would be, affected by flow.

New demands added in the northeast quadrant should be accompanied with new generation capacity. The addition of capacity to offset the demands that are added is required, and the additional capacity in the new plant is strongly recommended since it helps resolve distribution challenges faced in the existing infrastructure.

ELECTRICAL POWER AND OTHER FUEL SUB-ELEMENT

a) A facility capacity analysis, by geographic service area, indicating capacity surpluses and deficiencies for:

1. Existing conditions, based on the facility design capacity and the current demand on facility capacity:

Duke Energy currently serves the majority of the campus via an underground loop system originating in the substations located at the south and east entrances of the campus.

Only a few buildings located on the northwest side of the campus (Lake Claire apartments and the fraternity/sorority houses) and the 475' tower located on the southwest side of campus are not on this loop system, and are fed from the existing overhead distribution lines that Duke Energy owns along Alafaya Trail (SR 434).

Duke Energy currently provides transmission power at 69 kilovolts (kV) to their owned and operated north and south substations located on campus. The Duke Energy electrical substations step down the voltage from 69kV into distribution power at 13 kV.

A combination of six distribution feeders, fed from both the north and south substation, provide 13 kV power that is stepped down by local station transformers near campus buildings and facilities to provide 480 volt power used for most UCF facilities campus-wide.

UCF's current demand outlined in our primary rental agreement between Duke Energy and UCF is 103,123kVa. Electric utilities measure demand in apparent power, known as Kilovolt Ampers (kVa).

The University of Central Florida's combined heat and power plant (CHP) provides the University with up to 5.5 megawatts of electrical generation at full load. This plant is behind Duke Energy's primary meter on feeder W1016, fed from the Duke Energy South Substation next to Facilities Operations. If the CHP plant is required to be removed from

service for routine maintenance or is tripped offline due to commercial grid voltage issues, a Duke Energy Automatic Transfer switch (ATS W116793) will pick up 6MW of load if the CHP falls below full output without campus operation interruptions, regardless of time or day.

Analysis:
Under the existing campus-wide power requirements, 5 kilowatts (kW) of real power is required per 1000 square feet of floor area for academic facilities.

The current peak summer capacities (worst case electrical demand) for both the north and south substations are in the table provided below. Feeder W1016 is purposely loaded with more capacity to provide the most economic benefit to the University, as this demand is primarily met by generation from the combined heat and power plant while base loaded.

Substation	Bank	Feeder	Summer Peak Load (MW)	Rating	Percent Summer load
UCF South	1	W1014	2.4	13.3	18%
UCF South	1	W104 (*non-firm)	9.4	13.3	71%
UCF South	2	W1016	9.5	13.3	71%
UCF South	2	W1016 (*non-firm)	8.6	13.3	65%
UCF North	1	W0942	2.6	13.3	20%
UCF North	1	W0989	0.6	13.3	5%
UCF North	2	W0940	0.2	13.3	1%
UCF North	2	W0982	6.7	13.3	50%
UCF South	1	Bank 1	16.7	34	49%
UCF South	1	Bank 1 (*non firm)	23.7	40	59%
UCF South	2	Bank 2	32.2	40	78%
UCF South	2	Bank 2 (non-firm)	30.3	40	76%
UCF North	1	Bank 1	22.6	34	37%
UCF North	2	Bank 2	25.2	34	74%

*** Non Firm – with UCF CHP Generation in parallel with commercial grid**

2. **The general performance of existing electrical power and other fuel facilities, evaluating the adequacy of the current level of service provided by the facility, the general condition and expected life of the facility, and the impact of the facility upon adjacent natural resources will continue to be evaluated.**

Duke Energy has adequate firm capacity to accommodate the proposed northeast quadrant's electrical demand. Currently, Duke Energy is operating and providing distribution power within the Florida Public Service Commission (FPSC) industry standard with regard to liability.

Duke Energy has had several noteworthy distribution outages, during the fall semester of 2013, t cause great concern to the University and its campus operations. Since these outages, Sustainability and Energy Management have partnered with Duke Energy to accommodate their operations to increase the frequency of the underground cable test, and to implement thermography reporting and switchgear inspections of all owned and operated distribution and transmission gear serving the Main Campus. Corrective action measures noted from the inspections have been prioritized by the utility, and Duke Energy has delivered an immediate action plan for capital replacement or field repair, depending on the criticality. These preventative measures have been deployed over the last several months and have positively impacted campus distribution electric reliability.

UCF has a five-year primary rental agreement in place that includes all distribution infrastructure repair and capital replacement owned and operated by Duke Energy. Each month, UCF pays a certain percentage of this rental cost in the monthly billing cycle based on a determination of a percentage multiplier. Equipment performance is evaluated by Duke Energy, through inspection, troubleshooting, and repair. Duke Energy uses a remaining life depreciation rate method, which takes into consideration salvage and cost of removal over the life of the asset. Duke Energy's return on investment is 7.362%, using an after-tax weighted average.

3. An ongoing assessment of opportunities or available and practical technologies to reduce University energy consumption.

UCF will continue to adhere to industry best practices based on continuing research and implementation by American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), Illuminating Engineering Society of North American (IESNA), BACnet protocol, and Leadership in Energy and Environment Design (LEED) to reduce site energy consumption.

UCF will also continue to evaluate and investigate alternative, renewable, and traditional power generation options to reduce source energy.

NATURAL GAS SUB-ELEMENT:

Description of Facilities:

UCF's houseline system is comprised of 24,360 linear feet of high and intermediate pressure composed of 6", 4" and 2" carbon steel pipe and low pressure ¾" -1" Polyethylene pipe.

Four separate gas feeds from TECO People's Gas are located on the north, south, west and Ara Drive, that provides distribution high pressure gas into the campus through 22 internal meter points and 16 valves. The west pipeline system has nine meter points and eight valves. The south pipeline system has 28 meter points and 23 valves.

Existing Distribution System

The South Service and West Service are UCF-owned distribution systems with a single TECO master gas meter for each. The North Feed and Ara Drive Feed are owned by TECO. The North Feed has a TECO gas meter at each structure served. The Ara Drive feed has a master meter located adjacent to Building 92 and transitions to UCF-owned beyond the master meter.

South Service
This service consists of a 6" carbon steel distribution line originating near the South Duke Energy Substation and running along Libra Drive to the south half of the inner campus circle.

The buildings served from this service include the:

- South Academic Villages
- Recreation and Wellness
- Combined Heat and Power Plant (CHP)
- Central Energy Plant
- Ferrell Commons
- Physical Sciences
- Mathematical Sciences Building
- Chemistry Building
- Library
- Education Complex
- JT Washington Center

This gas line has the most demanding flow/pressure requirement on campus due to the flow and minimum inlet pressure requirements of the CHP Plant. A minimum residual pressure of approximately 77 PSI is needed in the line to meet the minimum inlet pressure requirement of the CHP Engine.

West Service
This service consists of a 6" carbon steel distribution line originating at Alafaya Trail (just North of Centaurus Drive) and running along Aquarius Agora, then to follow around Pegasus Circle. This line serves the inner campus circle.

The buildings served from this service include the:

- Visual Arts
- Student Union
- Engineering II
- Health and Public Affairs

This gas line is lightly loaded with respect to its overall capacity. A residual pressure of approximately 20 PSI is adequate in the line to meet the minimum requirement inlet pressure of the appliances served from it.

North Feed
This feed consists of a 2" carbon steel distribution line originating at Alafaya Trail and running along Gemini Boulevard North to serve the north side of campus. The North Feed is owned by TECO and has TECO gas meters at each structure served. The buildings served from this service include the ones north of Gemini Boulevard North and various houses within Greek Park. This gas line appears to be adequate for the loads served.

Ara Drive Feed
This feed consists of a 2" carbon steel distribution line originating at Libra Drive and running east between the power line right-of-way and Ara Drive to serve structures along Ara Drive. The Ara Drive Feed is owned by TECO. The Ara Drive feed has a master meter located adjacent to Building 92 and transitions to UCF-owned beyond this master meter. This gas line appears to be adequate for the loads served.

Recommendations for Existing Gas Distribution Systems

- Interconnect the South and West Services with a new 6" carbon steel line.
  This is intended to allow some of the loads currently on the South Service to be transferred to the West Service. This would reduce the occurrences of inadequate residual pressure at the CHP Plant that have occurred during a campus gas load peak.

- Add a UCF owned, networked gas meter at the South and West Services.
  This is intended to allow measurement of instantaneous flow and pressure being delivered by TECO. It would be used to balance how much gas load should be on each of these services with the intent being to minimize, if not eliminate, inadequate residual pressure at the CHP Plant. Currently, only monthly consumption data is available from the metering provided by TECO.

- Add residual pressure monitoring at the far ends of the South and West Services.

This is intended to allow monitoring of the available residual pressure available during periods of peak gas demand. Pressure sensors would be required at the far ends of each service. Having this residual pressure information along with data on the instantaneous flow and pressure coming from TECO into the system would allow a more accurate assessment of the available capacity in the gas distribution piping system.

Building	GSF	Estimated Gas Main Size
Interdisciplinary Research I	118,000	4”
Interdisciplinary Research II	61,000	2”
Simulation and Training	60,000	2”
Civil and Environmental Engineering	75,000	2”
Global UCF and Continuing Education	54,000	2”

Estimated Costs for Existing Infrastructure Upgrades:

- Interconnect the South and West Services with a new 6” carbon steel line. This would involve approximately 1500 lineal feet of pipe and has an estimated cost of $250,000.00 to $300,000.00.
- Add a UCF-owned, networked gas meter at the South and West Services.

This work has an estimated cost of $200,000.00

- Add residual pressure monitoring at the far ends of the South and West Services.

This work has an estimated cost of $40,000.00.

Gas Infrastructure for Future Buildings in the Northeastern Quadrant of the Academic Core

Currently five Buildings totaling approximately 368,000 Square Feet are proposed with the possibility of additional research buildings.

The closest UCF-owned source of gas for this area is the 6” line located in Pegasus Circle that is served from the West Service. A 6” line could be routed from Pegasus Circle to the Northeastern Development area. This line size was chosen to provide maximum capacity and flexibility. It is consistent with the existing maximum line size on campus and is likely not to represent a capacity constraint for the addition of additional research buildings that may be added in the area.
The construction cost for development of this gas infrastructure is estimated to be in the $500,000 to $750,000 range.

Gas Infrastructure for Second CHP Plant at North Substation

Based on the installation of 5-10 megawatts of natural gas fired generation capacity a 6” gas line would be required. That type of capacity is not present in the vicinity of the North Substation. The closest 6” line is at the intersection of McCulloch Road and Alafaya Trail. The new line would likely be routed along the south side of McCulloch

Road. The construction cost for this line would likely be in the range of $550,000 to $800,000. Given the significant gas consumption that the second CHP Plant would represent, it is likely that a significant portion of the cost could be absorbed by TECO, based on a tariff for consumption.

TELECOMMUNICATIONS SYSTEMS SUB-ELEMENT

a) A facility capacity analysis, by geographic service area, indicating capacity surpluses and deficiencies:

1. Existing conditions, based on the facility design capacity and the current demand on facility
The telecommunications infrastructure consists of an underground network of encased duct banks and Maintenance Holes interconnecting the majority of the buildings on campus, as well as the satellite hubs or nodes.

The main copper telephone trunk originates from existing Siemens and VOIP telephone switches located in the Library Building and other buildings (nodes) to all the existing and new facilities. The data systems are connected to the Computer Science Building (CSB) and other buildings (nodes) via fiber optics cable.

2. The end of the planning time frame, based on the projected demand at current level of service standards for the facility, projected student populations and land use distributions, and any available existing surplus facility:
As the campus continues to grow, the demand for additional copper lines and fiber optic cables will rise, and the need for additional copper and fiber nodes throughout campus will have to be reviewed with the Computer Services and Telecommunications Department. Also as technology keeps constantly changing, the need to review standards increases in the same fashion.

b) The general performance of existing telecommunications systems and facilities, evaluating the adequacy of the current level of service provided by the facility, the general condition and expected life of the facility, and the impact of the facility upon adjacent natural resources, will continue to be evaluated.
The level of service provided by the telecommunications appears to be quite high. This is a great accomplishment considering the rapid changes in this field.

c) An assessment of potential electromagnetic hazards resulting from facilities required to meet future telecommunications needs of the University, and an analysis of practical ways to mitigate such:
No hazards are known at this time.