

Architectural/Engineering Program

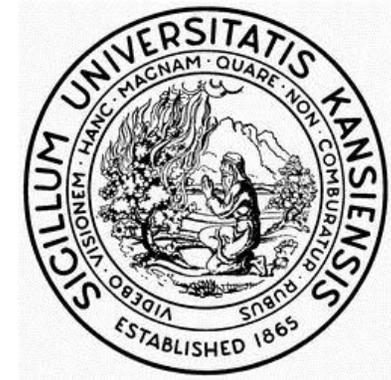
Ellsworth Annex - HVAC and Electrical Improvements

KU Project No. 089A-9226

Date: July 18, 2012

Prepared by:

**The University of Kansas, Lawrence Campus
Office of Design & Construction Management**



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- Jeff Perry, Director – Information Technology Services
- Vince Avila, Interim Director – Facilities Services
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- Leigh Myers, Project Manager - DCM (Programming)
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Introduction

The Ellsworth Annex is a 7,930 gross square foot concrete and brick building with basement and 1st floor. It was built in 1968 as a telecom equipment addition to Ellsworth Residence Hall. The telecom space is a mission critical facility which houses the KU primary telecommunications node. The cooling system for the space is a single DX rooftop unit which has exceeded its mean expected service life and cannot keep up with cooling loads on design days. The electrical service is 208 volt and is not sized to handle expected future loads.

On September 23rd 2011, the Westar electrical service to the Annex failed. A new switch enclosure and meter was installed at the manhole at the northeast corner of the building. New cabling was installed as well. The new switch should have provisions for extra bay to make the electrical cutover for this project easier.

Annex First Floor:

The east end of the first floor houses the main phone frame, equipment, and server racks. The west end houses work areas for IT operations staff and support areas. The mechanical room is located in the connection area between Ellsworth Annex and the Residence Hall.

Annex Basement:

A partial basement is located on the eastern half of the lower level of the Annex. It houses electrical equipment, switchgear, UPS batteries, and telecom cables. There is an open area on the south portion of the basement with approximately 700 square feet of usable space.

Annex Roof:

A new modified bitumen roof over ½” dense deck over tapered polyisocyanurate insulation over existing concrete roof deck was installed under KU project number 089A-7547 in February 2011. The roof is drained with two primary roof drains and storm piping routed in the telecom room. The roof includes lighting protection.

Proposed Work:

A 5-year master plan for the Ellsworth Annex was completed in October of 2005 by HTK Architects and Black & Veatch. This plan will be made available electronically, however, a more recent study should be used as noted below.

In December 2010, Tevis Architects and Black & Veatch completed an HVAC and Electrical Replacement/Upgrade Study under KU project #089A-9226. This study should be used for reference during the design of this project, in conjunction with the requirements of this program and input from the client group. A copy of this report is included in the appendix.

Design Criteria and Goals

This project shall be conceptually based on the 2010 Study and the key program needs and goals are noted below:

1. New HVAC for the telecom room to meet current and future loads with N+1 redundancy.
2. New 480V electrical service to meet current and future loads.
3. Provisions for future battery room.
4. Extend existing fire alarm system.
5. New backup emergency diesel generator with sound enclosure, sized to run data center, chiller, pumps, and HVAC. Estimated input load from the 2010 report is 641 kVA.
6. Building addition to house MEP equipment only, since existing Annex space will be utilized for telecom expansion.
7. Coordinate basement space for future distributed antenna system head end equipment.
8. Design of new central UPS system shall be included in A/E basic services, but shall be bid as an alternate.
9. Add fire suppression systems to the new and existing equipment, mechanical and electrical spaces.

Site Improvements & Infrastructure

Utilities & Infrastructure

- All utility system shutdowns or outages shall be planned well in advance and coordinated with the KU Project Manager.

- Site is adjacent to residence hall. Design and construction shall be sensitive to residents, with special attention paid to noise control, both in design and construction of project.
- Proposed building addition requires re-routing of existing natural gas and sanitary lines.
- Addition of chilled water condensing unit(s).

Hazardous Materials

The KU Environmental Health & Safety Office is available to test any suspect materials encountered during construction.

- A review of proposed construction will be performed by KU EHS prior to construction to verify any known locations containing materials that need to be abated.
- KU policy is to remove all hazardous materials when undertaking construction projects.
- The University will separately contract for this work.

Code Requirements

- Codes currently used on KU projects include the following:
 - International Building Codes, 2006 editions.
 - Kansas Fire Prevention Code, KSFMO, current edition.
 - NFPA 70, 2008 edition (NEC).
 - Other codes as listed at the State of Kansas, Office of Facilities and Property Management (OFPM) website.

Design Standards

& Consultant Services

- The consultant team shall comply with the latest provisions of The University of Kansas *Design and Construction Standards*, as maintained by the Office of Design and Construction Management (DCM).
 - These standards are available at the DCM website: <http://www.dcm.ku.edu/standards/design/>
 - The consultant team shall also comply with supplemental updates to these standards which may be issued during the course of the project.
- The University's Project Representative shall be a DCM staff person assigned to serve as KU's Project Manager, and who shall be the primary point of contact for all communications between the Owner, A/E and Contractor.
- Special Consultants that will be required on the design team, in addition to the usual architectural and engineering disciplines:
 - Mechanical and electrical engineers with experience designing energy-efficient telecom spaces.
 - Civil Engineer
 - Telecommunications System Engineer (must be pre-approved by KU-ITS).
 - Fire Protection Engineer, if required to supplement A/E's own expertise.
 - Commissioning Agent (to be contracted by KU).
- Energy Performance: The consultant team shall make system and configuration recommendations on the basis of energy performance, reliability and budget. Systems must comply with University design standards (exceed ASHRAE 90.1-2007 by 30% minimum).

- Electronic Files: Consultants shall deliver to KU complete sets of electronic drawing and spec files for each project's bid sets and as-built sets, and shall include both PDF and AutoCAD .dwg files.

Annual Maintenance & Operating Costs

Funding for annual maintenance and operating costs will come from current departmental sources.

Space Standards & Utilization Analysis

It is anticipated that this project will involve light remodel of existing space as well as a new 2-story building addition adding approximately 3,500 GSF new MEP equipment room space to the University's space inventory.

Historic Preservation & City Cooperation Agreement Reviews

Project is located on State of Kansas property and does not pass through any historical district and is not located within 150' of any City of Lawrence property lines.

Project Budget

Estimated Construction Costs

Mechanical/Electrical Space Addition	600,000
Fire Suppression	50,000
Equipment Pads and Screening	30,000
Sitework	90,000
Utility Relocation	130,000
HVAC	800,000
1250 kW Diesel Generator w/ Sound Enclosure	500,000
Electrical	<u>1,350,000</u>
Subtotal - Est. Construction Costs	\$3,550,000

Miscellaneous Costs

Fees - Consultants & State/KU Agencies	400,000
Printing & Shipping of Bid Documents	3,000
Abatement	7,000
Construction Testing & M/E Commissioning	40,000
Design, Bidding, & Const. Contingency (5%)	<u>200,000</u>
Subtotal - Miscellaneous Costs	\$650,000

Total Estimated Project Cost **\$4,200,000**

Notes:

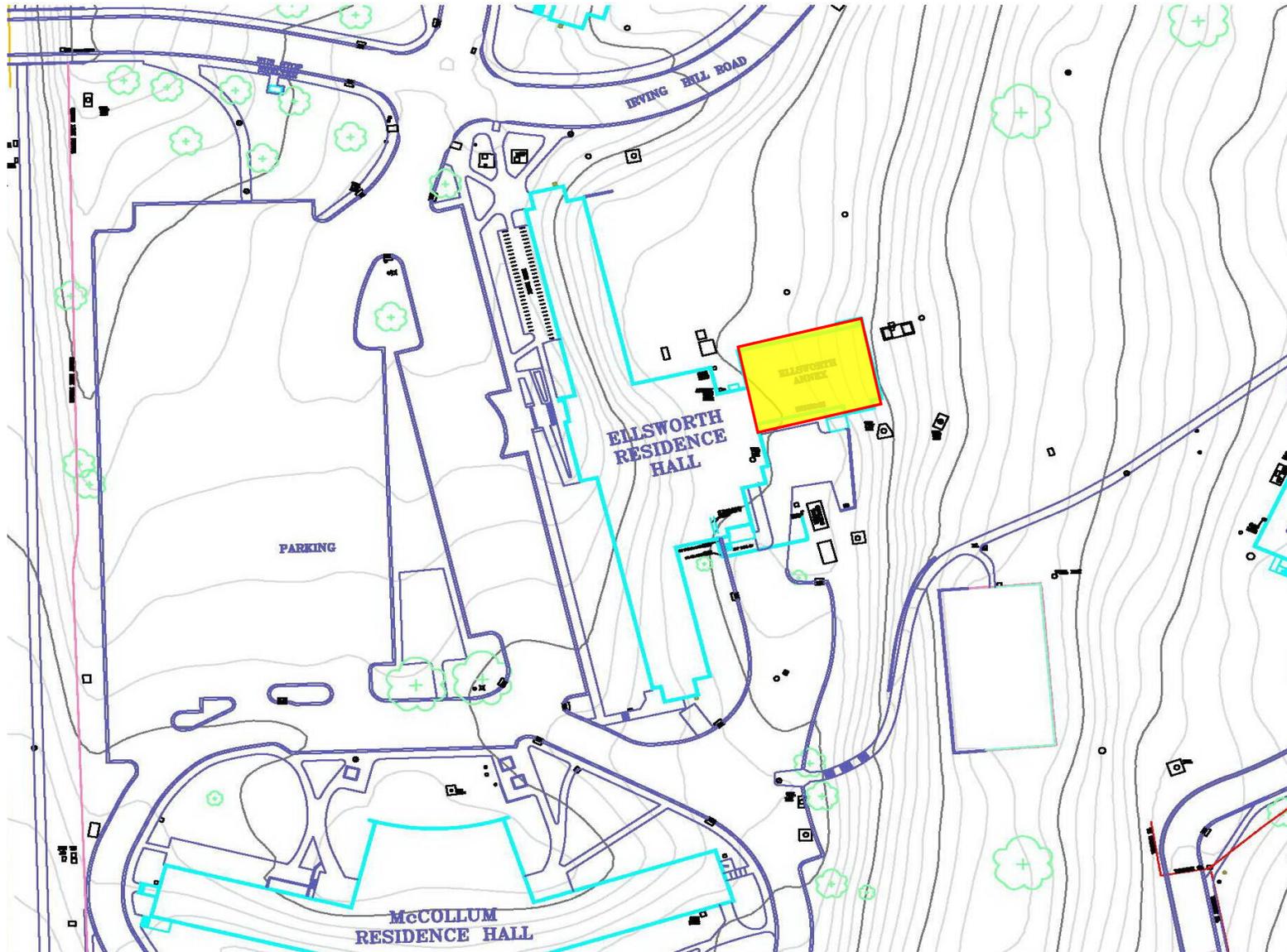
- 1) Funding for project costs is proposed to come from State 190 EBF / R&R funds in two distributions—one in FY 2013 and one in FY 2014.
- 2) Estimated construction costs are based in part on the December 2010 study completed by Tevis Architects and Black & Veatch Engineers, adjusted for inflation and proposed line item allocations.

Project Schedule

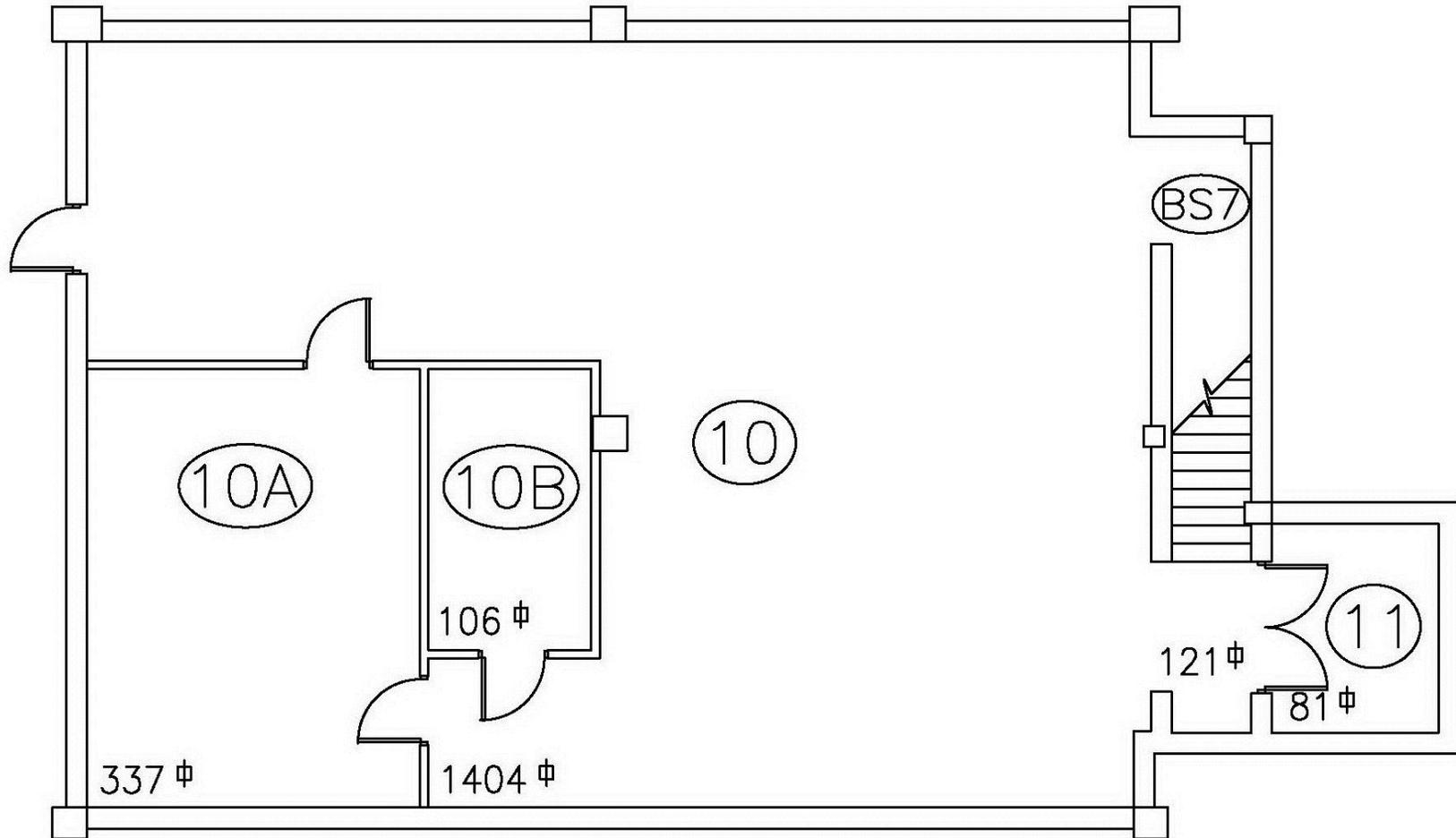
Submit Architectural Program to State of Kansas / OFPM	July 2012
Funding Approval for FY 2013 (partial project funding)	July 2012
Receive RFQ Submittals	Aug. 2012
Interview shortlisted A/E firms, select consultant	Aug. 2012
Negotiate Fees & Process Contracts (2 weeks)	Sept. 2012
Schematic Design & Code Plan Preparation (4 weeks*)	Oct. 2012
Design Development (6 weeks*)	Nov. - Dec. 2012
Construction Documents (6 weeks*)	Jan - Feb. 2013
OFPM/KSFM Review and Approval	March 2013
Bid Documents Released to Bidders	April. 2013
Bid Date	May. 2013
Contract Award & Execution (3 weeks)	May 2013
Construction (10 months)	June 2013 - March 2014
Funding approval for 2014 (partial project funding)	July 2013
Commissioning (4 weeks)	March 2014
Project Substantially Complete	April 2014

** Assumes one-week Owner reviews, which are concurrent with ongoing design efforts.*

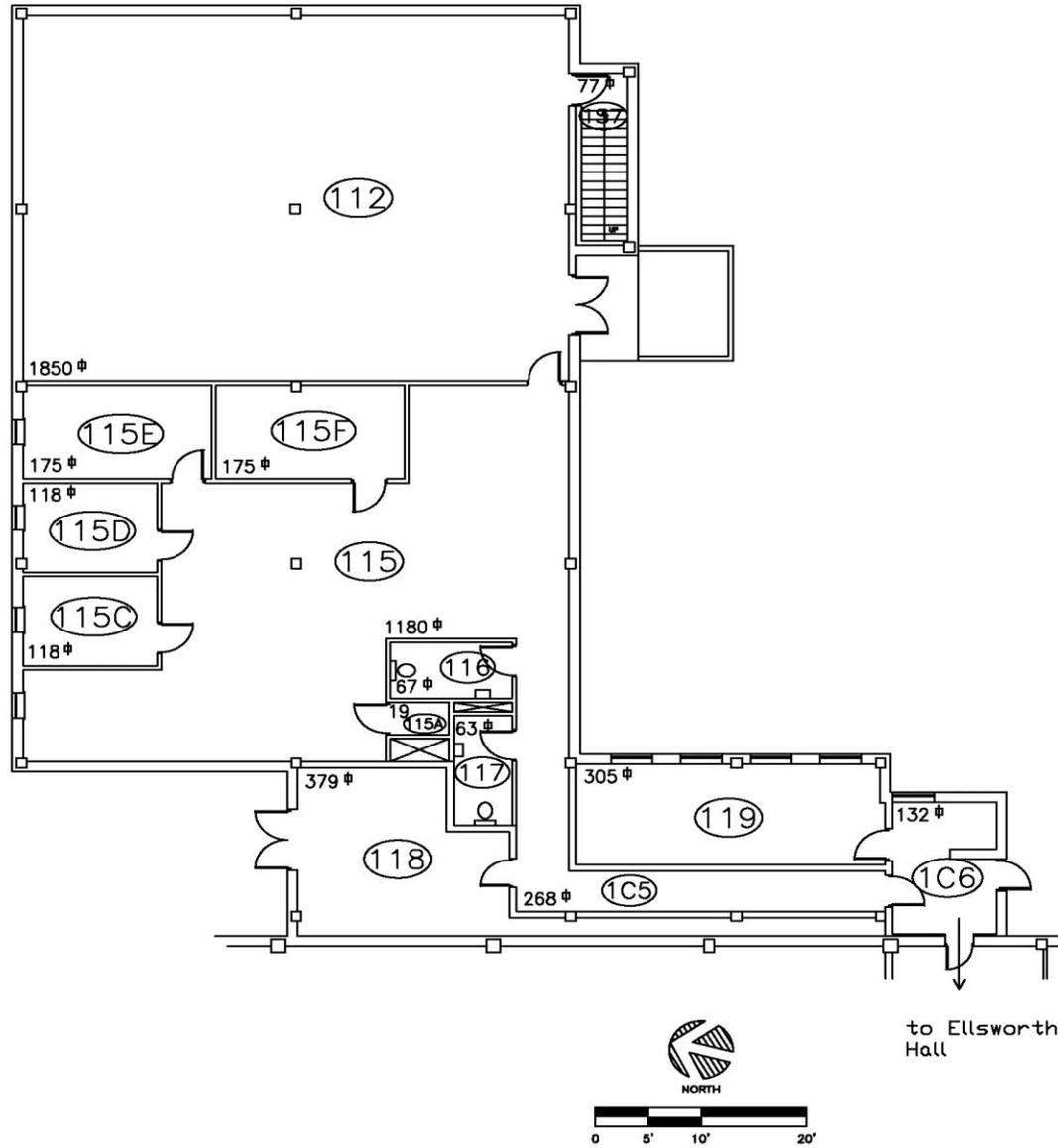
Existing Site Plan



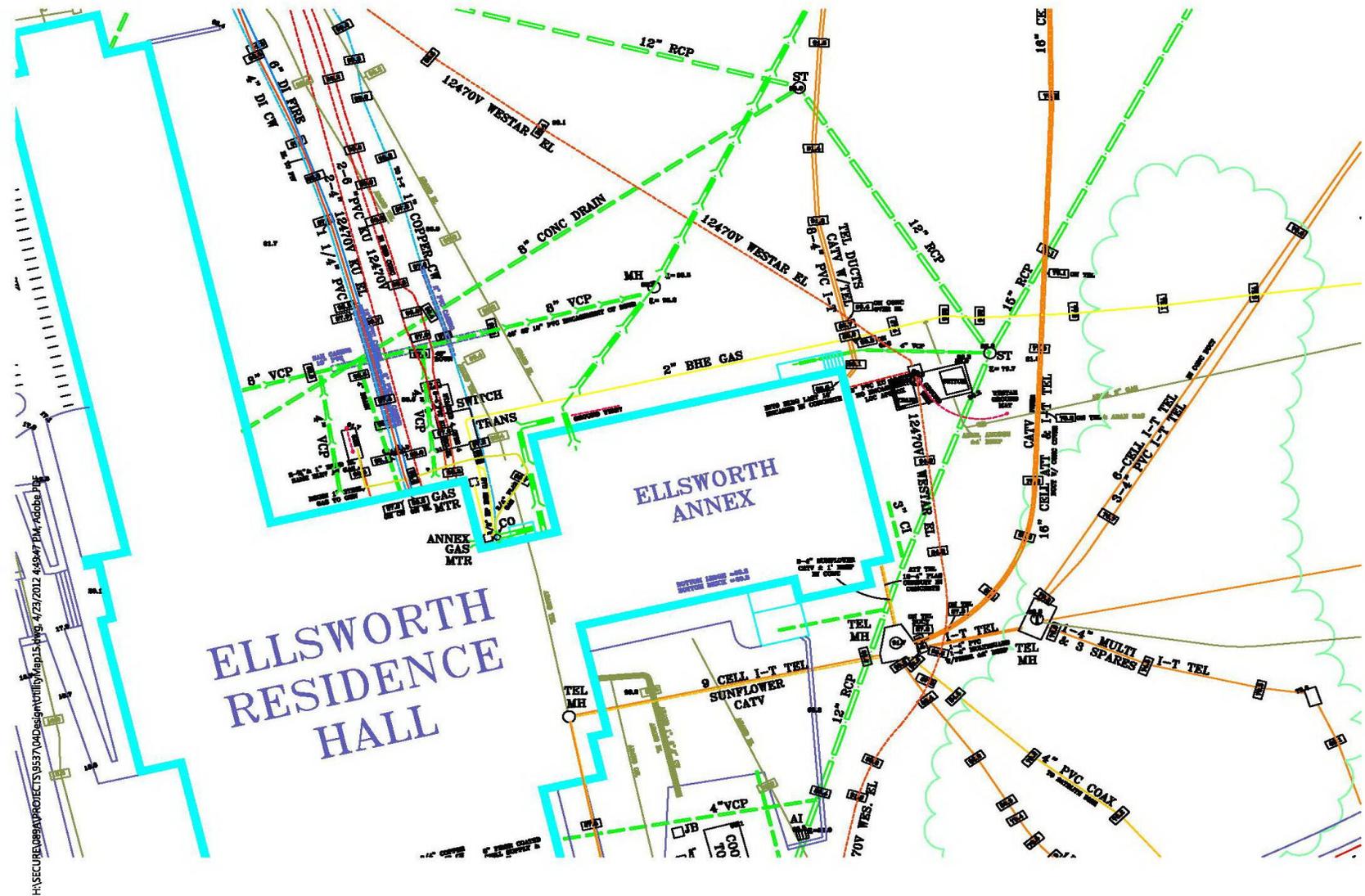
Existing Basement Plan



Existing 1st Floor Plan



Existing Site Utility Plan



Appendix A – HVAC and Electrical Replacement/Upgrade Study

Study completed December 3, 2010 by Black & Veatch Engineers and Tevis Architects (28 pp.)

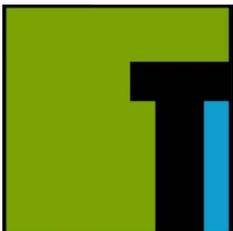
THE UNIVERSITY OF KANSAS

ELLSWORTH ANNEX STUDY

HVAC AND ELECTRICAL REPLACEMENT/UPGRADES

KU #089A-9226

December 3, 2010



Tevis Architects



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ELLSWORTH ANNEX STUDY

HVAC AND ELECTRICAL REPLACEMENT/UPGRADES

KU #089A-9226

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Sheet SK-1 – Conceptual Floor Plans, Site Plan and Elevations
Electrical One-Line Drawing
Ellsworth Annex Cooling Load Estimate

APPENDIX

Meeting Notes from KU Meeting of September 3, 2010
Meeting Notes from Pre-Proposal meeting of September 9, 2010
Meeting Notes from Kick-off Meeting of September 30, 2010
Meeting Notes from Workshop Meeting of October 27, 2010



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December 3, 2010

ELLSWORTH ANNEX STUDY

HVAC AND ELECTRICAL REPLACEMENT/UPGRADES

KU Project #089A-9226

BACKGROUND

Ellsworth Annex, Building 089A, is a mission critical facility, which houses the KU primary telecommunications node.

In October, 2005 a 5 Year Master Plan was developed for Ellsworth Annex. Although the Master Plan was re-visited and re-planned in 2006; and an electrical project was specified for bid, no projects from the plan have been implemented.

KU Information Technology Services (ITS) has now determined that some of the primary goals established to guide the Master Plan are no longer valid. Specifically, it has been determined that the Ellsworth Annex interior space is to be preserved for expansion of the equipment floor since the mission of the facility as a telecommunications switch is of critical service to the University and future expansion of the equipment floor footprint is expected. Further, ITS has noted increasing maintenance and reliability problems with the HVAC system serving the equipment floor and wishes to replace this system expeditiously and economically.

The Architectural and Engineering Team of Tevis Architects and Black & Veatch has been asked to review the Ellsworth Annex Master Plan with respect to replacement of the HVAC system, explore options for a new HVAC system to serve the equipment floor (without consuming floor space inside the Annex) and to make a recommendation to proceed with the upgrades.

ARCHITECTURAL

Existing Ellsworth Annex Facility

First Floor:

Currently, the east end of the First Floor houses the Main Phone Frame and equipment and server racks. The west end houses work areas for operations staff and support areas. The Mechanical Room is located in the connection area between Ellsworth Annex and Ellsworth Residence Hall.

Basement:

The Basement is only a partial basement located on the eastern half of the lower level of the Ellsworth Annex Facility. The Basement currently houses electrical equipment, switchgear and UPS batteries, etc. There is an open area on the south portion of the Basement with approximately 700 square feet of usable space. It is anticipated that this open area will house future Distributed Antennae System (DAS) equipment. Even if this area were not utilized to house future DAS equipment, it is not large enough to house the new (current or future) mechanical and/or electrical equipment described in this study.

Existing Ellsworth Annex Facility Remodeling

Based on the Kick-Off Meeting and the Workshop Meeting, the direction for the remodeling of the existing facility is summarized as follows:

First Floor:

- The operations staff currently housed on the west end of the First Floor will be relocated out of the facility within the next three years.
- Equipment and server racks will be added at the existing Equipment Room.
- The Staff Areas will be remodeled to house additional equipment and server racks.
- The existing Mechanical Room will be remodeled into storage upon completion of the new Mechanical Room.

Basement:

- The Basement will continue to house the existing electrical gear and equipment.
- The open area on the south side of the Basement will house the new Distributed Antenna System.

Ellsworth Annex Addition

Based on the Kick-Off Meeting and the Workshop Meeting; and based on analysis, the direction for the Ellsworth Annex Addition is summarized as follows:

Building Addition Configuration Considerations:

The building addition configuration was given thoughtful consideration regarding whether the addition should be a single story with a slab on grade, or an upper level with a basement. It was determined that the most cost effective building configuration would be a two level addition (upper level with a basement.) This determination was based on the following:

- The only area that will allow for a cost effective addition is located to the north of the current Ellsworth Annex.
- This area has a considerable number of utilities located underground. These utilities cross the site in multiple directions with close adjacency. A one story addition, with an area large enough to house the necessary new (current and future) mechanical and electrical equipment, would require relocation of multiple utilities. One of the most costly, and inconvenient, utility relocations would be the sanitary sewer and large manhole that serves Ellsworth Hall.
- The site to the north of Ellsworth Annex slopes to the east and lends itself to a semi-walkout basement. Because of this slope, to design a single story addition would require a deep, and more costly, foundation on the east and north of the addition.

- A single story, slab on grade, building addition would be more costly for the following reasons:
 - It would be enclosed by approximately 37% more exterior finished wall.
 - It would be covered by twice the area or roof.
 - It would have deep foundations which are utilized for only building foundation. The amount of required foundation would increase by approximately 37%.
 - It would require considerably more relocation of existing utilities.
- It is estimated that a single story, slab on grade, building addition would cost approximately 20% more than a two level building addition with a basement.

Site Work:

- The two level addition has been conceptually designed to provide the area necessary to house new mechanical and electrical equipment (current and future); and to minimize relocation of underground utilities.
- The underground gas line and the sanitary sewer from Ellsworth Annex, are the only utilities that will require relocation.
- The condensing unit foundation, slab and screen will be located to the northeast of the building addition to support and enclose the new (current and future) condensing units. Although this is still a conceptual design, a potential design for the condensing unit foundation, slab and screens could be as follows:
 - Trench and top formed concrete footings
 - Concrete slab on grade
 - Pre-finished decorative concrete masonry unit walls of sufficient height to provide sound protection and baffling from the condensing units for the adjacent residence halls.

First Floor:

The First Floor Addition will house the following mechanical equipment:

- Two air cooled chilled water systems with flexibility to add future air cooled chilled water equipment.
- Two air handling units with flexibility to add a future air handler.
- Space allocated for a future cooler/heat exchanger for an economizer.
- A Make-up Air Unit (MAU.)

Basement:

The Basement Addition will contain spaces to house electrical gear and equipment as follows:

- The new Electrical Room will house the new 480 volt switchboard and associated panels with the flexibility to add future gear and equipment.
- The new UPS Battery Room will allow for addition of future UPS batteries.
- The new DC Battery Room will allow for addition of future DC batteries.

Building and Equipment Layouts:

Refer to Drawing Sheet SK-1, which describes the proposed conceptual design of the Ellsworth Annex Remodeling and Addition, including Site Plan, Floor Plans and Elevations. Sketch conceptual drawings include the proposed layouts of the mechanical and electrical equipment.

MECHANICAL SYSTEMS

New air conditioning systems for current and future Annex IT spaces will be designed to capture the heat as close to the heat source as practical. There are many available products in the market to accomplish this. The industry trend is to arrange the IT equipment so that they align in a hot-aisle cold-aisle configuration. All the IT equipment heat can then be directed to the hot-aisle where it is collected and removed by the air conditioning system.

The cooling system will be designed as an N+1 redundant system. Based on estimated loads described in the Electrical section of this report, this would require approximately 45 to 50 Tons chilled water cooling and AHU capacity. The concept is to provide two units initially with provision for a third to be added in the future as the IT equipment load grows. Refer to Ellsworth Annex Cooling Load Estimate, based on loads provided to A/E by KU, located in the Exhibits section of this Report.

To achieve this, new chilled water and air handling systems will be designed as described below.

Air Handling Units will be designed and installed to serve the existing Annex IT spaces. The AHU's will be modular VAV type sensible cooling units with fan, chilled water cooling coil, and filter sections.

KU ITS prefers that the cooling of the IT spaces be accomplished by distributed ductwork. The main trunk duct would be installed in the new mechanical room with branch ductwork routed to the IT spaces. Supply (and return if practical) ductwork will be aligned with the hot-aisle cold-aisle configuration. In transition to the new, tie-ins to the existing ductwork would be accomplished so that there is no downtime of the existing cooling systems. The final step in construction would be to remove the old ductwork/HVAC equipment once the new system is commissioned.

The new Makeup Air Unit (MAU) will be an electric preheat/reheat, chilled water type unit. As an alternative the designer should evaluate the practicality (lower annual energy cost vs. higher installed cost) of using an indirect gas fired furnace instead of the electric heat. The unit will be sized to provide the correct dehumidification capacity for the summer design conditions. The MAU system will be designed with appropriate cooling coil freeze protection. The MAU system will maintain the facility at a positive pressure for contamination and humidity control.

Mechanical design for cooling will be provided by a KU preferred DX type split system with the chiller evaporators and compressors located inside the new mechanical room with pad mounted air cooled condensers outside. Chilled water from the evaporators will be circulated to the AHU and MAU cooling coils. For future expansion considerations the design will provide flexibility in the piping design for in-row cooling, rack cooling, or CRAC units.

The HVAC controls will be a DDC type system able to tie into the existing KU Metasys building automation system. AHU fans will be equipped with VFD controls, return and supply temperature sensors will control the heating and cooling system, room humidity sensors and a duct humidity sensor will control the humidifier and HVAC zone thermostats will control volume dampers.

KU Standards as well as ASHRAE Standards will be followed in the design. Though the equipment vendors will allow a larger environmental range in the IT spaces; this table shows the recommended operating envelope for Class 1 and 2 data center types based on the 2008 ASHRAE Environmental Guidelines for Datacom Equipment:

Parameter	Recommended
Low-end Temperature	64.4°F DB
High-end Temperature	80.6°F DB
Low-end Moisture	41.9°F Dew Point
High-end Moisture	60% RH & 59°F Dew Point

Outdoor Ambient Design Temperatures for design of the heating and cooling systems from 2009 ASHRAE Fundamentals Handbook for Lawrence, Kansas are:

Parameter	Recommended
Cooling Design Outdoor Temperature at 0.4% percentile	99.1°F DB / 76.9°F MCWB
Heating Design Outdoor Temperature at 99.6% percentile	5.1°F DB

Normal operation of the spaces in the Annex is recommended to be in the ranges of 74–78°F DB and 35-55% RH.

The facility humidity will be controlled by a dedicated humidification system with steam injected directly into the make-up air supply ductwork and controlled by the DDC system. The space humidity will be controlled by a wall mounted dew point sensor within the Ellsworth Annex operating envelope described by the ASHRAE standard above.

Until the Staff Office area is converted to IT equipment space in the future, provisions for comfort air conditioning will be provided. Cooling shall be in the form of VAV boxes with terminal heating connected to the new duct distribution system as required by the design. Heating can be accomplished with electric heating coils. The VAV boxes would be removed in the future when the space becomes occupied by IT equipment.

The system shall be designed with provisions for adding an economizer in the future. An Air-side economizer was ruled out in the Workshop due to the practicality of controlling dust and humidity for the large quantity of outside air that would be exposed to the IT equipment. It is most likely that a dry cooler with a heat exchanger can economically provide chilled water when outdoor ambient conditions are favorable.

To accommodate the building addition an existing sanitary drain and natural gas line will need to be relocated. Appropriate plumbing shall be included into the new addition design per the Plumbing Code. As the campus water quality is poor, the make up water to the humidifier will require a water softener designed to the humidifier water quality requirements.

Provisions for the future battery room exhaust shall be incorporated into the design.

The existing Fire Detection System will be extended into the addition to the Annex.

ELECTRICAL SYSTEMS

The project at Ellsworth Annex is to replace the HVAC system. The new equipment will be supplied with 480 V motors that cannot be served from the existing 208 V electrical service. Therefore, new electrical service equipment will be provided as a part of this project. Since new electrical service equipment will be provided, it must be sized so that it is able to accommodate the future needs of the University. The goal is to provide sufficient flexibility in the design so that future additions can be readily made, without installing more equipment than is needed in the immediate future.

The most important step in the project development process was the determination of the current critical load as well as a forecast of future load. Westar billing records indicate that the current maximum peak electrical load for the Ellsworth Annex is 118 kW. KU prepared a spreadsheet indicating that the future University critical load is expected to be approximately 157 kW.

In addition to this, the distributed antenna system (DAS) project is expected to add to the electrical load of the facility. Currently, the DAS project has requested a 200 A, 208 V three phase distribution panel to serve their loads. Such a panel can serve 57 kW of electrical load; assuming 80 percent loading. Adding 57 kW DAS load to the 157 kW University load gives an expected critical load of 214 kW.

As presented in the Mechanical Systems, another method of estimating the future critical load is to apply a uniform load density allowance to the data center floor area. That method indicated a maximum critical load of 227 kW.

Assuming a critical load of 227 kW and a power utilization efficiency (PUE = Total facility power load/critical power load) of 2.0 indicates a total electrical load of 454 kW. The design load is then determined by applying a 20 percent reserve capacity. Therefore, the design capacity would be 545 kW. If the load has a power factor of 85 percent the input load would be 641 KVA. The next larger standard transformer size would be 750 KVA.

The electrical system will be designed as a single feed with no redundancy, except that provisions will be made to backup the facility with a portable, rollup generator. Provisions will also be made for future facility hardening by bringing a second utility feeder into the site. A conceptual one-line diagram of the electrical system is included on Sheet E-100, Conceptual One-Line in the Exhibit section of this Report.

The new electrical system will serve the new HVAC equipment at 480 V.

The electrical system will be designed to back up the existing 208 V switchboard from the new 480 V switchboard. A 300 KVA transformer will be provided to back feed the existing 208 V switchboard.

The electrical system will also provide for the future addition of an uninterruptable power supply (UPS), DC rectifiers, and the addition of a future permanent standby generator.

A conceptual layout of the proposed electrical system is shown on Sheet E-100, Conceptual One-Line and on the Sheet SK-1 in the Exhibits section of this report.

Sensitivity Analysis – DAS Project

The estimated load of the DAS head end installation in the Ellsworth Annex basement was approximately 57 kW. Thus, elimination of the DAS would reduce the forecast critical electrical load by that amount.

The cooling associate with that electrical load is approximately 15 tons. The cooling load is provided by two chillers, so 15 tons total reduction would result in 7.5 tons reduction in the size of each chiller. Since the chillers are manufactured in discrete sizes, it is unlikely that a 7.5 ton reduction in chiller load would result in a chiller size reduction. Therefore, the elimination of the DAS equipment is not expected to reduce the chiller size.

Assuming that the chiller size remains the same, the electrical capacity required to power the chillers would remain the same. Therefore, the only electrical capacity requirement reduction is from eliminating the DAS equipment itself. The required electrical design capacity would still be over 500 KVA which means that the Westar transformer would still be 750 KVA.

Elimination of the DAS equipment is not expected to have a significant affect on the electrical or mechanical equipment rating, size, or cost.

Furthermore, elimination of the DAS equipment is not expected to reduce the, Ellsworth Annex addition size because the space available in the basement is only approximately 700 square feet compared to 1740 square feet required to house all new and future electrical equipment.



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**THE UNIVERSITY OF KANSAS
 Ellsworth Annex Study - KU #089A-9226
 Preliminary Opinion of Probable Construction Cost**

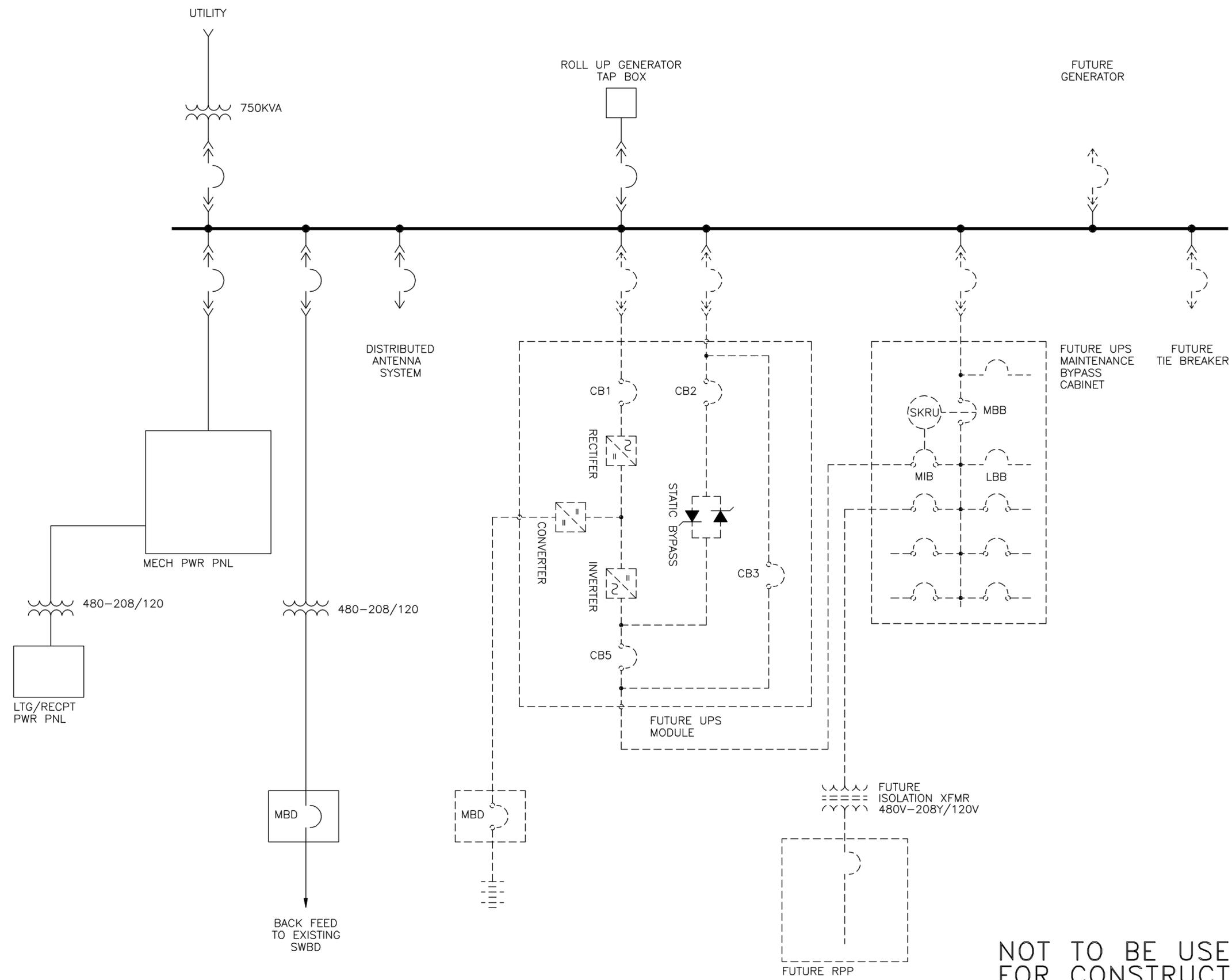
DESCRIPTION	OPINION OF PROBABLE COST
<u>GENERAL CONSTRUCTION</u>	
General Conditions, Bonds, Mobilization Etc.	\$75,000
Basement Addition	\$220,000
First Floor & Stairway	\$280,000
Equipment Pads and Screening	\$40,000
Site Work	\$85,000
Utility Relocation	<u>\$120,000</u>
Subtotal	\$820,000
<u>MECHANICAL CONSTRUCTION</u>	
Mechanical Systems	<u>\$640,000</u>
Subtotal	\$640,000
<u>ELECTRICAL CONSTRUCTION</u>	
Electrical Systems	<u>\$1,100,000</u>
Subtotal	\$1,100,000
PROJECT SUBTOTAL	\$2,560,000
<u>Contingency @ 10%</u>	<u>\$256,000</u>
PROJECT SUBTOTAL	\$2,816,000
<u>Overhead @ 10%</u>	<u>\$281,600</u>
PROJECT SUBTOTAL	\$3,097,600
<u>Profit @ 10%</u>	<u>\$309,760</u>
CONSTRUCTION TOTAL	\$3,407,360
<u>ARCHITECTURAL AND ENGINEERING FEES</u>	<u>\$375,000</u>
PROJECT TOTAL	\$3,782,360

EXHIBITS

1 2 3 4 5 6 7 8

A
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A
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B	12/10/2010	REPORTS		JEB		LEF	
A	12/06/2010	PRESENTATION		JEB		LEF	

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CONSTRUCTION, INC.

ENGINEER	DRAWN
CHECKED	DATE

ELLSWORTH ANNEX
ELECTRICAL

CONCEPTUAL ONE-LINE

PROJECT	DRAWING NUMBER	REV
	169592-E100	B
CODE		
AREA		



Ellsworth Annex

Cooling Load Estimate

± 30%

11/2/2010

Room	Description	Area Sq.Ft.		Loads kW	Sensible Cooling Load Tons AC
First Floor					
Staff Areas			(Assuming office areas become future equipment space)		
115	Open Area	1,153	2 W/SF	2.31 kW	
115A	Janitor's Closet	19	2 W/SF	0.04 kW	
115C	Office	121	2 W/SF	0.24 kW	
115D	Office	120	2 W/SF	0.24 kW	
115E	Office	177	2 W/SF	0.35 kW	
115F	Office	175	2 W/SF	0.35 kW	
116	Restroom	67	2 W/SF	0.13 kW	
	Critical load	1,832	50 W/SF	91.6 kW	
	Sub-Total			95.3 kW	27.1 Tons AC
112	(Existing equip room)	1,851	2 W/SF	3.7 kW	
113	[original room removed]				
113A	[original room removed]				
	Main phone frame	-285	(Floor area cannot be used without significant cost, excluded from load SF)		
	Critical load	1,566	50 W/SF	78.3 kW	
	Sub-Total			82.0 kW	23.3 Tons AC
Basement					
	Entry/Exit	127	2 W/SF	0.25 kW	
	Cable rack space	294	2 W/SF	0.59 kW	
	Electrical Room	337	10 W/SF	3.37 kW	(includes x-former load)
	Battery room	106	2 W/SF	0.21 kW	
	Equipment area	981	2 W/SF	1.96 kW	
	DAS Rack Load		(based on new panel capacity)		57.0 kW
	Sub-Totals:	1,845		63.4 kW	18.0 Tons AC
	Building shell peak cooling load (ballpark):				10 Tons AC
	MAU/OA load	2,000	CFM	73,656 Btu/hr	6.1 Tons AC
	Total Critical Load			226.9 kW	
	Electrical Load		@ PUE = 2	453.8 kW	
	Total Cooling Load:	5,528		240.7 kW	84.6 Tons AC Required

APPENDIX

September 3, 2010

Project: Ellsworth Annex HVAC Improvements 089A-8399

Meeting at University of Kansas, Carruth-O'Leary, Room 121

Attendees: Jeff Perry, Bill Pesek, Jim Wilmington, Thomas Bell, Steve Scannell, John Eye, Leigh Myers

- Discussed the October 2005 Ellsworth Annex Master Plan produced by Black & Veatch and Horst, Terrill & Karst Architects (089A-6149 and 089A-7663).
- Information Technology Services (ITS) personnel, needs, and priorities have changed since Master Plan was completed.
- The most pressing current need per ITS is to upgrade the current HVAC/cooling systems for the server rack room. This work should be completed before spring of 2011 and is to be considered phase I of a new master plan. This should be an expandable system with capability to easily add capacity in future.
- Since this is a critical facility with relatively high dollar upgrades to take place in phases, it was decided to work with an outside consultant to assist in review and update of the master plan as well as help out with cost estimates. It is hoped that a cost estimate for phase I could be available within 6 weeks.
- Some specific details discussed:
 - A command center is not needed in phase I.
 - N+1 cooling requested.
 - 2N type design power needed in some future phase.
 - Currently have 25 to 30 small in-rack UPS's. This is not optimal.
 - There is need to modernize rack and cabling layout sometime in the future.
 - Is there enough power for phase I without new electrical service?
 - Housing owns the Annex building. Annex maintenance is shared between housing and KU FO.
 - In-row cooling not planned for phase I. May be added in future.
 - There is no backup generator currently for switch.
 - ITS does not want raised floor in phase I. Could be considered in future with consultant's recommendations and funding.
 - ITS expects phase I to include overhead ducting of supply air.

- Switch and current cooling must stay in operation without outage while new systems installed.
- ITS does not want equipment on roof of Annex.
- Since it is likely that the switch may need more floor space in the future, and since it makes sense to expand the switch to the west, and since the basement does not have much available space, and since the Distributed Antenna System Project is to take space in the basement, it is likely that the new air handling units and chillers would be located outside of the current building footprint. There are fewer existing utilities on the site to the north of the building.
- If funding is available, roof repair should be included in phase I.
- 156 kW faceplate load in switch room (servers, switches, UPS's).
- Water cooled chillers may be preferred over air-cooled chillers due to noise considerations.

September 9, 2010

Project: Ellsworth Annex HVAC Improvements 089A-8399

Meeting at University of Kansas, Carruth-O'Leary, Room 103B

Purpose of Meeting: Bring design team (Doug Friedel, Dan Rogge, and Bob Fincham) up to speed on current needs for the switch room. Provide forum for all stakeholders to ask questions and provide input.

Attendees: See attached.

- Leigh Myers recapped what was discussed at last meeting on 9/3/2010.
- Bill Pesek: The switch will expand in the future. Disc backup will be part of expansion.
- Doug Riat asked why use water cooled chillers if designing for approximately 100 to 120 tons cooling. He had concerns about the cooling tower sump and maintenance. Team thought a good approach to avoid noise concerns with air-cooled chillers would be to use split chillers with barrel and compressors in indoor space and condensing units outside.
- Tier III reliability was discussed. The design team will need to know the level of reliability that KU is looking for. I found a brief description: Tier III is composed of multiple active power and cooling distribution paths, but only one path active, has redundant components, and is concurrently maintainable, providing 99.982% availability.
- Doug Friedel mentioned that the 208V electrical service is currently maxed out. New HVAC equipment will require a new 480V service. WestStar power may be within 200 feet of Annex.
- Jeff Perry mentioned that he will be discussing project with Chuck Crawford, Director of KU-ITS. The Annex houses critical telecom equipment including ATM servers and 911 calls. Does not want to do raised floor or racking work in this phase of this project. The future rack area will not grow as much as the rack density will grow. Floor space is a premium. A little bit of cooling load has been added to the switch since the master plan was done in 2005.
- Steve Scannell asked if geothermal was a choice. Doug Friedel said that it could be done but that it would be expensive and other solutions would be more applicable based on funding.
- Jeff Perry mentioned that the Distributed Antenna System (DAS) racks to be placed in the basement might require approximately 5 tons when installed and could grow to a need of 20 tons cooling. There is AC/DC gear in the existing basement electrical room that is to be removed in the future. 2N power is goal for future. Current funding limits are unknown at this time.

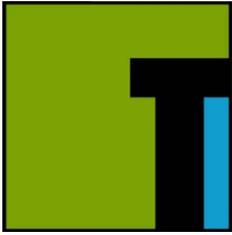
- Doug Riat suggested using existing exterior walls to minimize new exterior walls for mechanical room if possible.
- If future cooling load requires 120 tons cooling, looking at three 40 ton chillers or two 60 ton chillers. Consider part load and redundancy.
- Leigh Myers asked what equipment will the new 480V electrical service be sized for.
- Dan Rogge mentioned designing for 200 to 400 watts/SF power density. Asked question about number of transformers wanted. Install one now with space for future transformer? Doug Riat suggested one transformer could be sufficient since they may be readily available. KU needs to inform design team of the level of redundancy we want.
- Steve Scannell requested that Bob Fincham put together the design team's understanding of scope of work, date of when the sketches, project systems descriptions, and cost estimates can be delivered, and a project schedule. Bob is to forward information to Leigh Myers.
- Doug Friedel asked if space can be freed up inside the building for new HVAC systems. Jeff Perry said that there may be some spaces available but that there would have to be justification based on high costs of new addition mechanical room.
- Doug Riat plans to discuss the master plan with Chuck Crawford tomorrow.
- Jeff Perry asked about plans for the Annex roof. A project to re-roof the Annex with a single-ply roof just bid. It would be nice to install a double membrane roof sometime after the existing RTU is removed when funding is available. However, everyone at the meeting agreed that to prevent the risk of a roof leak between now and the next opportunity to add a double membrane roof, it makes sense to proceed with the new roof now. This will require the roofer to return after demo of the RTU to cap the curb and seal the opening.

Ellsworth Annex HVAC Improvements 089A-8399

Meeting 9/9/10

	Name	Organization	Title	Phone
X	Bill Pesek	KU-ITS	Dept. Mgr, Infrastructure & Data Center Support	864-0112
X	Jeff Perry	KU-ITS	Proj. Mgr. Information Services Facility	864-0489
X	Jim Wilmington	KU-ITS	Proj. Coordinator	864-9307
X	Doug Cherry	KU-ITS	Computer Technician	864-0234
X	Thomas Bell	KU-ITS	Computer Technician	864-0115
✓	Doug Riat	KU-FO	Director	864-4036
	Randy Samuels	KU-FO	Associate Director	864-4677
	Jay Atchison	KU-FO	Assistant Director Electricians	864-5602
KS	Kevin Swisher	KU-FO	HVAC Specialist	864-4770
✓	Brett Edwards	KU-FO	Skilled Trades Supervisor	864-3783
	Vince Avila	KU Housing Maint.	Associate Director	864-3097
X	Steve Scannell	KU-DCM	KU-DCM Asst. Dir. Consultant Services	864-5649
	John Eye	KU-DCM	KU-DCM PM	864-5637
X	Bob Rombach	KU-DCM	KU Fire Marshal, Special Proj. Mgr.	864-2717
X	Leigh Myers	KU-DCM	KU-DCM PM	864-5651
DF	Doug Friedel	B&V	Director, Energy Intensive Industry	913-458-0841
DF	Dan Rogge	B&V	Electrical Engineer	913-458-8038
DF	Bob Fincham	Tevis Arch.	Vice President/PM	785-234-6664

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October 1, 2010

**THE UNIVERSITY OF KANSAS
ELLSWORTH ANNEX HVAC IMPROVEMENTS STUDY
KU PROJECT #089A-8399**

KICK-OFF MEETING NOTES

Date/Time of Meeting: September 30, 2010/10:00 a.m.

Refer to attached Attendance Roster for attendees.

MEETING NOTES:

GENERAL DISCUSSION

1. Funding for A/E Study has been approved. Approval in process.
2. Roof Replacement Project has been bid. Contractor selection is in process
3. There is a new Project # for this study project – indicated above.
4. A link to drawings was sent to Tevis Architects. Still need a Utility Plan or a link to Campus Map with current utility information on it.
5. Although this is an HVAC Improvement Study, a discussion regarding associated electrical requirements is needed:
 - Current electrical needs. Is there historical data available that indicates current electrical usage?
Electrical bills.
 - Future electrical projections.
 - Cost to move utility meter
 - Ellsworth Annex is on a separate meter.
 - As a reference point, before the meeting Lud Funke read the utility meter which indicates that the maximum load has been 100 kW.
6. Leigh will check with Jay Atchison at Facilities Operations (FO) regarding electrical bills for the last 12 months.
7. Current Westar electrical service is 208 volt, which will not meet future needs. Jeff Perry (JP) would like 480 V into new UPS. Need to add additional capacity.
8. JP would like to consider replacing existing 800 KVA generator at Computer Service Facility (CSF) with a larger one and relocate the 800 KVA generator at Ellsworth Annex.
9. Bottom Line: Want to consider new electrical service with additional capacity for future needs.
10. KU not receptive to 2 N + 1 because of cost; But are receptive to multiple power sources. (That could mean a standby generator as a backup source.)
11. JP would like to improve on current 208V panel and electrical distribution system.
12. KU plans on utilizing this facility as long as it is economically feasible.

13. JP would prefer to provide 480V into future UPS. Future UPS would allow the existing equipment to be moved from the old UPS to the new UPS one at a time. UPS would be provided later as funding becomes available. KU ITS does not know the required capacity for the UPS yet.
14. Existing UPS at the CSF could be moved to the Annex. The existing UPS is upgradable to 90 kw.
15. Need to minimize the shutdown of the phone switch – affects the entire campus.
16. Regarding the Distributed Antenna System (DAS) Project: When will the design documents be available to provide more information? Presently, the stated load is 10 cabinets at 12 kW each; but this is believed to be very high.
17. Future Loads?
 - JP: KU/K-State/KU Med have an agreement for joint usage of some equipment.
 - JP will research anticipated future loads.
18. JP: KU desires an addition (to house equipment only) if it is economically feasible.
19. JP has talked to Tom Wachter about technical area layout.
20. It seems to make sense to divide the facility into three pods.
 - Continue to use Basement as equipment room.
 - Upper Level, east side, will continue as the primary area for server equipment.
21. KU ITS will work on numbers for future growth, including future staff. It is anticipated that technical staff will be downsized in this building.

HVAC

22. Redundancy is desired. Don't want to rely on a single unit.
23. Maximize floor space. It may be acceptable to consider a couple of CRAC Units on floor – but would prefer to avoid them if possible.
24. Avoid placing equipment in staff area.
25. Bill Pesek indicated that KU ITS has a layout that shows locations of existing racks and other equipment.
26. Majority of current HVAC equipment is hot/cold design with some general air supply.
27. Flexibility is desired in new HVAC – Perhaps the majority hot/cold with 20-30% general AC. Anticipate hybrid system.
28. KU will consider in-row cooling although they typically try to avoid it because of difficulty with maintenance. KU will try to avoid need for in-row cooling by minimizing density.
 - Will DAS require in-row cooling.
 - 5-8 KW/rack. 5.4 is average.
 - Collection racks have highest density.
 - 30 stand-alone UPSs in racks – new.
 - Trane CGAM air-cooled scroll chillers.
 - Humidity controls required. Currently have problems.
29. Economizer:
 - Do we need to comply with ASHRAE 90.1 requirements for economizer on data center projects?
 - A dry cooler on the water side is a possibility for economizer.
30. Freeze plugs on hw/cw coils is now a KU Standard.
31. There will be acoustical issues with equipment located outside because of proximity to residence hall.
32. Consider keeping compressors inside.
33. KU ITS just wants an HVAC system that is reliable and redundant. Will consider N + 1.

BUILDING ADDITION

34. Building aesthetics will be an issue.

- Building will need to comply with KU Standards and be sensitive to its surroundings.
- Containers?

35. Since this building addition will only house equipment, the cost is anticipated to be lower than a typically finished building.

POWER

36. Since this site is not conducive to 2N, perhaps a good solution would be N + 1.

- Doug R. wants 1N
- KU ITS prefers N + 1
- Doug Friedel (DF) suggested the new power be designed for N + 1 but with alternates for an additional 50% capacity.

37. Power redundancy could be achieved by designing for N + 1 with a good generator as the +1.

- Plan for connection to generator.
- Generator location?

38. KU ITS desires a transformer with plenty of additional capacity.

- DF: Transformer probably would not be 2N; but could provide a transformer that has plenty of capacity with an option for a second transformer if required in the future.

39. The Ellsworth Annex facility must remain in operation with its essential missions. KU ITS indicated that in case of emergency, the Ellsworth Annex is a more essential facility than the Computer Services Facility.

40. The Fire Alarm system will be extended into addition. Fire suppression system not currently anticipated.

INFORMATION GATHERING

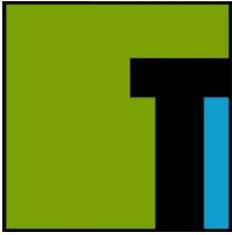
41. KU ITS and Facility Operations will provide information on the following:

- Power from gas
- Existing AC/DC systems
- Historical electrical usage/cost information – B & V just needs power requirements.
- Phone switch and gear – What is feeding what?
- Equipment layout showing the existing racks, etc.
- Will probably take 2 weeks to gather this information.

42. KU DCM will provide a Site Plan showing current locations of utilities, or a link to the campus map that shows that information.

43. A/E will respond with a schedule for completing the study.

Notes by Bob Fincham, Tevis Architects.



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October 29, 2010

**THE UNIVERSITY OF KANSAS
ELLSWORTH ANNEX HVAC IMPROVEMENTS STUDY
KU PROJECT #089A-9226**

WORKSHOP MEETING NOTES

Date/Time of Meeting: October 27, 2010/1:00 p.m.

Refer to attached Attendance Roster for attendees.

MEETING NOTES:

ELECTRICAL SYSTEM

1. Critical Electrical Load (Current/Future.)
 - The future critical electrical load estimate is “driving” the electrical system design.
 - The assumed critical load needs to be reviewed and confirmed.
2. Electrical load calculations/assumptions were reviewed.
 - The Power Utilization Efficiency (PUE) is assumed to be 2.0.
 - The historical data provided to engineer by KU was reviewed.
 - Current electrical capacity appears to be approximately twice that used (based on 240 KW maximum usable – without safety factor).
 - Data provided by KU accounted for future equipment based on best known information.
 - The new phone equipment will be fairly dense.
 - DAS equipment will be comprised of four to 12 racks.
3. The concept for the 480 V. electrical supply was reviewed.
 - Reviewed the One-Line Diagram.
 - It was agreed that the 480 V. UPS is the most efficient way to proceed, based on a 480 V. – 1200 Amp. panel.
 - Installation of phone switches will begin in approximately 18 months. Staff will be moved out of building in approximately three years.
 - DAS Panel will provide power only without UPS capacity.
 - DAS equipment requires approximately 20 tons of cooling.
 - It was agreed to base the Study Design on a 480 V. – 1000 KVA system, based on current requirements. The existing 208 V. system will be back-fed with a step-down transformer.

4. Separate metering was discussed.
 - It is believed that separate metering could be accomplished.
 - However, it was agreed that perhaps a better method would be to back charge the DAS with a flat rate based on electrical usage calculations.
 - A separate breaker will be provided for the DAS System. They will provide their own step-down transformer for any 208 V. needs.
5. It was agreed that, based on information gathered and presented, a meeting with Westar representatives would be effective.

MECHANICAL SYSTEM

6. Mechanical equipment calculations and assumptions were reviewed.
7. Different cooling systems were discussed.
 - Proposed systems should capture the heat as close to the source as practical. There are various products in the market to accomplish this. Adding a drop ceiling was ruled out because of the existing web of cable tray.
 - Split system versus a packaged air cooled chiller system on exterior: It was noted by B&V that the difference in noise was about 1 dB between the two system types. KU prefers the indoor chiller/compressor.
 - Glycol system versus chilled water system: KU prefers the Chilled Water system.
 - It was agreed to proceed with Mechanical design for this study based on a DX type split system with the chillers/compressors inside the building addition with pad mounted air cooled condensing units on exterior.
8. Economizer solutions discussed.
 - Air versus water: Air type economizer systems tend to require more space for duct and louvers. Also they require good and well maintained filtering systems to keep dust out of the IT equipment. Drawing more outside air into the building may require a larger humidification system.
 - KU IT needs to provide parameters that may be effected by warrantees.
 - KU IT stated that they defer to ASHRAE Standards. Though the equipment vendors will allow a larger environmental range; this table shows the recommended operating envelope for Class 1 and 2 data center types based on the 2008 ASHRAE Environmental Guidelines for Datacom Equipment:

Parameter	Recommended
Low-end Temperature	64.4°F
High-end Temperature	80.6°F
Low-end Moisture	41.9°F Dew Point
High-end Moisture	60% RH & 59°F Dew Point

- Outdoor Ambient Design Temperatures from 2009 ASHRAE Fundamentals Handbook for Lawrence, Kansas:

Parameter	Recommended
Cooling Design Outdoor Temperature at 0.4% percentile	99.1°F DB / 76.9°F MCWB
Heating Design Outdoor Temperature at 99.6% percentile	5.1°F DB

- Report will include provisions for adding an economizer to the proposed system. Likely a dry cooler with a heat exchanger to make chilled water when outdoor ambient conditions are favorable.

- A/E will review KU Standards and include in report.
9. Will In-Rack cooling be considered?
 - KU preference is for ducted cooling. But provide flexibility for future in-row cooling.
 10. CRAC units will still be considered and could be added in the future if needed.
 11. The old DNS in the Tech Area is failing. Duct over.
 12. T-stat locations. Provide comfort cooling. Consider VAV boxes in Staff Area.
 13. How will heating be provided if it is required? Will it be provided with re-heat? Heating will be provide in the VAV boxes where needed as well as reheat in the Makeup Air Unit.
 14. How will humidity be kept within parameters?
 - Controlled separately with a dedicated 100% outside air Makeup Air Unit and humidification system designed with appropriate freeze protection.
 - Needs good monitoring system.
 15. The mechanical system will maintain the facility in positive pressure.

BUILDING ADDITION

16. The Floor Plans, Site Plan and Elevations were reviewed.
 - The mechanical system is determining the size of the addition.
 - The mechanical system is on the Upper Level and the electrical system is in the Lower Level.
 - This arrangement has allowed the addition to be configured to avoid relocating the sanitary sewer manhole to the north, and the Westar underground electrical line that angles down and across from the northwest to the southeast.
 - Options for egress from the basement were discussed. It was agreed to retain the northwest stair out of the Lower Level.
 - Doug Riat asked the question regarding the need to stand off from the crawl space portion of the existing structure due to shallow foundations.
 - It was indicated that current interpretation of the drawings of the existing facility indicate that the crawl space footings are at the same elevation as the Basement footings.
 - However, it has since been determined (after additional review) that the crawl space footings are shallow, which will require that the west portion of the Lower Level addition be separated from the existing footings to maintain their stability.

GENERAL DISCUSSION

17. Consider future dual UPS.
18. This is a Class III Communication Facility.
19. The existing Mechanical Room will revert to storage upon completion of new Mechanical Room.

SCHEDULE

20. The A/E Team will complete this Study based on the following schedule:
 - Opinion of Probable Cost – Preliminary cost range on 10/29.
 - Draft Report by 11/5.
 - Final Report by 11/12.
 - Plan on making short presentation of Final Report after completion.

Notes by Bob Fincham, Tevis Architects.

