Priority: High priority should be given to energy efficiency and sustainability in all aspects of the design of ATU facilities.

Life Cycle Cost: Each design decision that significantly affects long-term energy use shall be based on a life cycle cost (LCC) analysis incorporating construction, energy and operating and maintenance costs.

Energy Efficient Equipment: The use of *EPA ENERGY STAR* labeled equipment is encouraged where applicable. For categories of equipment not included in the *ENERGY STAR* program, selection of highly-energy efficient equipment is encouraged.

Central Utilities: Central utility systems typically operate with greater energy efficiency than do building level systems. Thus, HVAC systems should utilize central distributed chilled water, steam and electricity when these utilities are available.

Central HVAC Systems: Buildings should be served by a small number of larger central HVAC systems rather than numerous smaller systems (i.e., less than 5,000 CFM) or individual units such as fan coil units, window air conditioning units or "split systems". The installation of a smaller number of larger central systems provides more opportunity for the application of energy conserving features and control strategies.

Energy Management System: All new major HVAC equipment shall utilize ATU's Building Automation System (BAS) Tridium as the primary means of control unless otherwise directed by ATU. Exceptions include stand-alone equipment and other specialized equipment.

Utility Metering: Automatic metering for electricity, chilled water, steam, natural gas, and water shall be installed in all new construction and renovations. See the *Utility Metering* narrative within these *Design Guidelines* for details.

Outdoor Air: Conditioning ventilation air is the most significant energy load on campus, so exhaust and associated outdoor-air makeup airflow should be minimized. Fume hoods and other equipment that require large quantities of exhaust and makeup air should be installed with discretion and restraint. Outdoor air quantities for ventilation should meet but not exceed the requirements of *ASHRAE Standard 62* at all load conditions. Consideration should be given to system designs and control strategies that reduce outdoor air required for ventilation during periods of reduced occupancy without violating the requirements of *ASHRAE Standard 62*. Demand control ventilation, occupancy sensors, scheduling, temperature/humidity resets and similar strategies should be employed to conserve energy while satisfying space requirements. Dedicated outdoor air units in conjunction with dual-path AHUs should be used as appropriate to condition return air separately from outdoor air.

Exhaust Air Systems: Exhaust air systems shall meet or exceed *ASHRAE Standard 90.1* requirements for energy recovery. Where possible, a total energy (sensible plus latent) recovery system should be employed. Strategies that allow exhaust air systems to be operated at reduced capacity or turned off altogether during periods of non-use or reduced demand should be employed. Consideration should be given to variable volume fume exhaust systems and other variable flow exhaust systems. General exhaust (GEX) and hood exhaust (HEX) valves should be carefully sized to provide accurate flow control and feedback to the Building Automation System (BAS).

Fans / Ductwork: Fan energy consumption should be minimized by selecting the most efficient fan type(s) and size(s) for each application. Ductwork should be carefully designed to minimize pressure drop and system-effect losses. In many cases, arrays of smaller fans are preferred due to their smaller footprint, flexibility, and ease of maintenance.

VAV Systems: In general, air distribution systems larger than 5,000 CFM shall be variable air volume (VAV) utilizing a variable frequency drive (VFD) to control fan motor speed. VAV systems reduce fan energy consumption while minimizing simultaneous cooling and heating of distributed air. Each room shall be considered a separate thermal zone, with individual thermostat connected to the BAS. Integration of occupancy sensors to allow VAV boxes to close during unoccupied periods is encouraged. VAV boxes should be properly sized to provide accurate flow control and feedback to the BAS.

Other Systems: Displacement ventilation systems should be considered. Appropriate applications include large lecture halls, sizable classrooms, and atria.

Air Side Economizers: Air side economizers or dedicated outdoor air systems with energy recovery, should be provided.

Pumps / Hydronic Systems: Pump energy consumption should be minimized by careful selection of the most efficient pump type(s) and size(s) for each application. Piping and hydronic system components should be sized and configured to minimize the total pressure requirement at pump(s). Variable frequency drives (VFD) should be provided for pump motors of 5 HP or greater.

Variable Flow Hydronic Systems: Closed loop hydronic secondary/distribution systems, both heating and cooling, shall be variable flow systems with two-way control valves. A final three-way valve or bypass valve may be provided to prevent deadheading at low loads. Circuit setters should be considered to maintain system flow balance over varying pressure conditions. Reverse return systems should be considered where feasible.

Cooling Equipment: Cooling equipment shall be selected with efficiencies that meet or exceed minimum values listed in *ASHRAE Standard 90.1*.

Heating Equipment: Heating equipment shall be selected with efficiencies that meet or exceed minimum values listed in *ASHRAE Standard 90.1.*

Electric Heating: Electric-resistance heating should be avoided. Electric heat may be provided as an integral component within specialized packaged HVAC units (e.g., Liebert CRAC unit) when needed to provide tight humidity control.

Specialty Heating Systems: Sidewalk and/or entryway snow melting systems should not be installed. Similarly, roof, gutter and/or downspout ice melting systems are not allowed.

Humidification: Humidification should be limited to systems serving only humidity-sensitive spaces, and those spaces should be surrounded by a continuous, sealed vapor barrier.

Domestic Hot Water Systems: Opportunities to reduce energy usage for domestic hot water systems are encouraged. The use of solar thermal heating should be considered. The use of steam condensate or other waste heat sources to preheat domestic hot water should also be considered. For small DHW loads, electric resistance heating may provide the lowest LCC. Point-source heaters should be considered for isolated loads.

Solar
Solar panels should be integrated into the buildings design to help reduce the building's electrical load.

Interior & Exterior Lighting: Interior and exterior lighting energy consumption should be minimized while providing adequate light level and control. General strategies shall include the use of efficient fixtures and layouts to reduce the total lighting power density below the maximum requirements specified by *ASHRAE Standard 90.1*. Use of dimmable LED systems is encouraged. Rooms with multiple workspaces should be provided with occupancy sensors. Multi-level switching and daylighting techniques should also be utilized as appropriate. See the *Lighting* section within these *Design Guidelines* for additional information. In rooms that are used primarily for computer monitors, and even general offices, consider reducing the ambient lighting and providing task lights at workstations.

Natural Lighting: Full advantage should be taken of opportunities to provide natural lighting. However, full compliance with the *ASHRAE Standard 90.1* shall not be sacrificed in the process. Daylighting strategies should incorporate opportunities to reduce artificial lighting during periods of adequate natural lighting.

Transformers: Transformers shall be rated NEMA TP-1 for energy efficiency.

Motors: Electric motors shall be of the manufacturer's high-efficiency design with a minimum efficiency of 92%. Motors shall be sized to be loaded to at least 75% of rated horsepower when driving equipment at full load conditions and shall be inverter-rated.

Public Entrances: High-use public entrances should include vestibules or revolving doors. These improve occupant comfort and reduce infiltration.

Exterior Glazing: Large expanses of exterior glazing, particularly on building faces exposed to the most solar gain (e.g., south, east, and west exposures) should be avoided to minimize summer heat gain and winter heat loss, except when justified by the LCC analysis. The use of multipane, "Low-E" exterior glazing is encouraged for energy conservation as well as occupant comfort. Fenestration U-value should be minimized within boundaries supported by LCC analysis, with requirements of *ASHRAE Standard 90.1* establishing the maximum allowable value. Treatments and architectural features that reduce solar heat gain, including awnings, blinds, and shades should be considered.

Envelope Insulation and Exfiltration: Envelope insulation shall meet or exceed requirements of *ASHRAE Standard 90.1* and those identified elsewhere within these Standards, whichever is more stringent. The judicious use of insulation can also reduce the size of mechanical equipment. Roofs should be vegetative or high-reflectance type. In general, UNL buildings should be designed to operate at a slight positive pressure relative to outdoor air. Design and implementation methods that tighten the building and reduce exfiltration are highly encouraged.

Water Conservation: Reduced-flow fixtures should be utilized to reduce water use while still meeting performance needs. However, waterless plumbing fixtures are not encouraged. Projects shall achieve a minimum 30% reduction from the baseline prescribed by *LEED 2009 for New Construction and Major Renovations*. Fixtures should meet or exceed *EPA WaterSense* program requirements.

UTILITY METERING

Summary

Applicability: Each utility must be metered at each building. ATU buildings may use utilities provided from the central campus utility systems, municipal providers, or a combination of the two. All meters must be connected to the ATU Tridium BAS via BACnet. All graphics and pages will also be provided and programmed into the system. ATU will be provided with the BACnet signal list with descriptors on what each signal represents.

Applicable Utilities: For purposes of these Guidelines, “utilities” include electricity, steam and/or steam condensate, chilled water, natural gas and potable water. In some situations, a building may use heating water produced in a different ATU building, and that too shall be metered according to this section. Where landscape irrigation systems are served from a building potable water system, a deduct water submeter is required.

Submeters: Some ATU buildings serve spaces occupied by separate administrative units or even non-ATU entities. In those cases, submeters must be provided to correctly apportion utility costs among the various entities. Submeters may also be required as part of LEED certification, or to separate intended uses (e.g.: potable water vs. irrigation).

Sizing, Design, and Installation: The AE determines design loads for each utility and provides that information to the utility provider which will be a municipal utility, which then selects the meter(s), and provides the AE with that selection information for final design. Meter costs are included in the total project construction costs.

Details

General Requirement: Each utility shall be metered at each building or facility. When electricity is provided to the building at several voltages, each voltage is considered a separate utility requiring its own meter.

Meter Location, Number and Type

- *Building with no Auxiliary Enterprise*: There shall be a single meter at the service entrance of each utility serving the building.
- *Building Housing Auxiliary Enterprises*: A separate meter shall be installed for each utility serving each enterprise, as well as meters for each utility serving any non-auxiliary enterprise portion of the building. When specifically permitted by ATU, the entire building may be metered by master meters for each utility, with individual meters for each auxiliary enterprise serving as deduct submeters.
- *Submeters*: ATU may require submeters for utilities that serve specific portions of a building or specific purposes within a building. Such direction be provided at or before the schematic design stage.
- *Meter Accessibility*: Each meter shall be located and oriented so that it can be read by a person standing on the floor. Make sure that all parts of the meter are accessible for connection, adjustment, calibration, and repair.

Meter Selection and Provision: Each meter be selected by the utility provider. When buildings are served directly from a municipal electric, water or natural gas provider, their design procedures shall be followed.

Meter Outputs. Each meter shall have a local display showing instantaneous and/or total values in digital form. In addition, each meter shall be connected to the ATU Tridium Building Automation System (BAS). Meter outputs are transmitted to the BAS using low-voltage analog signals, switch (pulse) closures or digitally, depending on the meter. In some cases, low-voltage AC or DC power to the meter may also be transmitted in the same cables or the same conduit.

Connection to BAS. The 95% drawings shall include continuous conduit paths from each meter connection point to the ATU Tridium BAS. When possible, meters provided by a municipal utility shall include a connection for use by the BAS. If this is not possible, then an additional meter, selected by ATU, shall be installed to provide that connection.

Electric Meters

(1) General Requirements:

a. Meter socket will be provided as part of the Project.
b. For all electrical services provide a 20-amp rated, instrument transformer type meter socket with integral test switch and with current transformers.
c. Meter sockets shall be installed outside of the building. It is ATU preference that the meter socket be installed directly onto the service transformer enclosure. Where not possible to install onto the transformer, meter socket shall be mounted on the building exterior and a CT cabinet shall be provided.
d. Panel Mounted Meter: In addition to the main electric meter described above, the Project shall provide a second meter integral to the building main distribution panel, switchboard, or switchgear.

Natural Gas Meters

Building Served by Municipal Natural Gas Utility Provider: ATU obtain an output signal from the municipal meter. Install a 4”x4” weatherproof box within 36” of the municipal meter location. A reliable switch closure signal, scaled to a specific gas volume, is required. Generally, this requires a rotary meter. If a diaphragm meter is selected, the pulse must be generated by an electronic register intended for that purpose.

Thermal (BTU) Meters for Chilled and Heating Water

Flow Meter, meter loop: The meter shall be installed in a separate pipe loop, parallel to the supply, as near the building service entrance as possible and ahead of any branches. Provide manual valves (normally open) to isolate the meter loop at both ends, and a bypass valve (normally closed) in the supply main parallel to the meter.

Flow Meter, diameter: Design for a fluid velocity between 15 and 25 ft/sec at the metering point under full flow conditions. This may require reducing the pipe diameter in the meter loop.

Flow Meter, straight pipe: The meter loop shall provide straight, unobstructed pipe for at least 10 pipe diameters upstream and 5 pipe diameters downstream of the meter.

Temperature Sensors: Install a pair of RTD thermowells for temperature measurement in the supply and another pair in the return pipe. Locate these as near the building service entrance and exit as possible. RTD wells are 4" long and installed in ½" thread-o-lets or tees.

Pressure Sensors: Install ½" pipe taps with ball valves, located as near the building service entrance and exit as possible, for installation of pressure sensors.

Note the conduit path to the Tridium BAS must be sized large enough to carry low-voltage output signals from the flow meter, three temperature sensors, two pressure sensors, and low-voltage power supply to the flow meter.

Steam Meters

Steam Meter, general: Metering of live steam is usually not required except when processes within the building utilize steam without returning it as condensate. ATU will determine, no later than design document stage, if steam metering is required. When required, the AE shall consult directly with ATU to determine the correct meter.

(Steam) Condensate Meters

Condensate Meter: This shall be installed downstream of all condensate receivers, and as near the building service exit as possible (after all branches have joined together). Design for the minimum meter size that exceeds the total capacity of the condensate pumps.

Flow Meter, meter loop: The meter shall be installed in a separate pipe loop, parallel to the condensate return, as near the building service exit as possible and after any branches. Provide manual valves (normally open) to isolate the meter loop at both ends, and a bypass valve (normally closed) in the return main parallel to the meter.

Flow Meter, straight run: Provide the same straight pipe and bypass requirements as for thermal meters (above). In addition, piping must be designed so the meter is always completely flooded. An extra check valve shall be provided at the beginning of the straight pipe to prevent backflow. Tees with full-port ball valves (capped) shall be provided at both ends of the straight pipe for calibration purposes.

Potable Water Meters

Water Meter: This shall be installed as near as possible to the building service entrance, after the backflow preventers but before any unmetered takeoffs. Isolation valves (normally open) shall be provided both upstream and downstream.

Submeters: When there are significant water uses which do not return water to the sanitary sewer system (such as irrigation or process use), additional deduct sub meters be required at the point(s) of service. ATU will determine whether and where these additional water meters are required no later than design document stage.

Fire Service: A separate meter is not required.