Codes and Standards: See *Codes, Standards and Regulations* section within these *Design Standards.*

Construction Specifications: Many mechanical specifications have already be written and posted in the *Design Standards.* This is not an all-encompassing set for all projects, they are meant to be a direct copy set to start with most specs applying to a 'typical' project. That's not to say some specs may need to be editing for a given project, or that additional sections may be needed.

Energy Conservation: See the *Energy Conservation* section within these *Design Standards* for specific HVAC requirements related to energy conservation.

ASHRAE: HVAC system design not addressed within these *Design Standards* shall be in accordance with recommendations of the latest version of *ASHRAE Handbook – HVAC Applications.*

Climatic Design Conditions: Climatic design conditions for HVAC systems shall be as published within the latest version of the *ASHRAE Handbook – Fundamentals.*

UNL
Lincoln Municipal Airport (interpolate to nearest stations for any outstate facilities). Values from 2009 ASHRAE Handbook are listed below.

Heating (10 year return period for minimum extreme dry bulb)
Heating DB: -20 Deg F

Humidification (99.6% annual cumulative frequency of occurrence)
Dew Point: -13.7 Deg F
Humidity Ratio: 2.7 Grains / Lbm DA
Mean Coincident Dry Bulb: -4.2 Deg F

Cooling (0.4% annual cumulative frequency of occurrence)
Cooling DB: 97.2 Deg F
Mean Coincident Wet Bulb: 75.1 Deg F

Dehumidification (0.4% annual cumulative frequency of occurrence)
Dew Point: 74.8 Deg F
Humidity Ratio: 136.1 Grains / Lbm DA
Mean Coincident Dry Bulb: 85.1 Deg F

UNK and UNO
Consult with NU FPC Engineering

Indoor Design Conditions, Occupied: Default indoor design conditions for HVAC systems that serve standard occupied spaces:

Heating DB: 70 Degrees F
Cooling DB: 74 Degrees F / 50% RH

These conditions represent current NU system-wide room temperature occupant set point policies.

When a system that serves a standard building/space is provided with humidity control, the space humidity set point shall be limited as follows:

Heating: Not more than 30% RH
Cooling: Not less than 50% RH

Proposed indoor design conditions for occupied spaces other than the default values provided above will be considered on a project-by-project basis.

Non-Standard Spaces: Examples of non-standard spaces to which the indoor design conditions identified above do not apply are library archival storage, musical instrument storage, museums, clean rooms, animal facilities, and data centers. In order to maintain space temperature and humidity outside standard design limits specialized HVAC equipment and/or special building construction is required. (See the *Doors & Windows, Glazing* and *Walls, Partitions* sections within these Design Standards.)

Occupied / Unoccupied: Systems shall be provided with adequate functionality and shall be zoned to support optimized occupied/unoccupied control sequences.

Central Utilities: HVAC systems shall typically utilize central distributed chilled water, central distributed steam and central distributed electricity whenever these utilities are available. Direction regarding the use of central utilities and specific design information shall be obtained from UNL FPCP.

Central HVAC Systems: The installation of a smaller number of larger systems typically results in higher equipment quality and reduced maintenance requirements while providing adequate opportunity for application of energy conserving features and control strategies. Therefore, a minimal number of central HVAC systems are preferred rather than numerous individual/package units such as fan coil units, heat pumps or DX “split systems”. Typically, each central system shall include an air handling unit, a return and/or exhaust fan or fans and air supply, return, exhaust ductwork.

HVAC Equipment Naming Conventions: The University has developed a standard naming convention for HVAC equipment identification and Building Automation System programming. Coordinate all HVAC equipment marks / callouts with NU FPCP Engineering.

Institutional Quality: HVAC equipment/systems shall be institutional grade as opposed to standard commercial grade. For the purposes of this writing, intuitional grade equipment/systems have minimum life expectancy of 25 years for dynamic system components such as motors, switches, pumps, valves, fans, dampers, compressors and burners, and a minimum life expectancy of 50 years for static system components such as casings, cabinets, ductwork and piping. Buildings will likely be around for 100 years, so attention shall be given to maintainability and ability for eventual individual replacement (adequate room, isolation valves, future tie-ins, etc.). Consideration shall be given to redundancy: the tradeoff of initial cost, vs. the consequences of the eventual component/system failure.

System Configuration: HVAC systems shall be configured such that spaces with similar usage are served by a common system. As much as possible, spaces with dissimilar usage types or schedules shall not be served by the same system. Areas that have special temperature and/or humidity requirements shall be served by dedicated systems. This allows the design of each system to be tailored to the specific needs of the areas being served. It also allows the implementation of specific control strategies (such as occupied/unoccupied modes and temperature resetting) for each system to conserve energy while satisfying the requirements of all of the spaces served by that system.

Future Requirements: Each HVAC system shall be sized and configured to accommodate anticipated/potential changes in loads, layout, etc. (within practical limitations) as the use of the areas served changes in the future. For any building main air handlers, this would typically mean some percentage (minimum 10%) of design airflow above the calculated building block-load. Identify the % oversizing in any narratives and equipment schedules for future reference.

Equipment Location and Access:

- See *Equipment Rooms, Mechanical* section within these *Design Standards*.
- Each piece of motorized HVAC equipment shall be located within a mechanical equipment room with the exception of roof mounted exhaust fans, window air conditioning units and specialized unitary equipment
- The installation of motorized HVAC equipment above finished ceilings is strongly discouraged (this includes suspended grid / drop-in tile ceilings). In no case shall any HVAC equipment such as fans, pumps, air terminal units, hand dampers, etc. shall be installed above a hard finished ceiling (e.g. sheet rock or plaster).
- The mechanical designer shall insure that adequate space provided for the service and removal of HVAC equipment (i.e., coil pull space, motor removal, etc.). All such service must be able to be accomplished without the removal / dismantling of any adjacent building systems including conduit, ductwork, walls, etc.
- All exterior equipment shall include permanent access to facilitate servicing.
- Provide access to both upstream and downstream sections of filters and coils for cleaning and inspection.
- In rooms without ceilings, all equipment requiring maintenance, calibration etc., shall be located within 12 ft. of finished floor. In rooms with ceilings, all equipment shall be located no higher than 2 ft. above the finished ceiling line.
- All serviceable equipment to have service clearances shown (hatched or dashed lines). This is especially important during programming or SD phases, as this can help reserve the necessary real estate in mechanical spaces. A 3' x 4' service cart will be used by BSM to service equipment, and mechanical rooms shall be designed to allow their passage. In addition, maintain 42" overall clearance from equipment along travel paths. Maintain 30" clearance between like equipment (pumps, tanks, etc.). These clearance must also take into account for connecting pipe (think end-suction pumps, buffer tanks, AHU coils). Show also VFD and electrical panel clearances.

Sound Control: Sound control as it relates HVAC systems shall be given adequate priority. The allowable HVAC-related background noise level for a given type of occupancy shall not exceed the guideline criteria provided in the chapter entitled *"Sound and Vibration Control"* in the *"*ASHRAE Handbook, HVAC Applications".

Vibration Control: Most floor-supported rotating HVAC equipment that is located within the lowest level of a building, with the exception of air distribution equipment and reciprocating equipment (e.g. air/refrigeration compressors and internal combustion engines) may be installed with no special provisions for vibration isolation. This equipment shall typically be "hard mounted" directly to a reinforced concrete housekeeping pad. In order to minimize vibration / sound transmissions through building piping systems, base mounted pump hook-ups should always include flexible pipe connectors. An exception to these general rules may be necessary in facilities where equipment that is especially vibration sensitive is located in close proximity to an equipment area. Rotating HVAC equipment that is supported from any ceiling or supported by any floor other than the lowest floor of the building shall be individually evaluated to determine if vibration isolation devices or inertia bases are needed to prevent unacceptable levels of vibration from being transmitted into the building structures.

Terminal Zoning: HVAC systems shall be configured such that each occupied space can be controlled as a separate zone with regard to temperature and/or airflow. In other words, a minimum of one terminal control unit (e.g. VAV unit with reheat coil, finned tube heating unit) shall be provided for each occupied space. Each occupied space shall have a minimum of one dedicated thermostat (or equivalent). Reception areas, lobbies, atriums and public assembly spaces shall be consider occupied spaces.

Chilled Beams: On new buildings and major HVAC renovations, use of chilled beams (passive and active) shall be considered/evaluated early in the project. Chilled beams do not necessarily require condensate capture ability. While chilled beams may be used in a particular building, chilled

beams without condensate capture ability shall not be used in spaces containing or adjacent to: exterior doors or operable windows, and areas of high humidity (showers/locker rooms, high physical activity). Chilled beam water loops shall have a minimum number of 3-way valves (or 2-way bypass, other design feature) to allow the loop temperature to be kept relatively constant (avoid temperature swings). Chilled beams shall be easily cleanable. Chilled beams with condensate capture ability shall have overflow alarm contacts.

Chilled beams shall be served by a water source separate from campus chilled water and would preferably utilize a plate and frame heat exchanger for the system but a shell and tube exchanger would be considered. This will help alleviate bacterial growth from stagnant water temperature and allow for a regulation of pressure within the system. Piping within a room or area should be served with a reverse return when served by a single control valve, this way the beams are self-balancing on the hydronic loop.

In systems with active chilled beams utilizing DOAS systems for ventilation air, the primary cooling coil provided with the DOAS unit shall be sized for outdoor air conditions of 100°F DB / 80°F WB to provide adequate latent cooling capacity in extreme conditions.

Control Systems: See the *HVAC Control and Building Automation Systems* section within these *Design Guidelines* for specific control system guidelines and requirements.

Backup Equipment: A 100% backup or duplex unit shall be provided for each critical piece of HVAC equipment that is vulnerable to failure. The determination of what is deemed “critical” and “vulnerable” shall be discussed with NU FPC engineering staff during project design.

Discouraged Equipment: The use of the following types of HVAC equipment/systems is discouraged:

1. Residential furnaces and air conditioning systems
2. Commercial grade “rooftop” units, similar packaged heating and/or cooling units
3. “Two-pipe” combination hydronic heating/cooling units/systems
4. Commercial or residential heat pumps. Exception: Ground-source heat pumps may be used with specific approval from NU FPC Engineering.
5. 3-way valves (would rather have two 2-way valves in lieu of a 3-way valve for better overall controllability)

Freeze Protection: Neither water, steam, nor condensate piping systems shall be installed in locations where they are vulnerable to freezing. Examples include: unheated spaces, within un-insulated building exterior walls or wall cavities, within exposed un-insulated overhangs, within exposed exterior walkways, etc.

Humidification: Humidification is costly, not only in terms of first cost but also in terms of maintenance and energy consumption. HVAC equipment/systems shall not incorporate space humidification unless the system uses 100% outside air or there are other programmatic requirements. Where practical, layout new AHU’s for a future addition of humidifier dispersion grid (typically 2-3’ upstream of the chilled water coil, as chilled water coil will catch any water droplet carryover). AHU sections that will house any future dispersion grid will need to have a floor drain in it as well.

When humidification is required it shall be provided by means of a steam-to-steam humidifier located at the applicable air handling unit. Makeup water to each humidifier shall be softened to reduce scaling and then further conditioned with reverse osmosis. Steam from the campus wide central steam distribution system shall not be used for direct injection humidification.

Animal Facilities: See the *Animal Facilities* section within these *Design Standards* for specific HVAC system requirements related to animal facilities.

Laboratories: See the *Laboratories, Chemical and Biological* and *Laboratory Ventilation Systems* sections within these *Design Standards* for specific HVAC system requirements related to these applications.

Temporary Use of Existing HVAC Equipment: The Construction Documents shall clearly describe the conditions, if any, that allow the use of existing equipment on remodeling projects. Use of existing equipment may benefit the Construction project but at the expense of the HVAC system. In general, construction remodeling projects shall not use existing HVAC equipment. Exceptions will require an approved Variance to these Standards with the identification of specific measures designed to protect the equipment.

Temporary Use of New Equipment during Construction: HVAC equipment shall not be used as temporary heating and cooling except by specific approval by the UNL FMP. Only after approval by the UNL FMP, the AE shall document the conditions by which HVAC equipment may be used during construction and clearly require the Contractor to implement measures to assure equipment will be like new when delivered to the Owner.

Renovations / Remodels: When designing a renovation or interior alteration project, the effect of any modification or increase in load on existing systems shall be considered. Heating or cooling shall not be diverted from an existing area to another area without analyzing the effect of such a decision. Because many existing buildings and their mechanical systems have been modified from the design shown on the original construction documents, testing and field verification of the system layout and performance are essential elements of the design process. NU staff personnel are willing and able to assist in this endeavor.

Drawing Review: When initially designing and reviewing drawings, try to see it thru general's and sub-contractor's eyes, and how are they going to take the job off. Make it obvious what they need to include in their bids.

Alternates: When designing projects, is good to have some ideas for 'easy' alternates