The following narrative pertains to UNL city and east campus buildings only (excluding campus housing). The design of HVAC Control and Building Automation Systems for UNL Housing or outstate buildings shall be coordinated with FP&CP Engineering on a project-by-project basis.

Building Automation Systems (BAS): A large percentage of UNL buildings are served by a campus wide Building Automation System (BAS). The campus BAS is developed, installed and maintained by in-house personnel. The system provides HVAC control, monitoring, alarming/paging, trending and user management.

BAS Integration: UNL's BAS has interface capabilities to BACnet/IP field gear. **All mechanical and electrical equipment that has communication protocol shall be BTL Certified**. Any integration of the BAS to other automation systems such as fire alarm, card access, security, lighting, refrigerant detection and elevator systems shall be coordinated with FP&CP Engineering and shall be limited to monitoring and alarming only.

BAS Design Documents: BAS system engineering drawings and schedules that would typically be provided by a control contractor are instead produced by UNL engineering personnel. UNL produced drawings and schedules shall be included by the A/E in their final bid documents.

BAS Operation Sequences: HVAC sequence of operation narratives for all HVAC and smoke evacuation systems shall be written by the A/E and included in the project specifications. Flow schematics for more complicated HVAC systems are also strongly encouraged.

BAS Approved Manufacturers: Currently, new installations of HVAC BAS are limited to software and hardware equipment developed and built or provided by UNL.

Any hardware not provided by UNL should be approved by FP&CP Engineering during the project design phase.

BAS Applications: At a minimum the following equipment and systems shall be integrated into the BAS.

1. Central Station Equipment: Includes air handling units and associated return/relief fans, chillers, chilled water pumps, cooling towers, condenser water pumps, chilled water BTU metering stations, boilers, heat exchangers, hot water pumps, hydronic filtering stations, steam condensate return units, sewage ejectors, sump pumps and domestic water booster stations.
2. Exhaust Fans: Includes toilet exhaust, general exhaust, and laboratory exhaust and equipment room ventilation fans.
3. Terminal Units: Includes VAV boxes, reheat coils, and perimeter heating units.
4. Room Pressurization Controls: Monitoring and control of room airflows, fume hoods, relative room pressurization, etc.
5. Hydronic System Control: Control of pump speed and monitoring of system fill pressure.
6. Metering Equipment: Includes meters for domestic water, natural gas, steam condensate, chilled water and electrical services.
7. Steam / Chilled Water Utility Service Entrance Devices and Sensors: Includes temperature and pressure sensors as well as pressure and flow control valves.

BAS Panel / Device Installation: Space for UNL BAS panels and devices shall be noted on enlarged mechanical equipment room plans. Wall locations are preferred, although locations that require free-standing panels are also allowed if wall space is not available.

BAS equipment should be located in rooms where ambient temperatures are in the range of 50-90 Deg F are maintained.

Provide adequate clearance so that BAS panel doors can be fully opened without obstruction.

Provide supplementary lighting above all BAS panels and VFD's

BAS Power: BAS controllers and system components shall be fed from dedicated circuits separate from non-BAS equipment or devices. BAS controllers and system components shall be powered from emergency panels.

Electrical receptacles should be provided adjacent to all BAS panels for power service tools.

Non-BAS Control Circuits: Any non-BAS control circuit associated with a piece of equipment shall be no greater than 120 V. It shall be configured such that it is active only when the equipment it serves is active.

Safety Control Devices: Each safety control device, such as a freeze protection thermostat, a high or low pressure safety switch, shall be hard-wired into the safety circuit (typically of the motor starter or VFD) that serves the associated piece of equipment by way of a BAS interface circuit. Safety devices shall be installed and wired such that system safeties remain functional even when the BAS is non-functional.

Pneumatic Controls: The use of pneumatic controls and devices is discouraged. The use of any new pneumatic control components shall be approved by FP&CP Engineering. If pneumatic controls are required, a dedicated control air compressor unit shall be installed. Each air compressor unit shall be a duplex unit sized to maintain adequate control air capacity with neither compressor running more than 33% of the time. Air filters, air dryer and other specialties shall be provided at each compressor unit installation.

Control Valves and Dampers: Control valves and dampers, with the exception of internal air handler and fire dampers are typically provided by UNL and installed by the contractor (see *Building Technology Coordination Schedule*). Exceptions do exist when such valves and dampers are provided as part of HVAC equipment (e.g., motorized backdraft damper provided with exhaust fan). Control valves to be Delta P.

The A/E is responsible for properly delineating all required valves and dampers on the drawings.

Actuators for Control Components: UNL provides and installs electric actuators for all **UNL** provided dampers and valves. Dampers and valves that are provided as part of a scheduled piece of HVAC equipment shall be provided with an integral actuator.

Instrumentation and Control Devices for HVAC: The University utilizes instrumentation with distributed direct digital control (DDC) capability and with electric/electronic actuation on all new control devices. Such equipment is typically provided and installed by UNL.

Variable Frequency Drives (VFD's): UNL makes extensive use of Variable Frequency Drives (VFD's) to conserve energy. Typical applications include motors for pumps, air handling unit fans, and chillers, etc. VFD's are typically provided by UNL and installed by the contractor. Any 3-phase motors to be NEMA MG1, Part 31.4.4.2 (1,600V) rated motors **All motors that are intended to be operated with VFD's need to be scheduled / specified with Helwig (No Equivalent) shaft grounding kits.** It is important to know this upfront, as not every motor can accept a Helwig kit, and may make sense to specify a pump/fan that you know does. Baldor Super-E motors have can be factory shipped with re-branded Helwig kits, and are Part 31 compliant.

Generally speaking, it is good to locate VFD's as close as possible to the actual motors. Three reasons to do this:

- the shorter the distance, the lower amount of voltage spikes which can cause bearing currents
- the shorter the distance, the higher the carrier frequency that can be safely used
- the symmetrical/shielded cable is 'expensive' @ $4/ft